M.Sc. in Mathematics

PROGRAME’S OUTCOMES (PO’S POINTS):

The PG Student’s will be able to:

PO 1: Scientific knowledge: Apply the knowledge of basic mathematical fundamentals for the solution of scientific problems.

PO 2: Problem analysis: Identify and solve scientific problems using mathematical skills.

PO 3: Design/development of solutions: Select, design and apply appropriate computational techniques to solve and models physical problems.

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern tool usage: Learn, select and apply appropriate methods and procedures, resources and computing tool such as Excel, MATLAB, MATHEMATICA etc with an understanding of the limitations.

PO 6: Social Interaction: Implement ethical principles and responsibilities of a mathematician to serve the society.

PO 7: Environment and Sustainability: Apply and improve the mathematical modeling to predict the effect of environment changes and contribute to the sustainable development.

PO 8: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO 9: Individual and team work: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.

PO 10: Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

PO 11: Project management and finance: Demonstrate scientific knowledge with the understanding of the management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context research, scientific and technological change.

PROGRAM SPECIFIC OUTCOMES (PSO):

After completion of the M. Sc. Mathematics program, the students should be able:

PSO-1: Understand the mathematical concepts and applications in the field of algebra, analysis, geometry, computational techniques, optimization, differential equations, Social Networking, engineering, finance and actuarial science.

PSO-2: Handle the advanced techniques in algebra, analysis, geometry, computational techniques, optimization, differential equations, engineering, finance and actuarial science to analyze and design algorithms solving variety of problems related to real life problems.

PSO-3: Adopt changing scientific environment in the process of sustainable development by using mathematical tools.

PSO-4: Have necessary skills and expertise in the field of research and developments through seminar and dissertation.

GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR

DEPARTMENT OF MATHEMATICS

COURSE STRUCTURE & SYLLABUS - M.Sc. in Mathematics

Semester	Course Name	Course code	Course	Credit Hours
I	Core	AMPATT1	Abstract Algebra	05
		AMPATT2	Topology	05
		AMPATT3	Discrete Mathematical Structures	05
		AMPATT4	Geometry of Manifolds	05
	Open Elective (OE)	AMPATO1	Applications of Fuzzy Sets & Fuzzy Logic	05
II	Core	AMPBTT1	Real Analysis	05
		AMPBTT2	Numerical Analysis	05
	DSE (Any Two)	AMPBTD1	Coding Theory	05
		AMPBTD2	Finsler Geometry	05
		AMPBTD3	Fluid Mechanics	05
		AMPBTD4	Mathematical Methods of Applied Mathematics	05
		AMPBTD5	Mathematical Statistics	05
		AMPBTD6	Riemannian Manifold and connections	05
		AMPBTD7	Fractional Calculus and Integral Transforms	05
	Research Methodology	AMUBTT3	Research Methodology	02
III	(Core)	AMPCTT1	Functional Analysis	05
		AMPCTT2	Theory of ordinary differential equations	05
	DSE (Any Two)	AMPCTD1	Algebraic Topology	05
		AMPCTD2	Complex Manifold	05
		AMPCTD3	Difference Equations	05
		AMPCTD4	Fuzzy Sets and Fuzzy Logic	05
		AMPCTD5	Information Theory and its Applications	05
		AMPCTD6	Integral Equations	05

		AMPCTD7	Multipoint Iterative Methods	05
		AMPCTD8	Fundamentals of Elasticity	05
		AMPCTD9	Advanced Numerical Analysis	05
	Project	AMPCPF1	Project Phase-I	05
IV	**Core**	AMPDTT1	Complex Analysis	05
		AMPDTT2	Theory of partial differential equations	05
	DSE (Any Two)	AMPDTD1	Advanced Differential Equations	05
		AMPDTD2	Advanced Functional Analysis	05
		AMPDTD3	Applications of Fuzzy Logic	05
		AMPDTD4	Ring and Category of Modules	05
		AMPDTD5	Cryptography	05
		AMPDTD6	Financial Mathematics and its Applications	05
		AMPDTD7	Mathematical Ecology	05
		AMPDTD8	Operations Research	05
		AMPDTD9	Theory of Relativity	05
		AMPDTD10	Fundamentals of theoretical Seismology	05
	Project	AMPDPF1	Project Phase-II	05

M.Sc. I YEAR I SEMESTER SCHEME

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPATT1	4	1	-	5 hours	30	70	100	5

ABSTRACT ALGEBRA

Course Objective: The objective of this course is

1. To learn the basic concepts of various type of Module with their algebraic features.
2. To study Smith normal forms and Jordan canonical forms over PID.
3. To enhance the ability among the students to understand the concepts of algebraic structures field with their advance features with various kind of extensions.
4. To give idea about Galois Theory with Applications.
5. To discuss about the algebra of linear transformations.

Syllabus Content:

Unit-1. Solvable, Nilpotient Group and Modules

Normal and Subnormal series, Composition series, Jordan -Holder theorem, Solvable groups, Nilpotent groups, Modules, Sub modules, Quotient modules, Direct sums, Modules generated by a subset, Cyclic module, Homomorphism of modules, Isomorphism theorems, Exact sequences of modules, Simples modules, Schur's lemma, Free modules, Nilpotent and nil ideals, Noetherian and Artinian modules and rings, $\mathrm{Hom}_r(\oplus M_i, \oplus M_i)$, Hilbert Basis Theorem, Wedderburn Artin Theorem.

Unit-2. Normal Forms over PID

Smith normal form over a PID and rank, Fundamental structure theorem for finitely generated modules over a PID and its applications.

Unit-3. Field Extensions

Field Theory**,** Extension fields, Algebraic and Transcendental extensions, Separable and inseparable extensions, Normal extensions, Perfect Fields, Finite Fields, Primitive elements, algebraically closed field.

Unit-4. Galois Theory

Galois Extension, Fundamental theorem of Galois Theory, Applications of Galois theory to classical problems.

Unit-5. Algebra of Linear transformations

Characteristic roots and matrices for linear transformations, Canonical forms - Similarity of linear transformation, Invariant subspaces, Reduction of triangular form, Nilpotent transformation, Index of Nilpotency, Invariants of a nilpotent transformation, The Primary Decomposition Theorem, Jordan blocks and Jordan forms

Text Books:

1. I. N. Herstein, Topics in Algebra, Wiely Eastern Ltd. New Delhi (1975).
2. P. B. Bhattacharya, S. K. Jain and S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, IInd Edition Cambridge University, Press Indian Edition.

Reference Books:

1. S. Lang, Algebra, Edition- Wisely.
2. M. Artin, Algebra, Prentice Hall of India, 1991.
3. N. Jacobson, Basic Algebra, Vol. I. II & III Hindustan Publishing Company.
4. D. S. Malik, J. N. Morderson & M. K. Sen, Fundamentals of Abstract Algebra, McGraw Hill International Edition 1997.

Course Outcomes: Students will be able to understand after the completions of the course:

1. To understand basic and comparisons with distinct algebraic structure along with their features that is. module, solvable and nilpotent groups, nilpotent and nil ideals, modules with isomorphism theorems. Also able to understand the research work written on noetherian and artinian modules for further investigation.
2. To build up Smith normal form and Jordan canonical form over PID.
3. To describe field theory with various extensions.
4. To describe Galois Theory with application make it research article for further Degree Programms.
5. To describe the concepts of linear and nilpotent transformation, finitely generated modules over PID with its applications.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			1			3		3	2		3	3	3
CO2	3	2			1			3		3	2		3	3	3
CO3	3	2			1			3		3	2		3	3	3
CO4	3	2			1			3		3	2		3	3	3
CO5	3	2			1			3		3	2		3	3	3

Weightage : 1 – Sightly; 2 – Moderately; 3 - Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPATT2	4	1	-	5 hours	30	70	100	5

TOPOLOGY

Course Objectives:

1. To introduce the student to elementary properties of topological spaces and structures defined on them.
2. To introduce the student to maps between topological spaces.
3. To develop the student's ability to handle abstract ideas of Mathematics and Mathematical proofs.
4. They will learn about the concepts of continuity and convergence in a more general sense.
5. To Prove basic results about completeness, compactness, connectedness and convergence within these structures.

Syllabus Content:.

Geometry and topology, from geometry to metric spaces, topological spaces, basis, sub basis, order topology, subspace topology, closed sets, closure, interior, limit points, separable spaces.

Continuous functions and their characterization, comparison of topologies, weak topologies, sequential continuity, homeomorphism, topological property, constructing continuous functions, metric topology, quotient topology

Connected topological spaces, Path-connected topological spaces, continuity and connectedness, intermediate value theorem, components and path component of a topological space, local connectedness

Compact spaces, limit point compact spaces, sequentially compact spaces, continuity and compactness, extreme value theorem, uniform continuity theorem, local compactness, one point compactification.

Countability axioms, separation axioms, Hausdorff topological spaces, Regular topological spaces, Normal topological spaces, Urysohn lemma and Tietze extension theorem

Product topology and box topology, compactness and product topology, tube lemma, Tychonoff theorem, connectedness and product topology

Text Book:

1. James R. Munkres, Topology, A First Course, Prentice Hall of India Pvt. Ltd., New Delhi.

Reference Books:

1. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company.
2. K. D. Joshi, introduction to General topology, New Age International Pvt. Ltd. Publ.,

New Delhi.
3. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by Prentice Hall of India Pvt. Ltd).

Course outcomes: Upon successful completion of this course, the students will be able to

1. understand the interconnection of metric space and topological spaces.
2. generalize the mathematical concepts.
3. Understand elementary properties of topological spaces and structures defined on them.
4. construct maps between topological spaces.
5. Understand of the concepts of metric spaces and topological spaces, and their role in mathematics.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	POS02	PSO3	PSO4
CO1	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2
CO2	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2
CO3	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2
CO4	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2
CO5	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPATT3	4	1	-	5 hours	30	70	100	5

DISCRETE MATHEMATICAL STRUCTURES

Course Objective: This course aims to:

1. Focuses on the study of discrete structures and concepts, such as graphs, sets, logic, and algorithms. The course aims to develop students' critical thinking and problem-solving skills by exposing them to various mathematical structures and techniques used to analyze them.
2. Introduce students to fundamental concepts in discrete mathematics, such as propositional and predicate logic, set theory, graph theory, and combinatorics. These concepts provide the foundation for further study in computer science, mathematics, and related fields.
3. Help students understand the relevance and importance of Discrete Mathematics in these fields.
4. Improve students' ability to construct and write mathematical proofs using logic and mathematical reasoning.
5. Develop students' analytical and computational skills by providing opportunities to solve problems and apply mathematical techniques to real-world problems.

Unit 1: Mathematical Logic:

Statements, Connectives, Statement formulas, Truth tables, Tautologies, Equivalence and Implications, functionally complete set of connectives, Normal forms (Disjunctive and Conjunctive), Ordering of normal forms, Rules of Inference, Consistency of premises, Indirect method of Proof, Automatic theorem proving, Predicate calculus, statement functions, Quantification, Predicate formulas, Inference theory for predicate calculus.

Unit 2: Set Theory:

Basics of set theory, Relations, different types of binary relations, relation matrix and graph of a relation, Partition and covering of a set, Equivalence and compatibility relation, Partial ordering, Hasse-diagram, Characteristic functions of a set.

Unit 3: Combinatorics:

Basic of Counting’s, Permutations and Combinations, Enumeration of Permutations and Combinations, Principle of inclusion and exclusion, The pigeonhole principle, Generating Functions of Sequences, Calculating Coefficients of Generating Functions, Recurrence Relations, Solving Recurrence Relations by Substitution and Generating Functions, The Method of Characteristic Roots.

Unit 4: Lattices and Boolean algebra:

Lattices as Partially Ordered Sets and as Algebraic systems, Properties of Lattices, Sub-lattices, Lattice homomorphism, Modular and Distributive Lattices, Complements, Boolean Algebra, Boolean homomorphism, Boolean identities, Stone

Representation Theorem for finite Boolean Algebras (statement only), Boolean Functions and products, Free Boolean Algebras, Relationship with Statement Logic, Karnaugh Map.

Unit 5: Graph Theory:

Fundamental concepts of graphs and digraphs, path, reachability and Connectedness, Eulerian and Hamiltonian graphs, shortest path problems, chromatic numbers and chromatic index, Matrix representation of Graph, Planarity of Graphs, Tree and their properties, Binary tree, Spanning tree.

Text Books:

1. J. P. Trembly and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Mc-Graw Hill Book Company, 1977.
2. Joe. L. Mott, Abraham Kandel, Theodore P. Baker, Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 2008.

Reference Books:

1. Kolman, Busby and Ross, Discrete Mathematical Structures, Prentice Hall Publication, New Jersey, USA.
2. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India.
3. HalukBingol, Discrete Mathematics.
4. Preparata and Yeh: Discrete Mathematical Structures.

Course Outcomes: Students will be able to:

1. Learn about partially ordered sets, lattices and their types.
2. Understand the notion of order and maps between partially ordered sets.
3. Solve real-life problems using finite-state and Turing machines.
4. Assimilate various graph theoretic concepts and familiarize with their applications.
5. Minimize a Boolean polynomial and apply Boolean algebra techniques to decode switching circuits.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	2	1				1	1	1	2	2	2	3
CO2	3	2	2	1	2	1			1	2	1	2	2	2	2	3
CO3	3	2	2	1	2	2			1	2	2	2	2	3	2	2
CO4	3	2	2	3	2	2			2	3	1	1	3	2	2	3
CO5	3	2	2	2	2	2			2	3	2	2	3	3	2	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPATT4	4	1	-	5 hours	30	70	100	5

GEOMETRY OF MANIFOLDS

Course objective:

1. To understand the basic concepts of Topological manifolds, smooth manifolds and differentiable structures defined on sets.
2. To learn linear Connection, Exterior Algebra, Exterior derivative
3. To understand the concept of Riemannian metric and Riemannian manifolds.
4. To analyze how topology, algebra and linear algebra involved in the study of Manifolds.
5. To study the application of manifold in different branches of Applied Sciences.

