K.K. UNIVERSITY

NALANDA, BIHAR - 803115

SCHOOL OF APPLIED SCIENCES

MASTER OF SCIENCE (M.Sc.)

MATHEMATICS

(Two Year Full Programme)

2024-2025

PROGRAMME STRUCTURE & SYLLABUS

K.K. UNIVERSITY 803115 NALANDA

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Berauti, Nepura, Bihar Sharif
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M.Sc. Mathematics 2 year Course Structure

Year	Semester	Course Code	Course Title	L	T	P	C
1	1	MSMT 1101	Modern Algebra	5	0	0	5
		MSMT 1102	Fluid Mechanics	5	0	0	5
		MSMT 1103	Real Analysis	5	0	0	5
		MSMT 1104	Advance Topology	5	0	0	5
			Total	**20**	**0**	**0**	**20**
	2	MSMT 1201	Operation Research	5	0	0	5
		MSMT 1202	Fundamentals of Computer	5	0	0	5
		MSMT 1203	Integral Equation	5	0	0	5
		MSMT 1204	Discrete Mathematics	5	0	0	5
			Total	**20**	**0**	**0**	**20**
2	3	MSMT 2101	Integration Theory	5	0	0	5
		MSMT 2102	Complex Analysis	5	0	0	5
		MSMT 2103	Partial differential Equation	5	0	0	5
		MSMT 2104	Functional Analysis	5	0	0	5
			Total	**20**	**0**	**0**	**20**
	4	MSMT 2201	Linear Algebra	5	0	0	5
		MSMT 2202	Numerical Analysis	5	0	0	5
		MSMT 2203	Integral Transform	5	0	0	5
		MSMT 2205	Project /Dissertation	5	0	0	5
			Total	**20**	**0**	**0**	**20**
			Total Credits				**80**

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SEMESTER –I

MODERN ALGEBRA

Sub. Code - MSMT-1101

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology and differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand the the fundamental concepts of groups, rings, fields, and their properties.

CO2: Explain the theorems and concepts related to homomorphisms, isomorphisms, and cosets in various algebraic contexts.

CO3: Apply abstract algebraic techniques to solve problems involving group theory, ring theory, and field theory.

CO4: Analyze the properties of different algebraic structures, such as finite vs. infinite groups or commutative vs. non-commutative rings.

CO5: Formulate and Construct proofs for algebraic theorems and develop original approaches to solve advanced algebraic problems.

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Course Objective:

The objective of the course is to understand the fundamental theory of Groups, Ring and their properties. Students will explore the concepts of Polynomial rings, UFD, ED, PID, Field extensions, Einstein's irreducibility criterion etc. Analyze the concepts of homomorphism and isomorphism and apply these concepts to solve mathematical problems.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Group, Subgroup and coests, Normal subgroups and quotient groups, Isomorphism theorems, Automorphisms, Normalizer and Centralizer, The class equation, Cauchy`s theorem, Permutation groups Sn and Alternating group An, Direct products of groups, Simple group.	24	1-4
II	Concept of divisibility in a ring and associates, Irreducible and Reducible elements, Maximal and Prime ideals , Ring of Polynomials, Characteristics of a ring, Integral domains, Unique factorization domain (U.F.D.), Principal ideal domain (P.I.D.), Euclidean domain, Relationship between U.F.D., P.I.D. and Euclidean domain**.**	24	5-8
III	Field theory-Extension fields, finite extension, Algebraic and transcendental extensions. splitting field existence and uniqueness, Separable and inseparable extension. Normal extensions. Perfect fields.	18	9-11
IV	Finite fields, Theorems on finite fields, Primitive elements. Algebraically closed fields. Automorphism of extensions, Galois extension. Fundamental theorem of Galois Theory.	18	12-14

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	Existence of multiple roots of a polynomial and irreducibility of the polynomial.		
Revision Week			15

Books And References:

- **Contemporary Abstract Algebra**, Joseph A Gallion, Narosa Pub.House P.Ltd.
- **A First Course In Abtract Algebra**, Joseph B. Fraleigh, Pearson Edu. Inc.,2003.
- **Algebra**, Vivek Sahai, Vikas Bist, Narosa Pub. House Pvt. Ltd., 2010.
- **Abstract Algebra**,V.K. Khanna and S.K.Bhabari, Vikash Pub. House P.Ltd.
- **Topics in Algebra**, I.N.Herstein, John Wiley and Sons, New York.
- **Modern Algebra**, Surjeet and Qazi Zameeruddin.