Syllabus Content:.

Manifolds: Topological manifolds smooth manifolds, Differentiable structures defined on sets, Differentiable functions on a manifold, Differentiable mapping from a manifold into another manifold.
Differentiable manifolds: smooth maps, chart, atlas, differentiable structure, Definition and examples of differentiable manifolds, differentials on smooth maps.

Vector fields and Lie bracket: vector fields as an equivalence class of curves, Tangent vector as a directional derivative operator, algebraic approach of tangent vectors, tangent spaces, Vector fields on differentiable manifolds, covariant Differentiation f- related vector fields, tangent bundle Immersions, embedding’s and transversality.

Integral curves and Flows: Definition, examples and related theorems of Integral curves. Definition, examples and related theorems of one parameter group of transformation.

Exterior Algebra and Exterior derivative: Definition, examples related problems of tensor products, tensor algebra and exterior Algebra.

Text Book:

1. U. C. De and A. A. Shaikh, Differential Geometry of Manifolds, Narosa Publishing House, New Delhi, 2007.

Reference Books:

1. R. L. Bishop and R. J. Crittenden, Geometry of Manifolds, Academic Press, 1964.
2. S.S. Chern, W.H. Chen and K.S. Lam, Lectures on Differential Geometry, World Scientific, 2000.
3. N. J. Hicks, Notes on Differential Geometry, Von Nostrand, 1965.
4. J.M. Lee, Introduction to Smooth Manifolds, Springer, 2006.
5. Y. Matsushima, Differentiable Manifolds, Dekker, 1972.
6. M. Spivak, A Comprehensive Introduction to Differential Geometry Vol. 1&3rd Edition Publish or Perish, 1999.

7. F. Warner, Foundations of Differentiable Manifolds and Lie Groups, Springer, 1983.

Course Outcomes: They are able to understand

1. Integral curves and Flows.
2. Linear Connection, Exterior Algebra, Exterior derivative
3. Understand the concept of Riemannian manifolds.
4. Students learnt how topology, algebra and linear algebra involved in the study of Manifold.
5. Also, they recognized the application of manifold in different branches of Applied Sciences.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2						2	3	3	2	1
CO2	2	3	3	3	3						3	3	3	2	1
CO3	2	3	3	3	3						2	3	3	2	1
CO4	2	3	2	3	3						2	2	3	2	1
CO5	2	3	3	3	3						2	3	3	2	1

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPATO1	4	1	-	5 hours	30	70	100	5

APPLICATIONS OF FUZZY SETS AND FUZZY LOGIC

Course Objective:

1. To learn to deal with uncertainty (of Fuzzy nature) and understand the scope of the subject.

2. To learn basic operations on Fuzzy sets and to understand the flexibility of various operations.

3. To understand the possibility theory and compare it with probability theory.

4. To understand the Fuzzy logic, implication rules, Fuzzification and Defuzzification methods.

5. To understand the application of Fuzzy logic in decision making under Fuzzy environment.

Syllabus Content:.

1. **From Classical (Crisp) sets to fuzzy sets: A grand paradigm shift and Operation on fuzzy sets**

Introduction, Crisp Sets: An overview, Fuzzy sets: basic types, Fuzzy sets: Basic concepts, Characteristics and signification of paradigm shifts.Types of operations, Fuzzy complements, Fuzzy intersections: t-Norms, Fuzzy unions: t-conorms, Combination of operations, Aggregation of operations

2. **Possibility Theory and Fuzzy Logic**

Fuzzy measures, Evidence Theory, Possibility theory, Fuzzy sets and possibility theory, Possibility theory vs. probability theory. Classical logic: An overview, multivalued logics, Fuzzy propositions, Fuzzy quantifiers, Linguistic hedges

3. **Approximate Reasoning**

Fuzzy expert system: an overview, Fuzzy implications, Selection of fuzzy implications, Multi conditional approximate reasoning, the role of fuzzy relation Equations, Interval-valued approximate reasoning.

4. **Fuzzy Systems**

General discussion, Fuzzy controllers: An overview, Fuzzy controllers: An Example, Fuzzy systems and neural networks, Fuzzy neural networks, Fuzzy automata, Fuzzy dynamic systems.

5. **Fuzzy decision making**

General discussion, Individual decision making, multi-person decision making, Multicriterial decision making, Multistage decision making, Fuzzy ranking methods, Fuzzy linear programming.

Text Book:

1. George J. Klir, Bo Yuan, Fuzzy sets and fuzzy logic Theory and Applications, PHI Publications 2002.

Reference Books:

1. Zimmermann, H. J. Fuzzy set theory and its applications. Springer Science & Business Media (2011).
2. Garg, H. Pythagorean, Fuzzy Sets- Theory and Applications. Springer, Singapore (2021).

Course Outcomes: After completion of this course a student is supposed to know:

1. Learn to deal with real world uncertainties especially of the fuzzy nature and use it as mathematical tool available for cutting edge research in the area of his/her choice
2. Basics of fuzzy sets and the significance of application of fuzzy sets.
3. Use of fuzzy logic for decision making under real world scenario which is mostly fuzzy.
4. A student is supposed to understand the application as Fuzzy measures evidence theory, Possibility theory and probability theory.
5. Basics of fuzzy controller, idea of fuzzification and defuzzification.

Course Outcome and Their Mapping with Program Outcome & Program Specific Outcomes																
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03	PS04
CO1	3	3	3	2		2	1	2	2	-	1	2	1	1	2	2
CO2	3	3	2	2		1	1	-	2	-	1	2	2	2	2	2
CO3	3	3	3	2		2	-	1	2	1	1	2	2	2	2	2
CO4	2	2	2	2		-	-	-	-	-	-	-	1	1	2	2
CO5	2	2	2	2		1	-	-	1	1	-	1	2	2	2	2
WEIGHTAGE: 1- Slightly, 2 – Moderately, 3 - Strongly																

M.Sc. I YEAR II SEMESTER SCHEME

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPBTT1	4	1	-	5 hours	30	70	100	5

REAL ANALYSIS

Course objective: The aim of this course:

1. To introduce the concept of function of bounded variation and its properties, including the total variation and variation function.
2. To teach the necessary and sufficient conditions for a function to be of bounded variation.
3. To understand measurable sets and their properties, including the concepts of non-measurable sets, set of measure zero, σ-algebra, Borel algebra, and complete measure.
4. To explain the concept of measurable functions and their properties, including positive and negative parts of a function, simple functions, and the relation between continuity and measurability of a function.
5. To understand the Lebesgue integral and its comparison with the Riemann integral, and bounded convergence theorem for a sequence of functions, Fatou's lemma, classical Lebesgue dominated convergence theorem, monotone convergence theorem, and Fubini's theorem.

Compact Metric Spaces: Totally bounded metric spaces**,** Compact metric spaces, Lebesgue Covering lemma and Characterization of Compact metric spaces.

Riemann-Stieltjes Integration: Riemann-Stieltjes Integration, Properties of Riemann-Stieltjes Integrals, Class of Riemann- Stieltjes Integrable functions.

Function of Bounded Variation: Function of bounded variation, Total variation and its additive property, Variation function and its properties, Necessary and sufficient conditions for a function to be bounded variation.

Measurable Sets: Measurable sets and their properties, Non- Measurable sets, set of measure zero, Cantor set, σ-algebra, Borel Algebra, Complete measure.

Measurable Functions: Measurable functions, Properties of Measurable functions, Positive and negative parts of function, Simple functions, Relation between continuity and measurability of function, Lusin's and Egoroff's Theorems.

Lebesgue Integral: Comparison of Lebesgue and Riemann integrals, Lebesgue integral of a bounded function over a set A of finite measure, Simple properties, Lebesgue integral for unbounded functions, Bounded convergence theorem for a sequence of function, Fatou's lemma, Classical Lebesgue dominated convergence theorem, Monotone convergence theorem, Fubini's Theorem.

Text Books:

1. Rudin W., “Principles of Mathematical Analysis”, 3rd ed., McGraw-Hill, 1983.
2. Royden H. L., “Real Analysis” (3rd Edition), Macmilan Publishing Co. Inc., New York, 4th Ed., 1993.
3. Rana I. K., “An introduction to measure and Integration”, Narosa Publishing House, Delhi, 1997.

Reference Books:

1. Apostol T., “Mathematical Analysis”, 2nd ed., Narosa Publishers, 2002.
2. G. de Barra, Measure theory and integration, Harwood Publishing Limited, Chichester, 2003.
3. E. M. Stein and R. Shakarchi, Real analysis, measure theory, integration and Hilbert spaces, Princeton University Press, 2005.

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

1. Understand the fundamental terms of theory of Compact metric spaces, Integration, Function of bounded variation, Measure theory viz. algebra, σ-algebra, and Lebesgue Integral.
2. Understand the basic concepts of measure theory namely Monotone convergence theorem, Fubini’s Theorem.
3. Apply the concept of measure in the problems pertaining to integration of function with respect to particular measure.
4. Analyse and identify important dissimilarities between Riemann integration and Lebesgue integration.
5. Evaluate the value of Lebesgue integration (with respect to its measure) of any measurable function.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2									3	3	2	1
CO2	3	3	3	2									3	3	1	1
CO3	3	3	3	2									2	2	1	1
CO4	2	2	2	2									2	2	1	1
CO5	3	3	3	3									2	2	1	1

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPBTT2	4	1	-	5 hours	30	70	100	5

NUMERICAL ANALYSIS

Course Objective:

1. To know about the types & sources of errors and its effect on any numerical computations and be familiar with finite precision computations and methods for solving an algebraic or transcendental equation using an appropriate numerical method.
2. To know about the methods for finding simultaneous roots of algebraic equations and methods to solve a linear system of equations using an appropriate numerical method which include direct and iterative methods.
3. To learns numerical methods to find Eigen-values and corresponding Eigen-vectors.
4. To approximate the given data with an interpolating polynomial for capturing function value, slope and curvature.
5. To learn methods for solving some ODE & PDE using appropriate numerical methods.

Course Contents:

Unit-I: Error and Rate of Convergence:

Brief review of numerical basic method for algebraic and transcendental equations, Errors, rate of convergence, efficiency index, computational order of convergence Transcendental & polynomial equations: Muller's method, Chebyshev's methods, higher order methods, modified Newton-Raphson method, method for finding multiple root in case of unknown multiplicity, Newton-Raphson method for nonlinear systems.

Unit-II: Method for finding Simultaneous roots & linear Systems

Cardano's method, Ferrari's method, Descarte's rule of signs, Sturm sequence, Birge-Vieta method, Bairstow method, Graeffe's root squaring method, System of linear equations: partial and complete pivoting in Gauss elimination method, Doolittle's' and Crout's method.

Unit-II: Numerical Method for finding Eigen Values & Eigen Vector

Eigen values & Eigen vectors: Bounds on Eigen values, method for finding Eigen values of symmetric matrices, method for finding Eigen values of arbitrary matrices,

Unit-II: Interpolation Techniques for capturing function value , slope and curvature

Interpolation: existence & uniqueness of Lagrange's & divided interpolation, Truncation error, Hermite's interpolation, cubic spline interpolation, errors in interpolation.

Unit-II: Numerical solution of ODE & PDE

Numerical solution of ordinary different equations: solution of boundary value problems by finite difference method, shooting method, Numerical solution of partial differential equations: solution of elliptic, parabolic and hyperbolic partial differential equations problems by finite difference method.

Text/ Reference Book:

1. Jain M K, Iyengar S R K and Jain R K, Numerical Methods for Scientific and Engineering Computation, 4th Edn, New Age International Pvt Ltd (2005).
2. S. S. Sastry, Introductory Methods of Numerical Analysis, 5th Edn. Prentice Hall of India (2013).
3. J. H. Mathews and K.D. Fink: Numerical Methods using MatLabs, 4rth edition, PHI Learning Private Limited, New Delhi (2021).
4. B. Bradie: A Friendly Introduction to Numerical Analysis, Pearson Prentice Hall, India (2006).

Course Outcomes:

Students will try to learn:

1. To know about the types & sources of errors and its effect on any numerical computations and be familiar with finite precision computations and methods for solving an algebraic or transcendental equation using an appropriate numerical method.
2. To know about the methods for finding simultaneous roots of algebraic equations and methods to solve a linear system of equations using an appropriate numerical method which include direct and iterative methods.
3. To learns numerical methods to find Eigen-values and corresponding Eigen-vectors.
4. To approximate the given data with an interpolating polynomial for capturing function value, slope and curvature.
5. To learn methods for solving some ODE & PDE using appropriate numerical methods.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2						2	2	2	2	2	3
CO2	3	3	3	3	2						3	3	2	2	2	3
CO3	3	3	3	3	2						2	3	2	2	2	2
CO4	3	3	2	3	2						2	3	2	2	2	3
CO5	3	3	3	3	3						2	3	2	2	2	3

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPBTD1	4	1	-	5 hours	30	70	100	5

CODING THEORY

Course Objective: The students will be able to gain the knowledge about coding theory:

1. Implement the encoder and decoder of one block code using any program language and comprehend various error control code properties
2. Apply linear block codes for error detection and correction, convolution codes for performance analysis & cyclic codes for error detection and correction and Design BCH & RS codes for Channel performance improvement against burst errors.
3. The main objective of a course on coding theory in mathematics is to study methods for transmitting information accurately and efficiently over noisy communication channels. In particular, coding theory focuses on the design and analysis of error-correcting codes, which are algorithms that add redundancy to the information being transmitted in order to detect and correct errors that may occur during transmission.
4. The course typically covers topics such as the fundamentals of coding theory, linear block codes, cyclic codes, BCH codes, Reed-Solomon codes, convolutional codes, and their decoding algorithms. Students will learn about the properties and parameters of these codes, their ability to correct errors, and the trade-offs between code complexity, error correction capability, and communication efficiency.
5. By the end of the course, students should have a solid understanding of the theoretical foundations of coding theory, as well as practical skills in designing and implementing error-correcting codes for various communication scenarios. They should also be able to analyze the performance of different codes under various noise conditions and understand the limitations of error-correcting codes in real-world applications.