Website and e-Learning Source:

- http://mathforum.org
- http://ocw.mit.edu/ocwweb/Mathematics
- http://www.opensource.org
- www.algebra.com

FLUID MECHANICS

SUB. CODE - MSMT 1102

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand the principles of fluid statics and dynamics, including the behavior of fluids at rest and in motion.

CO2: Demonstrate problem-solving using fluid mechanics equations.

CO3: Differentiate between flow types and analyze flow patterns.

CO4: Evaluate the fluid system performance and critique experimental studies.

CO5: Create a fluid system and develop a research proposal in fluid mechanics.

Course Objective:

The objective of this syllabus is to provide students with a comprehensive understanding of basic principles of fluid mechanics. Explores various methods of analysis, including Lagrangian and Eulerian approaches.

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Analyze the equations of motion, boundary conditions,

and complex potential theory. Students will develop analytical skills to solve complex fluid dynamics problems and gain insights into real-world applications of fluid mechanics in engineering and science.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Lagrangian and Eulerian methods, Equation of continuity in different coordinate system, Boundary surfaces, Stream lines, Path lines and streak lines, Velocity potential, Irrotational and rotational motions, Vortex lines.	24	1-4
II	Lagrange's and Euler's equations of motion. Bernoulli's theorem. Equation of motion by flux method. Impulsive actions. Stream function Irrotational motion.	18	5-7
III	Complex velocity potential. Sources, sinks doublets and their images in two dimensions. Conformal mapping. Milne Thomson circle theorem.	18	8-10
IV	Two-dimensional Irrotational motion produced by motion of circular, co-axial and elliptic cylinders in an infinite mass of liquid, Theorem of Blasius, Motion of a sphere through a liquid at rest at infinity, Liquid streaming past a fixed sphere, Equation of motion of a sphere.	24	11-14
Revision Week			15

Books And References:

- **A Treatise on Hydro mechanics;** W.H.Besaint & A. S. Ramsey, Part II. CBS Publishers. Delhi. 1988.
- **An Introduction of Fluid Mechanics;** G.K. Batchelor, Foundation Books. New Delhi1994.
- **Textbook of Fluid Dynamics;** F. Choriton. Textbook of Fluid Dynamics. C.B.S. Publishers. Delhi 1985.
- **Fluid dynamics;** M.D. Raisinghania, S.Chand Publication**.**
- **A Text Book of Fluid mechanics**, R K Bansal, Laxmi Publ.,2008.

Website and e-Learning Source

- https://nptel.ac.in/courses/105105119
- http://mathforum.org
- http://ocw.mit.edu/ocwweb/Mathematics
- www.mathpages.com

REAL ANALYSIS

SUB. CODE- MSMT-1103

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand the concepts of convergence for sequences and series of functions, including point wise and uniform convergence.

CO2: Apply the tests for uniform convergence and approximation theorems in practical problems involving series of functions.

CO3: Analyze the properties of Riemann-Stieltje's integral and the implications of rearranging series terms.

CO4: Synthesize the knowledge of power series and related theorems to solve complex problems in analysis.

CO5: Assess the functions of several variables using advanced mathematical techniques and theorems.

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Course Objective:

This course is designed to provide a deep understanding of foundational concepts of calculus and rigorous framework behind it. Explore the concepts and techniques related to integration, differentiation, functions of several variables, and optimization methods. Analyze the behavior of sequences and series, including concepts of convergence, divergence and limits. Develop the knowledge of Riemann Stieltjes integral.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Sequences and series of function : Point wise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, Uniform convergence and continuity, Uniform convergence & Integration, Uniform convergence & differentiation, Weierstrass approximation theorem.	24	1-4
II	Rearrangements of term of a series, Riemann's theorem, Power series, Uniqueness theorem for power series, Abel's and Tauber's theorems.	12	5-6
III	Riemann-Stieltje's Integral: Definition and existence of the Riemann-Steieltje's integral, Linearity properties of the integral, Integration and differentiation, The fundamental theorem of calculus.	12	7-8
IV	Functions of several variables: Linear transformations, Derivatives in an open subset of **R**, Chain rule, Partial derivatives interchange of the order of differentiation	24	9-12

	derivatives of higher orders, Taylor's theorem for functions of two variables.		
V	Jacobians and functions with non-zero Jacobians, Inverse function theorem, Implicit function theorem, Extremum problems with constraints, Lagrange's multiplier method.	12	13-14
Revision Week			15