UNIT I: Block codes, linear codes, minimum distance, generator and parity check matrices, hamming codes, Nearest neighbour decoding for linear codes, syndrome decoding, weight enumerators.

UNIT II: Singleton and sphere packing bounds, MDS codes and perfect codes, Gilbert–Varshamov bound, Griesmer bound, Non-linear codes, Hadamard codes, binary and ternary Golay codes.

UNIT III: Constructions of linear codes**,** Reed-Solomon and Justesen codes, Reed–Muller codes, Subfield codes, Cyclic codes, generator and parity-check polynomials, Weight distribution of codes, Generalized BCH codes, Self-dual codes and invariant theory, Covering radius problem.

UNIT IV: Reed Solomon codes, binary group code, polynomial code, binary cyclic codes of Length 2n (n odd), generalized Reed-Muller codes, Simplex codes, t-designs, Steiner systems, quadratic residue codes, Convolutional Codes.

UNIT V: Goppa codes, Quaternary codes, binary codes derived from codes over$\mathbb{Z}_4$, Galois ring over$\mathbb{Z}_4$, cyclic and quadratic residue codes over$\mathbb{Z}_4$, self-dual codes over$\mathbb{Z}_4$.

Text Books:

1. J. H. Van Lint, Introduction to Coding Theory, 3rd ed., Graduate Text in Mathematics, 86, Springer-Verlag, 1999.
2. W. C. Huffman and V. Pless, Fundamentals of Error-correcting Codes, Cambridge University Press, 2003.
3. S. Ling and C. Xing, Coding Theory, A First Course, Cambridge University Press, 2004.

Reference Books:

1. J Buchmann, T. Hoholdt, H. Stichtenoth, Coding Theory, Cryptography and Related Areas.
2. Wakerly, J. North-Holland, Error-correcting codes, self-checking circuits and applications, New York 1978.
3. Wan Zh. Wissenschaftsverlag, Algebra und Codes, Peking, 1980.
4. Welsh, D., VCH, Weinheim, Codes and Cryptography, 1991.
5. Wolfowitz, J., Coding theorems of information theory, Springer, Berlin, 1978.
6. Wozencraft, M., Jacobs, I. John Wiley Principles of communication engineering, New York.
7. Wozencraft, M., Reiffen, B Sequential Decoding, M.I.T. Press, Cambridge/Mass.
8. Wiggert, D. Artech, Boston/Mass, Codes for error control and synchronization, 1988.

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

1. Design the channel performance using Coding theory.
2. Comprehend various error control code properties.
3. Compare various capacity reduction based coding techniques for image and video type of data.
4. Illustrate various security oriented coding techniques for Block codes.
5. Implement various error control techniques for Convolutional.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	2	1			1	1	1	2	1	1	2	2
CO2	3	2	2	2	2	2			2	2	1	2	1	2	2	2
CO3	3	2	2	3	2	2			2	2	3	2	2	2	2	2
CO4	3	2	2	3	2	3			2	3	2	2	2	2	2	2
CO5	3	2	3	3	3	2			2	3	2	2	3	3	2	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPBTD2	4	1	-	5 hours	30	70	100	5

FINSLER GEOMETRY

Course Objective: Students will be able to:

1.Learn basic terminology of Finsler geometry.
2.Understand the concept of covariant differentiation.
3.Know the Berwald covariant differentiation.
4.Understand the projective change and invariant tensors.
5.Learn about Geodesic.

Line element, degree of homogeneity, Finsler space, Euler's theorem, metric tensor, generalized Christoffel symbols, Cartan tensor, Minkowskian space, Tangent space, dual tangent space, length of a vector, Geodesic.

δ-differentiation, partial δ-differentiation, Berwald differentiation, commutation formulae, metrical connection, Landsberg space, Affinely connected space, Ricci commutation formula, Berwald curvature and torsion tensors, Berwald deviation tensor, Bianchi identities, Recurrent Finsler space, Symmetric Finsler space.

Projective change, projective deviation tensor, projective curvature and torsion tensors.

Cartan two processes of covariant differentiation, Cartan curvature and torsion tensors.

Books Recommended:

1. H. Rund, The Differential Geometry of Finsler Spaces, Springer-Verlag, Berlin, 1959.
2. M. Matsumoto, Foundations of Finsler Geometry and Special Finsler Spaces, Kaisheisha Press, Otsu, 1986.
3. P. L. Antonelli (ed.), Handbook of Finsler Geometry, Kluwer Academic Publishers, Dordrecht, the Netherlands, 2003.
4.

Course Outcomes: Students will be able to:

1.Learn basic terminology of Finsler geometry.
2.Understand the concept of covariant differentiation.
3.Know the Berwald covariant differentiation.
4.Understand the projective change and invariant tensors.
5.Learn about Geodesic.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	2					1	1	1	2	1	1	3
CO2	3	2	2	1	2					2	1	2	2	1	1	2
CO3	3	2	2	1	2					2	2	2	2	1	1	2
CO4	3	2	2	3	2					2	1	1	3	1	1	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPBTD3	**4**	**1**	**-**	**5 hours**	**30**	**70**	**100**	**5**

FLUID MECHANICS

Course Objectives: Objective of the course are to make Students will able:

1. To understand the basic principles and properties of fluids and also governing equation of fluids.
2. To learn about Lagrangian and Eulerian descriptions of fluid model and derivation of continuity equation.
3. To know the Euler's equation in streamline coordinates, Bernoulli's equation, Application of Bernoulli's equation, Kelvin's theorem, Reynolds Transport Theorem (RTT), Application of RTT of fluid model.
4. To study about the basic properties of vortex motion of a fluid and its application.
5. To familiarize about the Navier-Stokes equation, Temperature distribution in Coutte flow and in flow past a flat plate. Mathematical formulation of the stability problem of incompressible flow.

Unit-I Introduction and Basic Principles, Properties of Fluids and Fluid Statics: Density, Bulk Modulus, Viscosity, Newtonian fluid, Non-Newtonian fluids, Reynolds number, Rotational and Irrotational flows, Compressible and Incompressible flows, Governing equation of fluid statics, Fluid under rigid body motion.

Unit-II Lagrangian and Eulerian descriptions, Concept of different flow lines, Acceleration of fluid flow, Deformation of fluid elements, Derivation of continuity equation, Stream Function, Circulation, Velocity Potential

Unit-III Euler's equation, Euler's equation in streamline coordinates, Bernoulli's equation, Application of Bernoulli's equation, Kelvin's theorem, Reynolds Transport Theorem (RTT), Application of RTT: Conservation of mass, Conservation of linear momentum, Conservation of angular momentum.

Unit-IV Vortex motion, Helmholtz's vorticity equation, Vortex line and filament equation of surface formed by streamlines and vortex lines in case of steady motion, Strength of a filament, Velocity field and kinetic energy of a vortex system, Vortex pair, Vortex doublet, Images of a vortex with regards to plane and a circular cylinder.

Unit-V Navier-Stokes equation, Pipe Flow, Principle of Similarity and Dynamical Analysis, Temperature distribution in Coutte flow and in flow past a flat plate.

Mathematical formulation of the stability problem of incompressible flow, Stability of flows under different cases, Prandtl's momentum transfer theory.

Text Books:

1. M.D. Raisinghania, Fluid Dynamics with complete Hydrodynamics and Boundary layer Theory (Revised Edition) , S. Chand Publication.

2. F. Chorlton, Text Book of Fluid Dynamics, CBS Publication.

Reference Books:

1. L.M. Milne-Thomson, Theoretical Hydrodynamics, Dover Publications Inc.

2. Batechelor, G.K., An Introduction to Fluid Dynamics, Cambridge Press.

3. Drazin, P.G., Reid W. H., Hydrodynamic Stability, Cambridge Press

4. Arthur Stanley Ramsey, Hydrodynamics, G. Bell and Sons, Limited.

5. L.D. Landau and E.M. Lipschitz, Fluid mechanics, Pergamon Press.

Course Outcomes: At the end of this course, the student will be able:

1. To familiarize basic principles and properties of fluids.
2. To solve the Lagrangian and Eulerian problems related to fluid model and Apply different moment equations viz., equation of continuity, equation of motion and equation of pressure to discuss any problem of gas dynamics.
3. To determine Bernoulli's equation, Application of Bernoulli's equation, Reynolds Transport Theorem (RTT), Application of RTT in fluid model.
4. To apply vorticity of fluids and its applications.
5. To know about Dynamical Analysis, Mathematical formulation of the stability problem of incompressible flow, Stability of flows under different cases, Prandtl's momentum transfer theory.

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	3			3	2		2		2		3	2	3
CO 2	3	2	3			3	2		2		2		3	2	3
CO 3	3	2	3			3	2		2		2		3	2	3
CO 4	3	2	3			3	2		2		2		3	2	3
CO 5	3	2	3			3	2		2		2		3	2	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPBTD4	4	1	-	5 hours	30	70	100	5

MATHEMATICAL METHODS OF APPLIED MATHEMATICS

Course Objectives:

1. To find the green's function for Laplace, Diffusion and wave equation.
2. To find the solution of ordinary differential equations using Laplace transform.
3. To solve the partial differential equations using Laplace transform.
4. To use the Fourier's transform and its applications.
5. To use the Z-transform and its applications.

Green's Function, Green's function for Laplace equation, The methods of Image, The Eigen function method, Green's Function for Wave Equation-Helmholtz theorem, Green's Function for Diffusion Equation.

Laplace transform methods, Transform of various functions, Complex Inversion Formula, Solution of Ordinary differential Equations, Solution of Partial Differential Equations, Solution of Diffusion Equation, Solution of Wave Equation.

Fourier Transform Methods, Transform of various functions, Multiple Fourier Transform, Solution of Diffusion Equation, Solution of Wave Equation and Solution of Laplace Equation.

Z – Transform and its Applications.

Text Book:

1. Rao, K.S., Introduction to Partial Differential Equations, PHI Learning, Private Limited, New Delhi, INDIA (2011).

Reference Books:

1. Jain, M.K., Iyenger, S. R. K and Jain, R.K., Computational Methods for Partial Differential Equations, Wiley Eastern, (1994).
2. Evans, L.C., Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, AMS (1999).
3. B.S. Grewal., Higher Engineering Mathematics, Khanna Publishers.

Course Outcomes: This course will enable the students to:

1. Apply the green's function on the various realistic problems.
2. Solve the ordinary differential equations by Laplace transform.
3. Solve the partial differential equations by Laplace transform.
4. Apply Fourier transform on the realistic problem.
5. Use the Z-transform and its applications.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3	2	2	1						2	3	2		2
CO2	3	3	3	2	2	1						2	3	2		2
CO3	3	3	3	2	2	1						2	3	2		2
CO4	3	3	3	2	2	1						2	3	2		2
CO5	3	3	3	2	2	1						2	3	2		2

Weightage: 1-Slightly; **2**-Moderately; **3**-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPBTD5	4	1	-	5 hours	30	70	100	5

MATHEMATICAL STATISTICS

Course objective: This course will enable the students to:

1. Understand different type of probability distributions.
2. Apply sampling technique to draw inferences about population.
3. Establish a formulation helping to predict one variable in terms of the other variables using the technique of correlation and regression.
4. Estimate the population parameters and evaluate the properties of estimators.
5. Translate real-world problems into probability models.

Basics of Random Variables: Introduction of Probability**,** Discrete and continuous random variables, probability mass function, probability density function, expectation, normal distribution.

Large Sample Theory: Types of sampling, parameter and statistic, tests of significance, procedure for testing of hypothesis, tests of significance for large samples, sampling of attributes, sampling of variables.

Exact sampling distributions-I: Derivation of the chi-square distribution, M.G.F. of chi-square distribution, some theorems on chi-square distribution, and applications of chi-square distribution.

Exact sampling distributions-II: Students ‘t’ distribution, Fisher’s ‘t’, applications of t-distributions, distribution of sample correlation coefficient when population correlation coefficient is zero(ρ=0), F-distribution, applications of F-distribution, relation between t and F distributions, relation between F and chi-square distributions, Fisher’s z-distribution, Fisher’s z- transformation.

Theory of estimation: Estimators, characteristics of estimators, Cramer-Rao inequality, complete family of distributions, methods of estimation, confidence interval and confidence limits.

Correlation and regression: Linear regression (introduction) and curvilinear regression, regression curves, correlation ratio, multiple and partial correlation, plane of regression, properties of residuals, coefficient of multiple correlation, coefficient of partial correlation, multiple correlation in terms of total and partial correlation, expression for regression coefficient in terms of regression coefficients of lower order, expression for partial coefficient in terms of regression coefficients of lower order.

Text Book:

1. S. C. Gupta and V. K. Kapoor: Fundamentals of Mathematical Statistics, S. Chand and Sons, New Delhi (2004).

Reference Books

1. M. Ray and H. S. Sharma: Mathematical Statistics, Ram Prasad & Sons (1966).
2. D. N. Elhance, Fundamentals of Statistics, Kitab Mahal (1964).