Books And References:

- **Principles of Mathematical Analysis**, W. Rudin, 3rd Edition. New Delhi: McGraw-Hill Inc., 2013.
- **Real Analysis**, H.L. Royden, and P.M.Fitzpatrick, 4th Edition. New Delhi: Pearson, 2010.
- **Real Analysis**, N. L. Carothers, Cambridge University Press, 2000.
- **Mathematical Analysis –A modern approach to Advanced Calculus,** T.M. Apostol, New Delhi: Narosa Publishing House, 1957.
- **Understanding Analysis**, *S.* Abbott, 2nd Edition. Springer, 2016.

Website and e-Learning Source:

- http://mathforum.org
- http://ocw.mit.edu/ocwweb/Mathematics
- http://www.opensource.org
- www.mathpages.com

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ADVANCE TOPOLOGY

SUB. CODE - MSMT-1104

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand fundamental concepts of topology, including open and closed sets, continuity, and compactness.

CO2: Apply topological definitions and theorems to solve problems related to convergence and connectedness.

CO3: Analyze various types of topological spaces, such as Hausdorff, compact, and connected spaces, and their properties.

CO4: Evaluate the implications of different topological properties and their relationships in both theoretical and practical contexts.

CO5: Create rigorous proofs and examples that demonstrate the topological concepts and theorems.

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Course Objective:

The objective of advanced topology course are to provide students with a deep understanding of complex topological concepts and techniques. Explore the property and classifications of various topological spaces, including compactness, connectedness and separation axioms. Apply separation axioms to prove theorems about space properties and function behavior. Encourage exploration of original research idea and the development of a research –oriented mindset.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Notion of a topological space, open set topology and fundamental concepts of open sets, closed sets, neighborhoods, adherent points, accumulation points, closure, interior and boundary in a topological space, subspace. Important interrelations between fundamental concepts.	24	1-4
II	Convergence of sequences in a topological space, continuity and homomorphism, characterisations of continuity and homeomorphism, base and sub base of a topology, continuity and sequential continuity**.**	12	5-6
III	Separation axioms in a topological space, T_0, T_1, T_2, Regular find normal space and their mutual implication relationships, unique limit of sequences in a Hausdorff (T_2) space. Hereditary and topological properties.	12	7-8
IV	Compactness concept in a topological space, compact subsets of a topological space with Hansdorff property,		

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	characterization of compactness by closed sets with finite intersection property, compactness and continuity, compact sets in real line R (under usual topology)	24	9-12
V	Connected and disconnected spaces, connectedness and continuity, characterizations of connected and disconnected spaces, connected sets in a topological space, sufficient conditions under which union of connected sets is connected, connected sets in R (under usual topology).	12	13-14
Revision Week			15

Books And References:

- **Advanced General Topology;** Prof. K.K. Jha – Advanced General Topology, Nav Bharat Prakashan, Delhi-6.
- **2. Introduction to General Topology and Modern Analysis;** G.F.Simmons , McGraw Hill Book Company, INC.
- **General Topology**, S.Lipschutz, Schaum's out line series.
- **Introduction to General Toplogy**, K.D. Joshi, Wiley Eastern Ltd. 1983.

Website and e-Learning Source:

- http://mathforum.org
- http://ocw.mit.edu/ocwweb/Mathematics
- http://www.opensource.org
- www.mathpages.com

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SEMESTER -II

OPERATION RESEARCH

SUB. CODE- MSMT-1201

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand key concepts of operations research, including optimization and decision-making.

CO2: Apply operations research methodologies to solve complex mathematical equations.

CO3: Analyze systems using quantitative techniques and interpret results for decision-making.

CO4: Evaluate optimization models and methods for effectiveness in specific applications.

CO5: Create new models and strategies to address operational challenges using learned techniques.

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Course Objective:

The objective of this syllabus is to provide students with a comprehensive understanding of optimization method and techniques. Develop skills to formulate, analyze, and solve complex decision- making problems using mathematical models. Apply analytical tools and techniques to real world problems in various field such as logistics, finance and manufacturing.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Origin and development of O.R. applications of O.R., Nature and features of O.R., Model in O.R. and its classification, advantages and limitations, Hyper plane, supporting and separating hyper planes, Hyper sphere, convex. Sets and their properties, convex combination of vectors**.**	24	1-4
II	Simplex method for solving a linear programming problem, Basic solution, Degenerate solution, Basic feasible solution, fundamental theorem of linear programming, conditions of optimality.	24	5-8
III	Two-phase method, Big-M method of solving a linear programming problem. Duality in linear programming, Duality theorems, existence theorem, Dual simplex method.	12	9-10
IV	Integer programming, fractional cut method, Branch and bound method. General non-linear programming problem, Lagrange's multipliers.	12	11-12

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V	Conditions for a general non-linear programming problem, Kuhn-Tucker conditions for general non-linear programming, Conditions for non-negative saddle point .	12	13-14
Revision Week			15

Books And References:

- **Operations Research,** Hamdy A. Taha , An introduction, Macmillan Co. INC, New York.
- **Operations Research,** Dr. B. S. Geoel & S. K. Mittal , Pragati Prakashan.
- **Optimization Theory and Applications**, S.S. Rao, Wiley Eastern Ltd. New Delhi. 1990
- **Operation research: Theory & Applications**, J.K Sharma, 3rd Edition, Macmillan India, 2007.

Website and e-Learning Source:

- http://mathforum.org
- http://ocw.mit.edu/ocwweb/Mathematics
- http://www.opensource.org
- www.mathpages.com

FUNDAMENTALS OF COMPUTER

SUB.CODE- MSMT 1202

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand key concepts related to the history of computers, types of software, and memory types.

CO2: Apply knowledge of programming languages, including machine, assembly, and high-level languages.

CO3: Analyze the components and functions of computer systems, including the CPU and input/output units.

CO4: Evaluate the between different number systems, such as decimal, binary, octal, and hexadecimal.

CO5: Create a model of a computer network that demonstrates the internet applications and their communication methods.

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Course Objective:

Understand of the fundamental concepts of computer systems, software, programming languages, communication technologies and their practical applications in various fields. Explore and analyze the theory of number system. Recognize and apply ethical principles in the use of computer technology.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Computer Fundamentals**:** History of Computers**,** Types of Software**,** Memory Types**,** Uses of Computer.	18	1-3
II	Languages: Generations of Computers**,** Machine Language, Assembly Language, High Level Language. Components: Input Unit, Output Unit, CPU, Input and Output Dev**ices,** Memory	24	4-7
III	Number System, Decimal, Binary, Octal, Hexadecimal, number conversation.	18	8-10
IV	Computer Communication & Internet: Basic of Computer Networks, Types of computer Networks, Internet, Application of Internet, Communication on Internet.	24	11-14
Revision Week			15

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Books And References:

- **Introduction to Information Technology;** ITL Education Solutions Ltd., Pearson Education India.
- **Computer Fundamentals;** Pradip K. Sinha, , BPB Publications.

Website and e-Learning Source:

- http://mathforum.org
- http://ocw.mit.edu/ocwweb/Mathematics
- http://www.opensource.org
- www.mathpages.com

INTEGRAL EQUATIONS

SUB. CODE- MSMT-1203

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand the fundamental concepts of integral equations, including their types and properties.

CO2: Apply various methods to solve integral equations, such as the method of successive approximations and the Laplace transform.

CO3: Analyze integral equations to determine their uniqueness and existence of solutions using relevant theorems.

CO4: Evaluate the effectiveness of different numerical methods for approximating solutions to integral equations.

CO5: Create the integral equations from real-world problems, demonstrating the ability to model complex systems.

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Course Objective:

The objective of this course is to provide students with a comprehensive understanding the theory and classification of integral equations. Analyze the various types of integral equations and their solutions. Explore advanced topics and techniques in integral equation. Critical analyze and evaluate different solution methods and their applicability to various problems.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Definition and classification, conversion of initial and boundary value problems to an integral equation, Eigen-Values and Eigen functions, Solutions of homogeneous and general Fredholm integral equations of second kind with separable kernels.	24	1-4
II	Solution of Fredholm and Volterra integral equations of second kind by methods of successive substitutions and successive approximations, Resolvent kernel and its results.	24	5-8
III	Integral equations with symmetric kernels: Complex Hilbert space, Orthogonal system of functions, fundamental properties of eigen values and eigen functions for symmetric kernels.	18	9-11
IV	Expansion in eigen-functions and bilinear forms, Hilbert-Schmidt theorem, Solution of Fredholm integral equations of second kind by using Hilbert-Schmidt theorem, Fredholm	12	12-13

	theorems.		
V	Solution of Volterra integral equations with convolution type kernels by Laplace transform.	6	14
Revision Week			15

Books And References:

- **Linear Integral Equations;** W.V.Lovitte, over Publications; Reissue edition (2005).
- **Linear Integral Equations;** Preston M. A. and Bhaduri R. K, Birkhäuser; 2nd edition , (1996).
- **Linear Integral Equations;** S.G. Mikhlin, , Routledge, (1961).
- **Introduction to Hilbert space and the theory of spectral multiplicity**, Halmos P.R.,, 2nd Edition. Chelsea Pub., Co., N.Y. 1957.