Course Outcomes: After completion of this paper students will be able to

1. Handle the real world problems regarding uncertainty of certain kind associated with random experiment.
2. Perform test of hypothesis as well as calculate confidence interval for a population parameter for single sample and two sample cases and draw inferences about population.
3. Perform non-parametric test such as the Chi-square test for independence as well as goodness of fit.
4. Compute and interpret the results of bivariate and multivariate regression and correlation analysis, for forecasting. This paper is also useful for further study of statistics.
5. Apply the theory of estimation to draw valid conclusions.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	1	2	3	3	3	1	2	2	2
CO2	3	3	3	3	3	3	2	1	2	3	2	3	2	2	2	2
CO3	3	3	2	2	3	3	3	1	2	3	3	3	2	2	2	2
CO4	3	3	3	3	3	3	3	1	2	3	3	3	2	2	2	2
CO5	3	3	3	3	3	3	3	1	2	3	3	3	2	2	2	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPBTD6	4	1	-	5 hours	30	70	100	5

RIEMANNIAN MANIFOLDS AND CONNECTIONS

Course objective:

1. To study Linear Connection.
2. To study Riemannian Metric, Riemannian Connection in Riemannian Manifolds
3. To study different type of Curvatures in Riemannian Manifolds.
4. To study conformal transformation in Reimanian manifold.
5. To Study different type of connections in Reimanian manifold.

Linear Connection: Affine connections, Torsion tensor of affine connection, Curvature tensor of affine connection and related problems.

Riemannian Manifold Riemannian Connection: Definition and examples of Riemannian Metric, Riemannian Connection and Riemannian Manifolds, Fundamental theorem of Riemannian Geometry, Koszul's formula, First and Second Bianchi's identities, Ricci identity.

Curvatures in Riemannian Manifolds: Riemannian Curvature, Ricci curvature, scalar curvature, Sectional curvature, Gaussian Curvature, Schur's theorem, Projective curvature tensor, conformal curvature tensor, Conhormonic Curvature tensor, Concircular Curvature tensor.

Connections on Riemannian Manifolds: Gradient vector fields, Semi- symmetric metric connection and related theorems, Jacobi Fields. Complete manifolds, Vector fields, all space forms, Theorem of Cartan on the determination of the metric by means of the curvature. Fundamental equations for Riemannian submanifolds, conformal killing.

Transformations on Riemannian Manifolds: Conformal transformation, Conformal killing vector field, Locally symmetric Riemannian manifold, Recurrent Reimanian manifold, Ricci recurrent Reimanian manifold, Ricci-semi- symmetric Reimanian manifold and related theorems.

Text Book:

1. U. C. De and A. A. Shaikh, Differential Geometry of Manifolds, Narosa Publishing House , New Delhi, 2007.

Reference Books:

1. S.S. Chern, W.H. Chen and K.S. Lam, Lectures on Differential Geometry, World Scientific, 2000.
2. MP do Carmo, Riemannian geometry, Birkhauser, 1992.
3. N. J. Hicks, Notes on Differential Geometry, Von Nostrand, 1965.
4. P. Petersen, Riemannian geometry, Springer 2006.
5. J. Jost, Riemannian geometry and Geometric Analysis (6ed. Springer, 2011).

Course Outcomes: They are able to understand

1. Linear Connection on manifolds.
2. The Riemannian Metric and Riemannian Connection in Riemannian Manifolds
3. How different type of Curvatures defined in Riemannian Manifolds.
4. Details study of conformal transformation in Reimanian manifold.
5. Different ifferent type of connections in Reimanian manifold.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2						2	3	3	2	1
CO2	2	3	3	3	3						3	3	3	2	1
CO3	2	3	3	3	3						2	3	3	2	1
CO4	2	3	2	3	3						2	2	3	2	1
CO5	2	3	3	3	3						2	3	3	2	1

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPBTD7	4	1	-	5 hours	30	70	100	5

FRACTIONAL CALCULUS AND INTEGRAL TRANSFORMS

Course Objectives:

1. The goal of this paper is to develop the basic concept of Fractional Calculus.
2. The understand integral transform with Fractional Calculus.
3. Analyze the properties of Hankel transform
4. Solve the ordinary differential equations and boundary value problems using fractional calculus,
5. Apply the concept of real life problems.

Unit-1:

Hankel Transform: Introduction, Definition and formulae, some more integrals involving exponential functions and Bessel's function of first kind; Inversion formula and Parsival's theorem for Hankel transform. Hankel transform of the derivative of a function; Application of Hankel transforms of boundary value problems. Finite Hankel transmission formation and another form of Hankel transform.

Unit-2:

Z-Transform: Introduction and basic operations on sequences of Z-transform; Properties and theorems of Z-transform; Solution of difference equation, Multiplication by K and division by K, Initial and final value problem; Partial sum. Convolution: Definition and property of casual sequence. Inverse of Z-transform: Inverse of Z-transform by Binomial expansion, partial fractions, residue method and convolution method.

Unit-3:

Fractional Calculus: Introduction and historical background; Riemann-Liouville fractional integrals of arbitrary order α and Riemann-Liouville fractional derivatives; Basic properties and Illustrative Examples.

Unit: 4

Laplace Transform: Laplace transforms of fractional integral, Laplace of fractional derivatives; Laplace transform of Caputo derivatives and Illustrative examples.

Unit:-5

Mellin Transforms: Definition and some elementary properties of Mellin transform. Mellin transform of fractional integral and Mellin transform of fractional derivative and Illustrative examples.

Text Books:

1. A M Mathai et al.,the H-function: Theory and applications; Springer Publication, New York.anform
2. H. K. Dass and Er. Rajnish Verma; Higher Engineering Mathematics; S. Chand & Company PVT. LTD. New Delhi (2014).

Reference Books:

1. Keith B. Oltham and Jerome Spanier; The fractional calculus: Theory and applications of differentiation and integration to arbitrary order; Academic press new York and London (1974).
2. A. R.Vasishtha and Dr. R. K. Gupta; Integral Transform; Krishna Prakashan Media (P) Ltd. Meerut.

Course Learning Outcomes:

1. **The** Students will be able to solve transformations, differential and integrals equation of arbitrary order.
2. This course will help to develop the extended mathematical modeling of fractional order in Science and Engineering.
3. Explain the Laplace transform and Mellin transform using fractional calculus.
4. Solve the ordinary differential equations and boundary value problems using fractional calculus,
5. Apply the concept of real life problems.

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2												2	1
CO2	3	2											2	2	1
CO3	3	2											3	2	1
CO4	3	2											3	2	1
CO5	3	2											3	2	1

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMUBTT3								2

RESEARCH METHODOLOGY

Course objective: The aim of this course:

1. To provide an introduction to the foundations of research, including its meaning, objectives, motivation, and utility.
2. To familiarize students with the concepts of theory, empiricism, deductive and inductive theory, and their relevance to research.
3. To teach students the characteristics of the scientific method and the importance of understanding the language of research, including concepts such as construct, definition, variable, and the research process.
4. To provide an understanding of research design, including its concept and importance in research, the features of a good research design, and different types of research designs such as exploratory, descriptive, and experimental designs.
5. To familiarize students with the basic concepts of independent and dependent variables in experimental design, and introduce them to some software that can aid in research design.

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method, Understanding the language of research, Concept, Construct, Definition, Variable, Research Process.

Research Design**:** Concept and Importance in Research, Features of a good research design, Exploratory Research Design, Descriptive Research Designs, Experimental Design: Concept of Independent & Dependent variables, Basic idea of few software's.

Reference book:

1. C. R. Kothari: Research Methodology: Methods Techniques , New Age International, 2004

2. P. K. Khatua and P. R. Majhi: Research Methodology Concepts Methods Techniques, Himalaya Publishing House, 2016

Course Out comes: After the completion of the course student will be able to

1. Understand basic elements of the research and systematics process research development.
2. Understand the characteristics of the scientific methods, language of research.
3. Understand the design of the research.
4. Analyze the features of the good research design.
5. Learn about descriptive research design and their concepts.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	3		3									1	2
CO2	3	3	2	3		3									1	2
CO3	3	3	2	3		3									1	2
CO4	3	2	2	3		3									1	2
CO5	3	3	2	3		3									1	2

M.Sc. II YEAR III SEMESTER SCHEME

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTT1	**4**	**1**	**-**	**5 hours**	**30**	**70**	**100**	**5**

FUNCTIONAL ANALYSIS

Course objective:

1. *The aim of this course is to put forward the most of the concepts from Real Analysis, Algebra and linear algebra as a basic foundation of functional analysis.*
2. *functional analysis which is essential for PG students to enhance their knowledge in the field of advanced analysis based on topology.*
3. *The topics include here are geometrical properties of normed linear spaces, Baanach spaces.*
4. *Most fundamental theorems of normed linear spaces and Banach spaces such as Hahn Banach Theorem, Open Mapping Theorem, Closed Graph Theorem, Uniform Boundedness Theorem, etc. should be understandable by the PG students.*
5. *Studies of Hyper plane such as Hilbert spaces and their applications. Operator Theory, etc.*

Normed linear spaces, Banach spaces, Properties of Normed linear spaces, Finite dimensional Normed linear spaces and subspaces, Compactness and finite dimension, Linear operators, Bounded and continuous operators, Linear functional, Linear operators and functional on finite dimensional spaces, Normed spaces of operators, Dual space.
Zorn's Lemma**,** Hahn-Banach Theorem, Hahn-Banach Theorem for complex vector spaces and Normed spaces, Applications to bounded linear functional on *C*[a, b], Ad-joint operator, Reflexive spaces, Category theorem, Uniform boundedness theorem, Strong and weak convergences, Convergences of sequences of operators and functional, Open Mapping Theorem, Closed linear operators, Closed Graph Theorem.

Inner product space, Hilbert space, Properties of inner product spaces, Orthogonal complements and direct sum, orthonormal sets and sequences, Series related to orthonormal sequences and sets Total orthonormal sets and sequences, Bessel's Inequality, Representation of functional on Hilbert spaces, Hilbert ad-joint operator, Self-ad-joint, Unitary and normal operators.

Contraction mapping principle and it's applications to Linear Equations, Differential Equations and Integral Equations.

Text Book:

2. Erwin Kreyszig, Introductory Functional Analysis with Applications, Wiley Classics Publications.

Reference Books:

1. Balmohan V. Limaye, Functional Analysis, New Age International Publications.
2. G. Bachman and L. Narici, Functional Analysis, Dover Publications.
3. B. K. lahri, Elements of Functional Analysis, Calcutta World Press.

4. P. K. Jain and Om P. Ahuja, Functional Analysis, New Age International Publications.

Course Outcomes:

1. To describe the concept of mathematics like Norms, Normed linear spaces, Banach spaces.
2. In a position to deal with inner product spaces, Hilbert spaces and their properties with elaborative examples and some fundamental theorems.
3. To identify variables controlling behaviour(s) and to generate hypotheses about its function(s) because Functional analysis is a methodology for systematically investigating relationships between problem behaviour and environmental events. So that students can understand how researcher uses concept of functional analysis to solve real world problems.
4. To do research work on Contraction principles in different spaces.
5. Applications of Banach Fixed Point Theory in different branches of Science and Technology.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2						1	2	1	2	2	2
CO2	3	3	2	2						1	2	1	2	2	2
CO3	3	3	2	2						1	2	1	2	2	2
CO4	3	3	2	1						1	2	1	2	1	2
CO5	3	3	2	2						1	2	1	2	2	2

➢
Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTT2	4	1	-	5 hours	30	70	100	5

THEORY OF ORDINARY DIFFERENTIAL EQUATIONS

Course Objectives:

1. To discuss the theoretical approach for the solution of linear ODE having constant coefficients.
2. To discuss the initial value problems.
3. To discuss the equations having analytic coefficients.
4. To discuss the linear equations with regular singular points.
5. To analyse the existence and uniqueness of solutions.

Linear Equations with Constant Coefficients: Second order homogenous equation, Initial Value Problem for Second Order Equation, Linear Dependence and Independence, A formula for Wronskian, The Non-homogeneous Equation of Order Two, Homogeneous Equation of Order n, Initial Value Problem for n^{th} Order Equation, The Non-Homogeneous Equation of Order n, A Special Method (Annihilator Method) for Solving the Non-homogeneous Equation.

Linear Equations with Variable Coefficients: Initial Value Problem for the Homogeneous Equation, Solution of the Homogeneous Equation, The Wronskian and Linear Independence, Reduction of the Order of a Homogeneous Equation, The Non-homogeneous Equation, Homogeneous Equation with Analytic Coefficients, The Legendre Equation, Justification of the Power Series Method.

Linear Equation with Regular Singular Point: The Euler Equation, Second Order Equation with Regular Singular Point (Example with General Cases as well), A convergence Proof, The Exceptional Cases, The Bessel Equation, Regular Singular Point at Infinity.

Existence and Uniqueness of Solutions: Equation with Variables Separated, Exact Equations, The method of Successive Approximations, Lipchitz Condition, Convergence of the Successive Approximations, Nonlocal Existence of Solution, Approximations to Solutions, Uniqueness of Solutions, Existence and Uniqueness of Solutions of System, Existence and Uniqueness for the Linear System.

Text Book:

1. Earl A. Coddington, An Introduction to Ordinary Differential Equations, Dover Publications, INC, New York (1989).

Reference Books:

1. S. G. Deo, V. Lakshmikantham and V. Raghavendra., Text book of Ordinary Differential Equations, Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997.