Website and e-Learning Source:

- http://mathforum.org
- http://ocw.mit.edu/ocwweb/Mathematics
- http://www.opensource.org
- www.mathpages.com

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DISCRETE MATHEMATICS

SUB. CODE- MSMT-1204

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand core concepts of set theory, logic, relations, functions, and algebraic structures.

CO2: Apply combinatorics, graph theory, and proof techniques to solve mathematical problems.

CO3: Analyze structures like graphs, trees, and finite automata to identify properties and relationships.

CO4: Evaluate the validity of propositions and proofs using logical reasoning and proof techniques.

CO5: Create solutions to complex problems using algebraic structures, recurrence relations, and graph theory.

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Course Objective:

Understand fundamental concepts of discrete mathematics. Analyze the basic principles of combinatorics, including counting techniques and pigeonhole principle. Explore various discrete structures, including trees, lattices and Graph colouring. Enhance critical thinking and problem-solving skills through rigorous mathematical reasoning and analysis.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Set Theory: Definition of Sets, Venn Diagrams, complements, cartesian products, power sets, counting principle, cardinality and countability (Countable and Uncountable sets), proofs of some general identities on sets, pigeonhole principle. Relation composition of relations, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation, Function, composition of functions, recursively defined functions.	18	1-3
II	Propositional logic: Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction, normal forms (conjunctive and disjunctive), modus ponens and modus tollens, validity, predicate logic, universal and existential quantification. Notion of proof: proof by implication, converse, inverse, contra positive, negation, and contradiction, direct proof, proof by using truth table, proof by counter example.	18	4-6
III	Combinatories: Mathematical induction, recursive		

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	mathematical definitions, basics of counting, permutations, combinations, inclusion-exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relation), generating function (closed form expression, properties of G.F., solution of recurrence relation using G.F, solution of combinatorial problem using G.F.)	18	7-9
IV	Algebraic Structure: Binary composition and its properties definition of algebraic structure; Groyas Semi group, Monoid Groups, Abelian Group, properties of groups, Permutation Groups, Sub Group, Cyclic Group, Rings and Fields (definition and standard results).	18	10-12
V	Graph terminology, types of graph connected graphs, components of graph, Euler graph, path and circuits, Graph colouring, Chromatic number. Tree: Definition, types of tree(rooted, binary), properties of trees, binary search tree, tree traverssing (preorder, inorder, postorder). Finite Automata: Basic concepts of Automation theory, Deterministic finiteAutomation (DFA), transition function, transition	12	13-14
Revision Week			15

Books And References:

- **Discrete Mathematics and its Applications;** Kenneth H. Rosen, Mc.Graw Hill, 2002.
- **Combinatories: Theory and Applications;** V. Krishnamurthy, East-West Press.
- **Discrete Matheamatical Structures;** Kolman, Busby Ross, Prentice Hall International.

- **Discrete Mathematical Structures applications to Computer Science**, J.P. Trembley and R.Manohar, Tata McGraw Hills, New Delhi.
- **Discrete Mathematics with Graph Theory and Combinatorics**, T. Veerarajan, Tata McGraw Hills Publishing Company Limited ,7th Reprint,2008.

Website and e-Learning Source:

- http://mathforum.org
- http://ocw.mit.edu/ocwweb/Mathematics
- http://www.opensource.org

SECOND YEAR

SEMESTER –III

INTEGRATION THEORY

SUB. CODE- MSMT-2101

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand key concepts of measure spaces, measurable functions, and types of integrals like the Lebesgue integral.

CO2: Apply integration techniques to solve problems involving measurable functions and convergence theorems.

CO3: Analyze the properties of integrals and measures, such as monotonicity and convergence.

CO4: Evaluate and compare different integration theories like Riemann and Lebesgue

integrals.