2. George F. Simmons, Differential Equations, Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. W.T. Reid, Ordinary Differential Equations, John Wiley & Sons, NY (1971).
4. Phillip Hartman, Ordinary Differential Equations, John Wiley & Sons, NY (1971).

Course Outcomes: This course will enable the students to:

1. Find out the linear dependence, independence and Wronskian of the solution of ODE.
2. Apply the power series methods.
3. Check the convergence of the solution.
4. Apply the methods of successive approximations.
5. Check the existence and uniqueness of solutions.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3	2	1	2						2	3	2		1
CO2	3	3	3	3	1	1						2	3	2		1
CO3	3	3	3	3	1	1						2	3	2		1
CO4	3	3	3	3	1	1						2	3	2		1
CO5	3	3	3	2	1	1						2	3	2		1

Weightage: 1-Slightly; **2**-Moderately; **3**-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD1	4	1	-	5 hours	30	70	100	5

ALGEBRAIC TOPOLOGY

The proposed course is intended to stimulate the students

1. To understand the interconnection of topology and Geometry and its applications in other subjects.

2. To show how basic geometric structures may be studied by transforming them into algebraic questions.

3. To introduce the most important examples of such invariants, such as singular homology and cohomology groups, and to calculate them for fundamental examples and constructions of topological spaces.

4. To explain the fundamental concepts of algebraic topology and their role in modern mathematics and applied contexts.

5. To demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from algebraic topology.

Product Topology: Preliminaries from general Topology, Product Topology, Tychonoff Theorem (Arbitrary Case).

Metrization Theorems and Para-compactness: Local Finiteness, Nagata-Smirnov Metrization Theorem, Para-compactness, Para-compactness Housdorff Spaces.

Fundamental Group: Homotopy, Paths Homotopy, The fundamental groups, covering spaces, Fundamental group of the circle, Lifting lemma.

Retraction and Fixed Points: Retraction, Brouwer fixed point theorem, Fundamental theorem of Algebra, Borsuk-Ulam theorem.

Fundamental Group Of Surfaces: Projective plane, Theorems on projective plane and fundamental group.

Text Book:

1. James R. Munkres, Topology, A First Course, Prentice Hall of India Pvt. Ltd., New Delhi.

Reference Books:

1. J. L. Kelley, General Topology, Van Nostrand, Reinhold Co. New York.
2. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by Prentice Hall of India Pvt. Ltd).

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

1. Understand the fundamental terms of topology.
2. Understand the rigorous aspects of Homotopy, Fundamental group.

3. Apply the concept of algebraic topology in the problems pertaining to topological fixed points and its applications.
4. To apply his or her knowledge of algebraic topology to formulate and solve problems of a geometrical and topological nature in mathematics.
5. Apply his or her knowledge of algebraic topology to formulate and solve problems of a geometrical and topological nature in mathematics.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	POS02	PSO3	PSO4
CO1	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2
CO2	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2
CO3	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2
CO4	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2
CO5	2	2	1	2	1	1	1	1	1	1	1	3	3	1	1	2

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD2	4	1	-	5 hours	30	70	100	5

COMPLEX MANIFOLDS

Course objective:

1. To study almost complex manifold, Almost Hermite manifold, Kaehler Manifolds, Nearly Kaehler Manifolds and Para Kaehler Manifolds.
2. To study Existence theorem and integrability condition, contravariant and covariant almost analytic vector fields.
3. To study Nijenhuis tensor and their properties in different complex Mnifolds.
4. To study Holomorphic Sectional Curvature, Bochner Curvature tensor, affine connection in almost Kaehler manifold.
5. To study different type of flat spaces/manifolds.

Complex Manifold and Almost complex manifold: Definition and example, Nijenhuis tensor, Eigen Values of an almost complex structure, Existence theorem and integrability condition, contravariant and covariant almost analytic vector fields.

Almost Hermite manifold: Nijenhuis tensor, Almost analytic vector fields, Curvature in almost Hermite manifold, Holomorphic Sectional Curvature, Linear connection in an almost Hermite manifold.

Kaehler Manifolds: Holomorphic Sectional Curvature, Bochner Curvature tensor, affine connection in almost Kaehler manifold.

Nearly Kaehler Manifolds: Definition, Projective correspondence between two Nearly Kaehler manifolds, Curvature identities.

Para Kaehler Manifolds: Definition, Curvature Identities and conformal flatness of parakaehler manifold.

Text Book:

1. U. C. De and A. A. Shaikh, Complex and Contact Manifolds, Narosa Publishing House , New Delhi, 2009.

Recommended Books:

1. S. S. Chern, W.H. Chen and K.S. Lam, Lectures on Differential Geometry, World Scientific, 2000.
2. E.J. Flaherty, Hermitian and Kahlerian Geometry in Relativity, LNP 46, Springer, 1976. 3. Y. Matsushima, Differentiable Manifolds, Dekker, 1972.
3. R. S. Mishra: A course in Tensor with applications to Riemannian geometry, Pothishala (Pvt.) Ltd, Allahabad.
4. B. B. Sinha: an Introduction to modern differential geometry, Kalyani Prakashan, New Delhi, 1982.
5. K. Yano: Structure of Manifolds, World Scientific Publishing Co. Pvt. Ltd., 1984.

Course Outcomes: They are able to understand

1. Basics of almost complex manifold, Almost Hermite manifold, Kaehler Manifolds, Nearly Kaehler Manifolds and Para Kaehler Manifolds.
2. Existence theorem and integrability condition, contravariant and covariant almost analytic vector fields in almost complex manifolds.
3. Nijenhuis tensor and their properties in different complex Mnifolds.
4. Different types of curvatures in different complex manifolds.
5. Different type of flat spaces/manifolds.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2						2	3	3	2	1
CO2	2	3	3	3	3						3	3	3	2	1
CO3	2	3	3	3	3						2	3	3	2	1
CO4	2	3	2	3	3						2	2	3	2	1
CO5	2	3	3	3	3						2	3	3	2	1

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD3	4	1	-	5 hours	30	70	100	5

DIFFERENCE EQUATIONS

Course objective: The aim of this course:

1. To teach students the basics of difference calculus, including the difference operator, summation, generating functions, and approximate summation.
2. To familiarize students with linear difference equations and their solutions, including equations with constant and variable coefficients, and the use of the z-transform.
3. To provide students with an understanding of stability theory for linear and nonlinear systems, including initial value problems and chaotic behavior.
4. To teach students asymptotic methods for the analysis of sums and solutions to linear and nonlinear equations.
5. To familiarize students with the self-adjoint second order linear equations and their properties, including Strurmian theory, Green's function, disconjugacy, the Riccati equations, and oscillation.

Difference Calculus: The Difference Operator, Summation, Generating functions and approximate summation.

Linear Difference Equations: First order equations, General result for linear equations, Equation with Constant coefficients, Applications, Equations with variable coefficients, nonlinear equations that can be linearized, the z-transform.

Stability Theory: Initial value problems for linear systems, Stability of linear systems, Stability of nonlinear systems, chaotic behavior.

Asymptotic methods: Introduction .of Asymptotic, Analysis of sums, Linear equations, Nonlinear Equations.

The self-ad-joint second order linear equations- Strurmian theory, Green’s function, Disconjugacy, The Riccati Equations and Oscillation.

Text Book:

1. W. G. Kelley and Allan C. Peterson- Difference Equations. An Introduction with Applications. Academic Press Inc., Harcourt Brace Joranovich Publishers, 1991.

Reference Books:

1. S. Goldberg, Introduction to Difference equations, Wiley Publication.
2. V. Lakshmikantham and D. Trigiante, Theory of difference equations, Academic Press.

Course Outcomes:

1. Link to preliminaries of Numerical Analysis and knowledge about operators.
2. Understand about solve the difference equations and apply into applications.
3. Understand about stability theory concept for linear and nonlinear systems
4. Learn about asymptotic methods for linear equations and nonlinear equations
5. Link with Green's function and understand about solving the self-adjoint second linear difference equations, conjugate and dis-conjugate and Ricati equations

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3									2	1		
CO2	3	3	1	1									2	3		
CO3	2	2	2	2									2	1		
CO4	3	3	2	1									2	2		
CO5	3	3	2	1									2	2		

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD4	4	1	-	5 hours	30	70	100	5

FUZZY SETS AND FUZZY LOGIC

Course objective:

1. Learn various type of uncertanities and specially of fuzzy type.
2. Learn the development of the concepts and operations on fuzzy sets through axiomatic approach.
3. Learn the scope of fuzzification of basic concepts of mathematics.
4. Learn various fuzzy relation equation solution methods.
5. Learn further development possibilities of basic fuzzy set theory.

1. **From Classical (Crisp) sets to fuzzy sets: A grand paradigm shift and Fuzzy sets vs. Crisp sets**
   Introduction, Crisp Sets: An overview, Fuzzy sets: basic types, Fuzzy sets: Basic concepts, Characteristics and signification of paradigm shifts. Additional properties of α- cuts, Representation of fuzzy sets, Extension principal for fuzzy sets
2. **Operation on fuzzy sets and Fuzzy Arithmetic**
   Types of operations, Fuzzy complements, Fuzzy intersections: t-Norms, Fuzzy unions: t-conorms, Combination of operations, Aggregation of operations. Fuzzy numbers, Linguistic variables, Arithmetic operation on intervals, Arithmetic operation on fuzzy numbers, Fuzzy equations.
3. **Fuzzy Relations**
   Crisp vs. fuzzy relations, Projections and cylindric extensions, Binary fuzzy relations, Binary relations on single sets, Fuzzy equivalent relations, Fuzzy compatibility relations, Fuzzy ordering relations, Fuzzy morphisms, Sup-i compositions of fuzzy relations, Inf-ω_i composition of fuzzy relations
4. **Fuzzy Relation Equations**
   General discussion, Problem partitioning, Solution methods, Fuzzy relation equation based on sup-I compositions, Fuzzy relation equation based on Inf-ω_i compositions, Approximate solutions, the use of neural networks.
5. **Various Generalizations of Fuzzy sets**
   Soft sets, Bipolar sets, Pythagorean fuzzy sets.

Text Book:

1. George J. Klir, Bo Yuan, Fuzzy sets and fuzzy logic Theory and Applications, PHI Publications 2002.

Reference Books:

1. Zimmermann, H. J., Fuzzy set theory—and its applications. Springer Science & Business Media (2011).
2. Garg, H., Pythagorean Fuzzy Sets- Theory and Applications. Springer, Singapore (2021).

Course Outcomes: Students will be able to understand after learning the course:

1. Need of techniques introduced under the course in using (logical) mathematical tools available for cutting edge research in the area of his/her choice.
2. Learn to deal with real world uncertainties especially of the fuzzy nature.
3. Basic idea of set theory and basics of fuzzy sets. The significance of application of fuzzy sets.

4. Binary and unary operations, combinations of operations on fuzzy sets. Aggregation operations.
5. Use of various types of fuzzy relation equation solution methods in his/her area of research.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	POS02	PSO3	PSO4
CO1	3	3	2	2		1	1	1	1	2	2	2	2	2	1	2
CO2	2	2	2	2		1	1	1	1	1	1	2	2	2	2	2
CO3	2	2	3	3		2	1	1	2	1	2	2	1	2	2	2
CO4	3	3	3	2		1	1	1	2	1	2	2	1	1	2	2
CO5	3	3	3	2		1	-	-	1	1	1	2	1	1	2	2

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD5	4	1	-	5 hours	30	70	100	5

INFORMATION THEORY AND ITS APPLICATIONS

Course Objectives: The students will be able to gain the knowledge about information theory and its applications:

1. ***The main concern of Information theory is to discover Mathematical laws governing the system design to communicate or manipulate information.***
2. ***It sets of quantitative measure of information of capacity of various systems to transmit, store and process the information.***
3. ***Coding is the application of Information theory which will be taught to the students in this paper.***
4. **To provide an insight into the concept of information in the context of communication theory and its significance in the design of communication receivers.**
5. **To explore in detail, the calculations of channel capacity to support error-free transmission and also, the most commonly used source coding and channel coding algorithms.**

Concepts of Probability For Information Theory: Probability measure, frequency of events, combinatorial problems in probability, random variables, discrete probability functions and distributions, bivariate discrete distribution, binomial distribution, Poisson distribution, expected value of random variable.

Communication System: Introduction, communication process, a model for communication system, a quantitative measure of information, a binary unit of information.

Basic Concepts of Information Theory: A measure of uncertainty, intuitive justification, formal requirement for the average uncertainties, H-function as a measure of uncertainty, an alternative proof for the entropy function posses a maximum, sources and binary sources.

Measure of Information: Measure of Information for two dimensional discrete finite probability schemes, conditional entropies, a sketch of communication networks, derivation of noise characteristics of channels, some basic relationship among different entropies, a measure of mutual information, set theory interpretation of Shannon’s fundamental inequalities redundancy, efficiency and channel capacities.

Elements of Encoding: The purpose of encoding, separate binary codes, Shannon’s-Fano encoding, necessary and condition for noiseless coding, a theorem on decidability, average length of encoded messages, fundamental theorem of discrete noiseless coding.

Text Book:

1. F.M. Reza, An introduction to information theory, Dover Publications Inc. New York.

Reference Books:

1. Robert B. Ash, Information Theory , Inter-science Publisher, New York
2. John R. Pierce, An Introduction to Information Theory, Dower Publications Inc. New York.
3. John Avery, Information theory and evolution, World Scientific, New Jersey.