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CO5: Create solutions to advanced problems using Fubini's and Tonelli's theorems.

Course Objective:

The objective of this syllabus is to provide students with a deep understanding of measure and integration theory. Analyze the complex mathematical problems and theoretical frameworks. Explore the foundational concepts and theorems in measure theory. students will develop the ability to identify and solve the problems in various areas of mathematics, including analysis, probability theory, and functional analysis.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Signed measure, Hahn decomposition theorem, Mutually singular measures.	24	1-4
II	Lebesgue-Stieltjes integral, Product measures, Fubini's theorem, Differentiation and integration.	18	5-7
III	Decomposition into absolutely continuous parts, Bair sets, Baire measure, Continuous functions with compact support.	18	8-10
IV	Regularity of measure on locally compact spaces. Integration of continuous functions with compact support. Riesz Markoff theorem.	24	11-14
Revision Week			15

Books And References:

- **Real Analysis;** H. L. Royden -Mecmillan Publishing Co. INC
- **Measure and Integration;** S. K. Berberian -, Chelsea Pub. Co. N.Y.

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- **An Introduction to Measure and Integration;** Inder K. Rana , Narosa Pub. House, Delhi.

Website and e-Learning Source:

- http://mathforum.org
- http://ocw.mit.edu/ocwweb/Mathematics
- http://www.opensource.org
- www.mathpages.com

COMPLEX ANALYSIS

SUB. CODE- MSMT-2102

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand key concepts of complex numbers, analytic functions, and the Cauchy-Riemann equations.

CO2: Apply techniques for evaluating complex integrals using Cauchy's integral theorem and residue theorem.

CO3: Analyze properties of holomorphic functions, including continuity and conformal mappings.

CO4: Evaluate the behavior of complex functions and their singularities.

CO5: Create solutions to advanced problems by applying theorems like the Riemann mapping theorem.

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Course Objective:

The objective of this syllabus is to provide students with a comprehensive understanding of complex analysis, focusing on the properties and behavior of functions of complex variables. Explore the power series and Laurent series, and analyze the concept of convergence and its applications. Students will develop analytical skills to solve complex problems and gain insights into the applications of complex analysis in various fields.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Complex number, analytic function , Cauchy Riemann equation, Cauchy-Goursat Theorem, Cauchy's Integral formula, Higher order derivatives, Morera's Theorem,Cauchy's inequality, Liouville's theorem and Fundamental theorem of Algebra.	24	1-4
II	Power series, Taylor's theorem, Laurents series, Maximum modulus principle, Schwarz lemma**.**	12	5-7
III	Singularities, Zeros & poles, Residues, Cauchy's residue theorem, Evaluation of real integrals, Branches of many valued functions with special reference to argz, Log z and z^n**.**	18	8-10
IV	Meromorphic functions, Principle of argument, analytic continuation, uniqueness of direct analytic continuation.	6	11
V	Bilinear transformation, their properties and classifications, Definition and examples of conformal mappings, Necessary and sufficient condition of conformal mappings, Preservance	24	12-14

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	of cross-ratio under the bilinear transformation.		
Revision Week			15

Books And References:

- **Complex variables and applications**, Churchill and Brown, McGraw-Hill Pub.Company.
- **Real and Complex Analysis,** Walter Rudin, Mc Graw Hill Book Co. 1966.
- **The Theory of Functions**, E.C. Titchmarsh, Oxford University Press. London.
- **Theory of functions of a complex variable;** Shanti Narayan ,S.Chand and company Ltd., New Delhi
- **Applied complex variable;** John W. Dettman , Macmillan Company, New York.

Website and e-Learning Source:

- http://mathforum.org
- http://ocw.mit.edu/ocwweb/Mathematics
- http://www.opensource.org
- www.mathpages.com

PARTIAL DIFFERENTIAL EQUATION

SUB. CODE- MSMT-2103

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand the concepts of partial differential equations, including classification and types.

CO2: Apply solution techniques like separation of variables and method of characteristics.

CO3: Analyze solutions to PDEs, focusing on boundary and initial value problems.

CO4: Evaluate the effectiveness of different solution methods for various PDEs.

CO5: Create mathematical models using PDEs to describe physical phenomena.