Course Outcomes: After successful completion of this paper the students will be able to:

1. To explain the concepts of entropy and mutual information.
2. The students will also be able to understand the concept of information theory and its usefulness in various fields such as in defence, in portfolio selection, in general election, in computer science, in pattern recognition and in image processing.
3. Perform mathematical analysis of problems in Information Theory and Coding, Implementation and verification using MATLAB simulation.
4. Implement the various types of source coding algorithms and analyse their performance.
5. Explain various methods of generating and detecting different types of error correcting codes

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3	2	1			1	2	1	2	2	2	2	1
CO2	2	2	2	1	1	1				1	1	2	2	3	1	2
CO3	3	3	3	2	2	2			2	2	2	2	2	3	1	2
CO4	3	3	3	2	2	2			2	3	3	3	2	2	1	2
CO5	3	3	2	2	3	2			2	2	3	2	3	3	3	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD6	4	1	-	5 hours	30	70	100	5

INTEGRAL EQUATIONS

Course Objectives:

1. *The paper is to develop the basic concept of Integral equations.*
2. *. To learns boundary value problems and initial value problems and its applications.*
3. To learn transformation of differential equation into integral equation vice-versa etc.
4. *The special interest Green's function.*
5. *To Understood Method of successive approximations.*

Unit-1

Basic concept of integral equation: Classification of integral equations; Leibnitz's rule of differentiation under the sign of integration; Transformation of differential equation into integral equation and vice-versa, Illustrative examples.

Unit-2

Conversion of ODE's into integral equations: Initial value problems, method of converting an initial value problem into a Volterra integral equation; Alternative method of converting an initial value problem into a Volterra integral equation; BVP and method of converting BVP into a Fredholm integral equation.

Unit-3

Fredholm Integral Equations: Method of successive approximation: Orthogonal kernels, Iterated kernels; Fredholm determinants, Degenerated kernels; Eigen value and Eigen function of homogeneous integral equation.

Unit-4:

Volterra Integral Equations: Resolvent kernel; Method of successive approximation; Volterra integral equation of first kind and solution of non-linear Volterra integral equation.

Unit-5:

Applications of Integral Equations and Green's function to ODE: Green's function: Conversion of a BVP into Fredholm Integral Equations solution of BVP; Green's function approach for converting an IVP into an integral equation and modified Green's function.

Text Books:

1. M D Raisinghania, Integral Equations and boundary value Problems; S. Chand and Company PVT. LTD, New Delhi.
2. A BChandramouli, Integral Equations with boundary value problems, Shree ShikshaSahityaPrakashan, Meerut.

Reference Books:

1. Abdul-MajidWazwaz, A first course in Integral Equations, World Scientific Publishing Co. Pvt. Ltd.
2. M. Rahman, Integral Equations and their applications WIT press, Boston.

3. Ram P. Kanwal, Linear Integral Equations, Theory and Technique, Academic Press, New York.
4. A. D.Polyanin and A V Manzhirov, Handbook of Integral Equations CRC Press, Boca Raton/ London/ New York/Washington D C.

Course learning Outcomes:

1. The students will be able to solve Fredholm and Volterra integrals equation of boundary value problems, initial value problems.
2. To learn of Green's function and its applications.
3. This course will help to develop the extended mathematical modeling of fractional calculus in Science and Engineering.
4. Demonstrate their under standing for how are modeled using integral equations.
5. Explain the applications integral equations and solving boundary value problems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2											3		
CO2	2	2											3		
CO3	1	2											3		
CO4	1	2											3		
CO5	1	2											3		

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD7	4	1	-	5 hours	30	70	100	5

MULTIPOINT ITERATIVE METHODS

Course Objective:

1. To Know the classifications of iterative methods (IMs) and important related concepts.
2. To know some cubically convergence iterative methods (IMs).
3. To understand optimal two-steps iterative methods (IMs).
4. To make aware about two-steps with memory iterative methods (IMs).
5. To learns two-steps iterative methods (IMs) for multiple roots.

Course Contents:

Unit-I: One-point iterative methods for simple and multiple roots
Classification of iterative methods, order of convergence, computational order of convergence (COC), *R*-order of convergence, computational efficiency of iterative methods, initial approximations, one-point iterative methods for simple zeros, methods for determining multiple zeros, stopping criteria.

Unit-II: Two-point without memory IM
Cubically convergent two-point methods: multipoint-point without memory IM, Traub's two-point methods, Two-point methods generated by derivative Estimation.

Unit-III: Optimal Two-point without memory IM
Ostrowski's fourth-order method and its Generalizations, Family of optimal two-point methods, Optimal derivative free two-point methods, Optimal two-point methods of Jarratt's Type.

Unit-III: Multi-point with memory IM
Multipoint methods with memory: Early works, Self-accelerating Steffensen-like method, Self-accelerating secant method, Multipoint methods with memory constructed by inverse interpolation, Generalized multipoint root-solvers with memory, Derivative free families with memory.

Unit-III: Optimal & Non-Optima IM for Multiple Roots
Non-optimal two-point methods for multiple Zeros, optimal Two-point methods for multiple roots, multipoint-point method for nonlinear systems,

Text/ Reference Books:

1. M. S. Petkovic, B. Neta, L.D. Petkovic, J. Dzunic (2013): Multipoint iterative methods for solving nonlinear equations, Elsevier, MA, USA.

2. J. F. Traub (1982): Multipoint iterative methods for solution of equations, Chelsea Publishing Company, NY, USA.
3. C. T. Kalley (1995): Iterative methods for linear and nonlinear equations, SIAM, Philadelphia.

Course Outcomes:

Students will try to learn:

1. The classifications of iterative methods (IMs) and important related concepts.
2. Some cubically convergence iterative methods (IMs).
3. Optimal two-steps iterative methods (IMs).
4. Two-steps with memory iterative methods (IMs).
5. Two-steps iterative methods (IMs) for multiple roots.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2						3	2	3	2	2	3
CO2	3	3	3	3	2						3	2	3	2	2	3
CO3	3	3	3	3	2						3	2	3	2	2	2
CO4	3	3	2	3	2						3	2	3	2	2	3
CO5	3	3	3	3	3						3	2	3	2	2	3

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD8	4	1	-	5 hours	30	70	100	5

FUNDAMENTALS OF ELASTICITY

Course Objectives:

1. To give the brief discussion about the stress.
2. To provide the basic concepts of strain.
3. To pave the basic concept of elasticity.
4. Brief discussion of mathematical theory of elasticity and technical mechanics.
5. To discuss the propagation of the waves in elastic solid media.

Analysis of Strain: Extension, Pure shear, Simple shear, Homogeneous strain, Component of strain, Strain quadric, Transformation of the components of strain, Types of strain, Identical relation between components of strain, Curvilinear orthogonal coordinates, Components of strain referred to curvilinear orthogonal coordinates, Dilatation and rotation referred to curvilinear orthogonal curvilinear orthogonal coordinates, Cylindrical and polar coordinates.

Analysis of Stress: Traction across a plane at a point, Surface traction and body forces, Equation of motion, Equilibrium, Specification of stress at a point, Measure of stress, Transformation of stress components, Stress quadric, Types of stress, Stress equation of motion and of equilibrium, Uniform stress and uniformly varying stress, Stress equation referred to curvilinear orthogonal coordinates.

The elasticity of solid body: Work and energy, Hook's law, Methods of determining the stress in a body, Elastic constants and modules of isotropic solids, Modulus's of elasticity, Initial stress.

The Relation Between the Mathematical Theory of Elasticity and Technical Mechanics: Limitation of the mathematical theory, stress-strain diagrams, Elastic limits, Saint-Venant's principle, Equation of Equilibrium in Terms of Displacements, Equilibrium Under Surface Traction Only, Various Methods and Results, Plane Strain and Plain Stress,

The Propagation of Waves in Elastic Solid Media: Waves of dilatation and waves of distortion, Motion of a surface of a continuity, Velocity of waves in isotropic medium, Velocity of waves in Allotropic solid medium, wave surfaces, Motion due to body forces, Waves propagated over the surface of an isotropic elastic solid body.

Text Book:

1. A.E.H. Love, A Treatise on the Mathematical Theory of Elasticity, Cambridge University Press (1906).

Reference Books:

1. Laurwerier, H.A and Koiter, W.T., Applied Mathematics and Mechanics, North-Holland Publishing Company - Amsterdam, London (1973).
2. Pujol, Jose, Elastic Wave Propagation and Generation in Seismology, Cambridge University Press (2003).
3. Sokolnikoff, I.S., Mathematical Theory of Elasticity, McGraw Hill Book Co., New-York (1956).
4. Kazimi, SMA, Solid Mechanics, McGraw Hill Education (India) Pvt. Ltd., (2013).

Course Outcomes: This course will enable the students to:

1. Measure the stress and to write the equation of motion.
2. Calculate the different types of strain.
3. Determine the stress in a body.
4. Find the relation among mathematical theory of elasticity and technical mechanics.
5. About the basic concept of wave propagation.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	2	2								2	3	2		1
CO2	2	2	2	2								2	3	2		1
CO3	2	2	2	2								2	3	2		1
CO4	2	2	2	2								2	3	2		1
CO5	2	2	2	2								2	3	2		1

Weightage: 1-Slightly; **2**-Moderately; **3**-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCTD9	4	1	-	5 hours	30	70	100	5

ADVANCED NUMERICAL ANALYSIS

Course Objective:

1. To know about the computational procedure for solving linear systems
2. To know about the computational for solving tridiagonal system systems
3. To learns about the numerical techniques for the solution of integral equation
4. To know about techniques prior to finite element techniques
5. To learn about FEM for linear boundary value problems.

Course Contents:

Unit 1: Numerical linear algebra
Numerical linear algebra: Brief review of LU decomposition, vector and matrix norm, solution of linear systems-direct methods, necessity of pivoting, number of arithmetic operations, computation procedure for LU decomposition method.

Unit 2: Solution of tridiagonal system
Solution of tridiagonal systems, ill-conditioned linear systems, method for ill-conditioned linear systems, solution of linear systems-iterative methods, singular value decomposition.

Unit 3: Solution of integral equation
Numerical solution of integral equation: Transformation of integral equation in initial value problem and vice-versa, Numerical method for Fredholm equations: method of degenerate kernels, method of successive approximations, quadrature methods, cubic Spline method, singular kernels.

Unit 4: Prior to FEM

Finite element methods: functionals, base functions, method of approximation, Rayleigh-Ritz method, Galerkin's method, finite element, shape function.

Unit 5: FEM for linear boundary value problems.

Finite element method for one-dimensional problems, and finite element of linear boundary value problems.

Course Learning Outcomes: This course will enable the students to: aware about numerical methods for lineal algebra problems, aware about Numerical solution of integral equation, fundamental idea about finite element methods

Text/Reference Books:

1. *M. K. Jain, S.R.K. Iyenger, R. K. Jain (2012), Numerical Methods for scientific and Engineering Computation, New Age Int. Publ, New Delhi.*
2. *S. S. Sastry (2013), Introductory Methods for Numerical Analysis, PHI Learning Pvt. Ltd, New Delhi.*
3. *N. H. Kim (2016), Introduction to Nonlinear Finite Element Analysis, Springer.*

Course Objective:

Students will try to learn:

1. The computational procedure for solving linear systems
2. The computational for solving tridiagonal system systems
3. The numerical techniques for the solution of integral equation
4. The techniques prior to finite element techniques
5. FEM for linear boundary value problems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2						3	2	3	2	2	3
CO2	3	3	3	3	2						3	2	3	2	2	3
CO3	3	3	3	3	2						3	2	3	2	2	2
CO4	3	3	2	3	2						3	2	3	2	2	3
CO5	3	3	3	3	3						3	2	3	2	2	3

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPCPF1	**4**	**1**	**-**	**5 hours**	**30**	**70**	**100**	**5**

PROJECT PHASE - I

Note: Under the guidance of faculty member(s) on the topic relevant to the Master's Degree Course.

M.Sc. II YEAR IV SEMESTER SCHEME

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTT1	4	1	-	5 hours	30	70	100	5

COMPLEX ANALYSIS

Course Objectives:

1. To give the detail study about the Cauchy's theory.
2. To discuss the uniform convergence.
3. To detail discussions about singularities.
4. Evaluation of standard integrals by residue theorem.
5. To provide the discussion about the various transformation.

Brief review of analytic function, Cauchy's estimates, Poisson integral formula, Cauchy Hadamard theorem, Complex power series, power series, radius of convergence of power series,

Uniform convergence, general principle of uniform convergence of a sequence, uniform convergence of series, Weirstrass M-test, continuity of sum function, term by term integration, analyticity of sum function, term by term differentiation.

Uniqueness of Laurent series, Singularities, isolated singularities, poles and essential singularities, removable singularities, Riemann's theorem, Casorati-Weirstrass theorem, argument theorem, Rouches's theorem.

Holomorphic functions and their properties, maximum modulus theorem, zeros of analytic functions, analytic continuation,

Cauchy residue theorem and its applications, evaluation of standard types of integrals by the residue calculus method,

Conformal mapping, Mobius transformation, critical points, fixed points, cross-ratio, harmonic conjugates, transformation of harmonic functions, Schwarz lemma, open mapping theorem.

Text Book:

1. M. R. Spiegel, Seymour Lipschutz, John J. Schiller and Dennis Spellman: Complex Variables with an introduction to conformal mapping and its applications, Second Edition, Schaum's Outline Series, Mc Graw Hill, New York (2009).

Reference Books:

2. J. W. Brown and R. V. Churchill: Complex variables and applications, McGraw Hill Education (India) Pvt. Ltd., New Delhi, reprint (2016).
3. S. Ponnusamy: Foundations of Complex Analysis, Narosa Publishing House Pvt. Ltd., India second reprint (2008).
1. S. Lang: Complex Analysis, Springer-Verlag New York, 4th edition (1999).

Course Outcomes: This course will enable the students to:

1. Apply the Cauchy's theory and integral formula.
2. Check the uniform convergence for the complex series.

3. Find out the singularities.
4. Evaluate the standard integrals.
5. Apply the open mapping theorem.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	2	3								2	3	3		2
CO2	3	3	2	3								2	3	3		2
CO3	2	3	2	3								2	3	3		2
CO4	3	3	2	3								2	3	3		2
CO5	3	3	2	3								2	3	3		2

Weightage: 1-Slightly; **2**-Moderately; **3**-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPBTT2	4	1	-	5 hours	30	70	100	5

THOERY OF PARTIAL DIFFERENTIAL EQUATIONS

Course Objective: *The objective of this course is*

1. *To learn to find solution of linear and non-linear PDE of first order.*
2. *To study to find solution of PDE of second order.*
3. *To discuss various application by using second order PDE.*
4. *To give idea about wave equations.*
5. *To discuss few other applications like diffusion equation.*

Unit-1. Cauchy Problem for First Order Equation, Cauchy's Method of Characteristics, Compatible System of First Order Equation, Charpit's Method, Jacobi's Method

Unit-2. Characteristics Curve of Second Order Equation, Solution of Linear Hyperbolic Equation, Separation of Variables, Nonlinear Equation of the Second Order

Unit-3. Occurrence of the Laplace Equation, Family of Equipotential Surface, Boundary Value Problem and its Solution by Separation of Variable, The theory of Green's Function for Laplace Equation, Mixed Boundary Value Problem.

Unit-4. Occurrence of the Wave Equation, Elementary Solution of the one Dimensional Wave Equation, Three Dimensional Problem, Green Function for the Wave Equation.

Unit-5. The Diffusion Equation, Duhamel's Theorem, Solution of Diffusion Equation, The use of Integral Transform and The use of Green Function.

Text Book:

1. Ian N. Sneddon, Elements of Partial Differential Equations, Dover Publications, (2006).

Reference Books:

1. Lawrence C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, American Mathematical Society (1998).
2. Phoolan Prasad and Renuka Ravindran, Partial Differential Equations, New Age International Publishers, (2011).
3. Rao, K.S., Introduction to Partial Differential Equations, PHI Learning, Private Limited, New Delhi, INDIA (2011).

Course Outcomes: After completions of this course, students will be able:

1. *To solve the problems of linear and non-linear PDE of first order by using various techniques.*
2. *To solve the problems of linear and non-linear PDE of second order by using various methods.*
3. *To deal with boundary value problems and mixed boundary value problems, Laplace equations using separation of variable methods.*

4. *To obtain solution of wave equation and its applications.*
5. *To derive solution of diffusion equation and its applications. Also know the Duhamel's theorem and Green's function.*

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2		1	1	2		2		2	2	1		3
CO2	3	2	2		1	1	2		2		2	2	1		3
CO3	3	3	2		1	1	2		3		3	2	1		3
CO4	3	3	2		1	1	2		2		3	2	1		3
CO5	3	3	2		1	1	2		3		3	2	1		3

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD1	4	1	-	5 hours	30	70	100	5

ADVANCED DIFFERENTIAL EQUATIONS

Course objective: The aim of this course:

1. To introduce students to the concepts of existence and uniqueness of solutions to differential equations and methods for their determination.
2. To teach students various numerical and analytical methods for solving boundary value problems, including Picard's theorem and Green's function.
3. To familiarize students with the theory of oscillations of second order equations and the comparison theorems of Hille and Wintner.
4. To provide students with an understanding of the stability of linear and nonlinear systems, including Lyapunov stability and the stability of quasi-linear systems.
5. To teach students how to solve differential equations with deviating arguments, including equations with constant delay and piecewise constant delay.

Existence and Uniqueness of Solutions: Preliminaries successive approximations – Picard's iteration method with some examples – Continuation of solution of IVP and dependence on initial conditions, – Fixed point method.

Boundary value problems: Introduction Boundary value problems, Sturm – Liouville Problem – Green's function –Application of Boundary Value Problem – Picard's theorem.

Oscillations of second order equations: Fundamental results - Sturm's Comparison theorem - Elementary linear oscillations - Comparison theorem of Hille – Wintner - oscillations of $x'' + a(t)\, x = 0$.

Stability of linear and nonlinear systems: Elementary critical points – system of equations with constant coefficients – Linear equation with constant coefficients – Lyapunov stability – stability of quasi linear systems – second order linear differential equations.

Equations with deviating arguments: Equations with constant delay – Equations with piecewise constant delay – a few other types of delay equations.

Text Book:

1. S.G. Deo, V. Lakshmikantham and V. Raghavendra: Text book of ordinary Differential Equations, Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997.

Reference Books:

1. George F. Simmons, Differential Equations, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. W. T. Reid, Ordinary Differential Equations, John Wiley & Sons, NY (1971).

3. Phillip Hartman, Ordinary Differential Equations, John Willy &Sons, NY (1971).
4. E.A. Coddington& N. Levinson, Theorem of Ordinary Differential Equations, Mac, Graw Hill, NY (1955).

Course Outcomes: The students will be able to understand

1. Develop a deep understanding of the theory of ordinary and partial differential equations, including existence and uniqueness of solutions, initial value problems.
2. Understand the techniques to solve Sturm – Liouville Problem, Green's function,– application of boundary value problem, Picard's theorem.
3. Understand the methods to solve oscillations of second order differential equations .
4. Understand about stability theory concept for linear and nonlinear systems.
5. Understand the fundamental concept of delay differential equations and its types

Overall, the course should provide students with a solid foundation in advanced differential equations that can be applied to a wide range of scientific and engineering problems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1									3	2	1	2
CO2	3	3	2	2									3	2	1	2
CO3	3	3	2	2									3	2	1	2
CO4	3	3	2	2									3	2	1	2
CO5	2	2	2	2									3	2	1	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD2	4	1	-	5 hours	30	70	100	5

ADVANCED FUNCTIONAL ANALYSIS

Course Objective:

1. ***The aim of this course is to put forward the most of the concepts from Real Analysis, Algebra, linear algebra, and functional analysis. as a foundation of applied functional analysis.***
2. ***Need to know the inner products and its geometrical properties.***
3. ***By using various examples to understand inner products, Hilbert spaces, product of Hilbert spaces, etc . Various types of operators and their applications in convex programming.***
4. ***Few fundamental theorems of Hahn Banach Theorem, Weak compactness theorem, Reisz Representation theorems to be for better understanding at the advance level.***
5. **Motivate to know the applications in the area of Differential Equations, Integral Equations, Game Theory, etc.**

After the Functional Analysis course in the previous semester student will be in a position to know more about the Applications of Functional in Differential Equations, Integral Equations, Operator Theory, Spectral Theory, Convex Programming.

Inner product spaces. Hilbert spaces. Orthonormal sets. Bessels inequality. Structure of Hilbert spaces. Projection theorem. Adjoint of an operator on a Hilbert space. Reflexivity of Hilbert spaces. Self adjoint operator, positive projection, normal and unitary operators.

Convex Sets and Projections, Orthogonality and Orthonormal Bases, Continuous Linear Functionals, Riesz Representation Theorem, Weak Convergence, Nonlinear Functionals and Generalized Curves, The Hahn-Banach Theorem.

Support Functional of a Convex Set, Minkowski Functinoals, The Support Mapping Theorem, Separation Theorem, Applications to Convex Programming, Generalization to Infinite Dimensional Inequality, The Fundamental Result of Game Theory: Minimax Theorem, Application: Theorem of Farkas.

Linear Operators and their adjoints, Spectral theory of Operators, Spectral theory of compact operators, Operators on separable Hilbert spaces.

Text Book:

1. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
2. Alampallam V. Balakrishnan, Applied Functional Analysis (Applications of Mathematics), Springer, 2nd edition (May 4, 1981), ISBN-10: 0387905278.

Course Outcomes:

1. After this course student may understand the basic properties of Convex Programming and fundamental result of Game Theory.
2. Might understand the applicability of various branches of mathematics such as Differential equations, Integral equations, Game Theory, etc.
3. Also, they can learn the applications of linear operators and their applications.
4. They may understand how to prove some theorems under weaker conditions.
5. This course will be helpful for them in joining research in Nonlinear Functional Analysis.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2						2	2	1	2	2	2
CO2	3	3	2	2						2	2	1	2	2	2
CO3	3	3	2	2						2	2	1	2	2	2
CO4	3	3	2	1						2	2	1	2	1	2
CO5	3	3	2	2						2	2	1	2	2	2

➢ **Weightage: 1-Sightly, 2-Moderately, 3-Strongly**

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD3	4	1	-	5 hours	30	70	100	5

APPLICATIONS OF FUZZY LOGIC

Course Objectives: *Objective of the course is to make Students will able:*

1. To acquaint a student with modern tools of decision making.
2. Learn to tailor a fuzzy set as per requirement.
3. Learn generalization of rules of classical logic into the realm of fuzzy universe.
4. Learn decision making and finding solution of leaner programming problems.
5. Find out applications of fuzzy tools and the techniques in real world seniors.To learn the properties of direct sums and products of ring and modules.

1. Fuzzy Logic and Constructing Fuzzy Sets and Operation on Fuzzy Sets

Classical logic: An overview, multivalued logics, Fuzzy propositions, Fuzzy quantifiers, Linguistic hedges .General discussion, Methods of construction: An overview, Direct methods with one expert, Direct method with multiple experts, Indirect methods with one expert, Indirect methods with multiple experts, Construction from sample data

2. Approximate Reasoning

Fuzzy expert system: an overview, Fuzzy implications, Selection of fuzzy implications, Multi conditional approximate reasoning, the role of fuzzy relation Equations, Interval-valued approximate reasoning.

3. Fuzzy Systems

General discussion, Fuzzy controllers: An overview, Fuzzy controllers: An Example, Fuzzy systems and neural networks, Fuzzy neural networks, Fuzzy automata, Fuzzy dynamic systems.

4. Fuzzy decision making

General discussion, Individual decision making, multi-person decision making, Multicriterial decision making, Multistage decision making, Fuzzy ranking methods, Fuzzy linear programming.

5. Miscellaneous Applications

Introduction, Medicine, Economics, Fuzzy systems and genetic algorithm, Fuzzy regressions, Interpersonal communications, other applications

Text Book:

1. George J. Klir, Bo Yuan, Fuzzy sets and fuzzy logic Theory and Applications, PHI Publications 2002.

Reference Books:

2. Zimmermann, H. J., Fuzzy set theory—and its applications. Springer Science & Business Media (2011).
3. Garg, H., Pythagorean Fuzzy Sets- Theory and Applications. Springer, Singapore (2021).

Course Outcomes: Students will be able to understand after learning the course:

1. Use of fuzzy logic for decision making under real world scenario which is mostly fuzzy.
2. Basic idea of set theory and basics of fuzzy sets. The significance of application of fuzzy sets.
3. Basics of fuzzy controller, idea of fuzzification and defuzzification. Study of fuzzy controllers by mean of examples, Individual and Multiple decision making, Multicriteria and Multistage decision making.
4. Use of individual and multiple decision making, multicriteria and multi stage decision making methods under the fuzzy environment.
5. Over all use of fuzzy methods in the various disciplines in the general and particular areas of his\her interest.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	POS02	PSO3	PSO4
CO1	3	3	2	2		1		1	2	2	1	2	3	3	3	2
CO2	2	2	3	2		-		1	2	1	1	2	3	3	2	2
CO3	2	2	3	2		-		1	2	1	1	2	1	2	2	2
CO4	2	2	2	2		-		1	2	2	1	2	2	2	1	2
CO5	3	2	2	2		-		1	2	2	1	3	3	2	3	2

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD4	4	1	-	5 hours	30	70	100	5

RINGS AND CATEGORIES OF MODULES

Course Objectives: *Objective of the course is to make Students will able:*

1. To understand the basic features of Rings and Categories of Module.
2. To learn the properties of direct sums and products of ring and modules.
3. To study the module categories including tensor Functors, flat modules natural transformations etc.
4. To introduce equivalence and duality for module categories.
5. To familiarize the injective modules, projective modules and their decompositions.

Unit-I: Rings, Modules and Homeomorphisms: Review of Rings and their Homomorphism's, Modules and Sub-modules, Homomorphism's of Modules, Categories of Modules, and Endomorphism Rings

Unit-II: Direct Sums and Products: Direct Summands, Direct Sums and Products of Modules, Decomposition of Rings, Generating and Cogenerating

Unit-III: Functors between Module Categories: The Hom Functors and Exactness-Projectivity and Injectivity, Projective Modules and Generators, Injective Modules and Cogenerators, the Tensor Functors and Flat Modules, Natural Transformations

Unit-IV: Equivalence and Duality for Module Categories: Equivalent Rings, the Morita Characterizations of Equivalence, Dualities, Morita Dualities.

Unit-V: Injective Modules, Projective Modules, and Their Decompositions: Injective Modules and Noetherian Rings-The Faith- Walker Theorems. Direct Sums of Countably Generated Modules-With Local Endomorphism Rings, Semi perfect Rings, Perfect Rings and Modules with Perfect Endomorphism Rings

Text Books:

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Cambridge University Press.

2. M. Artin, Algebra, Prentice Hall of India, 1991.

Reference Book:

1. Frank W. Anderson Kent R. Fuller, Rings and Categories of Modules, Springer-Verlag, New York.

Course Outcomes: At the end of this course, the student will be able:

1. To solve the basic problems of Rings and Categories of Module.
2. To identify the problems of direct sums and products of ring and modules.
3. To learn the module categories including tensor Functors, flat modules natural transformations etc.
4. To new aspects of the equivalence and duality for module categories.
5. To distinguish the injective modules, projective modules and their properties.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1		1					1			1	1		1
CO 2	3	1		2					1			1	1		1
CO 3	3	1		1					1			1	1		1
CO 4	3	1		2					1			1	1		1
CO 5	3	1		2					1			1	1		1

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD5	4	1	-	5 hours	30	70	100	5

CRYPTOGRAPHY

Course Objective: The Students undergoing this course are expected:

1. To learn fundamentals of cryptography and its application to network security.
2. To learn about how to maintain the Confidentiality, Integrity and Availability of a data.
3. Describe the process for implementing cryptographic systems and Identify processes for key administration and validation.
4. Describe the implementation of secure protocols, raise awareness of some of the legal and socio-ethical issues surrounding cryptography.
5. Explain the principles and underlying mathematical theory of today's cryptographic algorithms and provide an understanding of potential weaknesses and problems with ciphers and cryptographic protocols.

Unit I:

Introduction to cryptography: Basic Cryptography Concepts, Mono-alphabetic and Polyalphabetic cipher, The Shift Cipher, The Substitution Cipher, The Affine Cipher, The Vigenere Cipher, The Hill Cipher, The Permutation Cipher, Cryptanalysis, Some Cryptanalytic Attacks, Stream & Block ciphers, Mode of operations in block and stream cipher.

Unit II:

Shannon's Theory of Perfect Secrecy: Perfect Secrecy, Birthday Paradox, Vernam One Time Pad, Random Numbers, Pseudorandom Numbers.

DES & AES: The Data Encryption Standard (DES), Feistel Ciphers, Description of DES, Security analysis of DES, Differential & Linear Cryptanalysis of DES, Triple DES, The Advanced Encryption Standard (AES), Description of AES, analysis of AES.

Prime Number Generation: Trial Division, Fermat Test, Carmichael Numbers, Miller Rabin Test, Random Primes.

Unit III:

Public Key Cryptography: Principle of Public Key Cryptography, *RSA Cryptosystem*, Factoring problem, Cryptanalysis of RSA, RSA-OAEP, *Rabin Cryptosystem*, Security of Rabin Cryptosystem, Quadratic Residue Problem, Diffie-Hellman (DH) Key Exchange Protocol, Discrete Logarithm Problem (DLP), *ElGamal Cryptosystem*, ElGamal& DH, Algorithms for DLP, Elliptic Curve, Elliptic Curve Cryptosystem (ECC), Elliptic Curve Discrete Logarithm Problem (ECDLP).

Unit IV:

Cryptographic Hash Functions: Hash and Compression Functions, Security of Hash Functions, Iterated Hash Functions, SHA-1, Others Hash Functions, Message Authentication Codes.

Digital Signatures: Security Requirements for Signature Schemes, Signature and Hash Functions, RSA Signature, ElGamal Signature, Digital Signature Algorithm (DSA), ECDSA, Fail Stop Signature, Undeniable Signature, Blind Signature, Proxy Signature, Group Signature.

Unit V:

Identification and Authentication: Passwords, One Time Passwords, Challenge-Response Identification, Zero-Knowledge Proofs, The Schnorr Identification Scheme, The Okamoto Identification Scheme, Identity-based Identification Schemes.

Secret Sharing: The Principle, Shamir Secret Sharing Protocol.

Text Books:

1. Wenbo Mao, Modern Cryptography: Theory and Practice. Pearsion Education, 2004
2. J Buchmann, Introduction to Cryptography, Springer (India) 2004.
3. Bruce Schenier, Applied cryptography, John Wiley & Sons, 1996.B. Forouzan, Cryptography and Network security, Tata McGraw Hill, 2011.

Reference Books:

1. D. R. Stinson, Cryptography: Theory and Practice. CRC Press, 2000.
2. W. Starling, Cryptography and Network security, Pearson Education, 2004.

Course Outcomes: Upon the successful completion of the course, students will be able to:

1. Gain knowledge of modern cryptographic algorithms, including symmetric-key and public-key cryptography, as well as their strengths and weaknesses.
2. Understand the basic cryptographic concepts of confidentiality, integrity, authenticity, and non-repudiation, and how these concepts relate to cryptographic algorithms and protocols.
3. Learn how to analyze the security of cryptographic systems, including the identification of vulnerabilities and attacks, and the selection of appropriate cryptographic algorithms and protocols to mitigate risks.
4. Develop the skills necessary to implement cryptographic algorithms, including the generation of keys, encryption, decryption, and digital signatures.
5. Develop critical thinking and problem-solving skills through practical exercises and assignments that require the application of cryptographic concepts and techniques.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	1	2	2	1			2	1	1	2	2	2	2	3
CO2	3	2	2	2	2	2			2	2	1	2	2	2	2	3
CO3	3	2	2	3	2	2			2	2	3	2	2	3	2	2
CO4	3	2	2	3	2	3			2	3	2	2	3	2	2	3
CO5	3	2	3	3	3	2			2	3	3	3	3	3	2	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD6	4	1	-	5 hours	30	70	100	5

FINANCIAL MATHEMATICS AND ITS APPLICATIONS

Course Objective: The objective of this paper is to study:

1. Various types of financial instruments and their applications in various fields.
2. The Mathematical concepts of Black-Scholes formula and option Greeks for option pricing will be explained.
3. To have a proper understanding of mathematical applications in Economics, Finance, Commerce and Management.
4. Understand and assess the principles underlying the evaluation of the main securities that are available in the financial markets.
5. Explain how to evaluate, and assign a single value to a series of cash flows under different assumptions on the time value of money (interest).

Financial Derivatives: Meaning of financial derivatives, Types of financial derivatives – Forwards and futures, Advantages and disadvantages of forward and future contracts, Features of future contracts. Hedging using futures, Difference between forward and future contracts.

Technical analysis: Meaning of technical analysis, basic principal of technical analysis, bullish trend, bearish trend, support and resistance.

Mathematical Indicators: Moving averages, simple moving averages and exponential moving averages.

Options: Definition of option, types of options, call option and put option. Long call, long put, short call, short put, purpose of options, profit and pay of curve, open interest, change in open interest, volume, put call ratio based on open interest and volume, Volatility and implied volatility, Swaps.

Pricing contract via arbitrage: Explanation of option pricing and arbitrage with examples, the Arbitrage Theorem, proof of the Arbitrage Theorem, The multi-period binomial model.

The Black-Scholes Formula: Proof of Black-Scholes formula, properties of Black-Schole's option formula, the delta hedging arbitrage strategy.

Option Greeks: Delta, gamma, Vega, theta and rho, Mathematical and theoretical explanation of option Greeks.

Text Books:

1. John C Hall, Options, features and other derivatives, Prentice- Hall of India Private Limited.
2. Sheldon M Ross, An introduction to Mathematical Finance, Cambridge University Press.

Reference Books:

1 Sahil N. Nettci and Ali Hirsa, An introduction to Mathematics of financial derivatives, Academic Press Inc

2 Robert J Elliot and P. ekkehard Kopp, Mathematics of financial markets, Springer-verlag New Yark Inc
3 S. Kevin, Security analysis and portfolio management, PHI learning Private limited.
4 Redhead, Keith, 1998, Financial Derivatives- An Introduction to Futures, Forwards, Options and Swaps, PHI New Delhi.

Course Outcomes: After successful completion of this paper the students will be able to:

1. Understand about the financial derivatives, technical analysis, Mathematical indicators and option Greeks used in option pricing of securities.
2. Employ methods related to these concepts in a variety of financial applications.
3. Apply logical thinking to problem solving in financial context.
4. Understand the mathematical concept of black schole's option prizing formula.
5. Use appropriate technology to aid problem solving.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	2			2	1	3	2	2	2	2	2
CO2	2	2	2	2	3	2			2	3	2	1	2	3	2	2
CO3	3	3	3	2	2	2			2	2	2	2	3	3	3	2
CO4	3	3	3	2	2	2			3	2	2	3	2	2	2	2
CO5	3	3	2	2	3	2			3	2	3	2	3	3	3	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD7	4	1	-	5 hours	30	70	100	5

MATHEMATICAL ECOLOGY

(To be prepared later)

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD8	**4**	**1**	**-**	**5 hours**	**30**	**70**	**100**	**5**

OPERATIONS RESEARCH

Course Objectives: Student will be able to:

1. Formulate and solve some real life problems where integer optimal value is desirable.
2. Aware about CPM/PERT techniques.
3. Handle many optimization problems that involve large number of decision variables and/or large number of inequality constraints by the technique of dynamic programming.
4. Handle the queuing problem.
5. Solve unconstrained and constrained nonlinear programming problems.

Operation research: Origin and development of O.R., Nature and future of O.R., scientific method in O.R., Modelling in operation research, advantages and limitations of models, general solution methods for OR models, methodology of operation research, operation research and decision – making, applications of operational research.

Brief Review of LPP, simplex method, duality, Integer Programming: Introduction, Pure and mixed integer problems, Gomory's All I. P. P. method, construction of Gomory's constants, fractional cut method All I.P.P. , fraction cut method -mixed integer linear programming problem, Branch and bound method, applications of integer programming.

CPM/PERT: Basic definitions, activity, fullkerson's rule, event numbering, critical path, critical path method, forward and backward pass computation, network diagram, PERT.

Queuing theory: Queuing system, elements of a Queuing system, operating characteristics of a Queueing system, deterministic Queueing system, probability distributions in Queueing system, classification of Queueing models, definition of transient and steady states, Poisson Queueing systems, non-Poisson Queueing systems, cost models in Queueing, other Queueing models.

Dynamic programming problem: Introduction, the recursive equation approach, characteristics of dynamic programming, dynamic programming algorithm, solution of DPP, some applications, solution of LPP by dynamic programming.

Non-Linear Programming: Introduction, formulating a Non-linear programming problem (NLPP), general NLPP, constraint optimization with equality constraints, constraint optimization with inequality constraints.

Text Book:

1. Kanti Swarup, P. K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.

Reference Books:

1. G. Hadley, Linear Programming, Narosa Publishing House, 1995.
2. G. Hadley, Nonlinear and Dynamic Programming, Addison –Wesley, Reading Mass.
3. H. A. Taha, Operation Research- An Introduction, Macmillan Publishing Co. Inc., New York.
4. S. D. Sharma, Operation Research, S. Chand Publ. New Delhi.

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

1. Formulate and solve some real life problems where integer optimal value is desirable.
2. Aware about CPM/PERT techniques.
3. Handle many optimization problems that involve large number of decision variables and/or large number of inequality constraints by the technique of dynamic programming.
4. Handle the queuing problem.
5. Solve unconstrained and constrained nonlinear programming problems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	1	2	3	3	3	1	2	2	2
CO2	3	3	3	3	3	3	3	1	2	3	3	3	2	2	2	2
CO3	3	3	2	2	3	3	3	1	2	3	3	3	2	2	2	2
CO4	3	3	3	3	3	3	3	1	2	3	3	3	2	2	2	2
CO5	3	3	3	3	3	3	3	1	2	3	3	3	2	2	2	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD9	4	1	-	5 hours	30	70	100	5

Paper Code: AMPDTD9
THEORY OF RELATIVITY
(To be prepared later)

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDTD10	4	1	-	5 hours	30	70	100	5

FUNDAMENTALS OF THEORETICAL SEISMOLOGY

Course Objectives:

1. To provide the basic concept of continuum mechanics.
2. To give the discussion about seismic wave propagation.
3. To study the reflection and transmission of seismic wave.
4. To study the Ray methods.
5. To study the transport equation and their solution.

Basic Relations of Continuum Mechanics, Stress-Strain relation, Strain Energy function, Green's Function, Seismic Wave, Classification of Seismic Waves, Seismic Source, Equation of Motion-3D Problem, Equation of motion in the time and frequency domains, Wave Potentials, Separation of the Equation of Motion, Plane Wave, Harmonic Plane Waves, Spherical Waves, Reflection and Transmission of Plane Waves at a plane Interface, Love Waves in a layered half-space, Love Waves in a layer over half-space, Seismic Response. The Ray Method, The Ray Series in the Frequency domain, The Ray Series in the Time Domain, The Basic System of the Equations of the Ray Method, Ray and Ray Field, Transport Equation, Solution of Transport Equations.

Text Book:

Peter Moczo, Introduction to Theoretical Seismology, Lecture Notes., http://www.fyzikazeme.sk/mainpage/stud_mat/Introduction_to_Theoretical_Seismology.pdf

Reference Books:

1. Shearer, P.M., *Introduction to Seismology*, Cambridge University Press (2012).
2. Ewing, W.M., Elastic Waves in Layered Media, McGraw-Hill Inc., US (2018).
3. Pujol, Jose, *Elastic Wave Propagation and Generation in Seismology*, Cambridge University Press (2003).

Course Outcomes: This course will enable the students to:

1. Understand the basic idea of continuum mechanics.
2. Understand the seismic wave propagation and their characteristics.
3. Evaluate the reflection and transmission coefficients.
4. Understand the Ray methods.
5. Solve the transport equation.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	3	2	2								2	1	1		1
CO2	2	3	2	2								2	1	1		1
CO3	2	3	2	2								2	1	1		1
CO4	2	3	2	2								2	1	1		1
CO5	2	3	2	2								2	1	1		1

Weightage: 1-Slightly; **2**-Moderately; **3**-Strongly

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
AMPDPF1	4	1	-	5 hours	30	70	100	5

PROJECT PHASE - II

Note: Under the guidance of faculty member(s) on the topic relevant to the Master's Degree Course.