Course Objective:

Partial differential equations (PDEs) covers fundamental concepts and solution techniques for various types of PDEs. It explores first-order PDEs, linear and nonlinear PDEs, as well as their

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applications in mathematical modeling and physical systems. Students will learn methods such as

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Charpit's method, Jacobi's method, and Monge's method for solving PDEs. The course also covers classification, reduction, and solution of second-order PDEs, including the Laplace, heat, and wave equations.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Partial differential equations of the first order, Integral surface, Orthogonal surfaces, Non-linear Partial differential equations, Charpit's method, Jacobi's method**.**	18	1-3
II	Homogeneous and non Homogeneous linear partial differential equation with constant co-efficient, Methods for finding C.F. and P.I. of linear homogeneous Partial Differential Equations**.**	18	4-6
III	Solution of equations under given geometrical conditions. Monge's method for integration of the equation Rr+Ss + Tt = V**.**	12	7-8
IV	Classification and solution of Partial Differential Equations of order two and their examples. Cauchy's problem for seemed order Partial Differential Equations characteristic equation and characteristic curves of the second order Partial Differential Equations. Reduction of linear Partial Differential Equations. in two variables to canonical form and then classifications into elliptic, parabolic and hyperbolic forms**.**	24	9-12
V	Laplace's, heat and wave equations in one and two dimensions in Cartesian, polar and cylindrical forms, Solution	12	13-14

	of Laplace' s equation, heat equations and wave equations.		
Revision Week			15

Books And References:

- **Ordinary and partial Differential Equation**; M.D. Raisinghania , S. Chand & Company Ltd.
- **Differential Equation**; Bhargava & Chandramouli, Pragati Prakashan.
- **Advanced Partial Differential Equation**; Pundir & Pundir –, Pragati Prakashan.
- **Elements of Partial Differential Equations,** I.N.Sneddon, McGraw Hill, New Delhi, 1983
- **Partial Differential Equations,** S, Sankar Rao, 2nd Edition, Prentice Hall of India, New Delhi. 2004

Website and e-Learning Source:

- http://mathforum.org
- http://ocw.mit.edu/ocwweb/Mathematics
- http://www.opensource.org
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FUNCTIONAL ANALYSIS

SUB. CODE- MSMT-2104

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand the fundamental concepts of functional analysis, including normed spaces, Banach spaces and their role in modern mathematics.

CO2: Apply principles of functional analysis to solve problems with bounded linear operators and continuity.

CO3: Analyze properties of functional and operators, including spectral theory and compact operators.

CO4: Evaluate implications of key theorems like the Hahn-Banach theorem and the Open Mapping theorem.

CO5: Create solutions to complex problems by constructing proofs using advanced concepts in functional analysis.

Course Objective:

The objective of this syllabus is to provide students with a rigorous understanding of functional analysis, focusing on the properties and structures of vector spaces equipped with norms, inner products, and operators. Through the study of fundamental principles and advanced topics, students will develop analytical skills to analyze linear transformations, boundedness, orthogonality, and spectral properties of operators in various functional spaces.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Normed linear spaces and Banach spaces, continuity of vector addition scalar multiplication and the norm function in a normed linear space, quotient space of a normed linear space, Lemma of F. Riesz.	24	1-4
II	Continuous linear transformation and functional & normed linear spaces of bounded linear transformations, dual spaces with examples, uniform boundedness theorem and some of its consequences, open mapping and closed graph theorems, Hahn- Banach theorem for real linear spaces, complex linear spaces and normed linear spaces.	24	5-8
III	Inner product spaces and Hilbert spaces, Cauchy-Schwrz inequality, continuity of inner product function, Parallelogram law, Polarisation identity, Lemma of F. Riesz on closed convex set in H.	18	9-11

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IV	Orthogonal complements, Projection theorem in a Hilbert space, Orthonormal sets, Bessel's inequalities, characterization on theorem for complete orthonormal set in a Hilbert space, Frechet Riesz representation theorem for bounded linear functionals in H.	12	12-13
V	Adjoint of an operator on H, self-adjoint operators and positive operators in H, normal operators, Unitary operators.	12	14
Revision Week			15

Books And References:

- **Functional Analysis with Applications;** K. K. Jha , Students Friends, Patna
- **Functional Analysis with Applications;** A. H. Siddiqui, Tata McGraw Hill, Publishing Company Ltd., New Delhi.
- **Introduction to Topology and Modern Analysis;** G. F. Simmons,McGraw Hill Book Company, New York, 1963

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SEMSTER-IV

LINEAR ALGEBRA

SUB. CODE-MSMT- 2201

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand the concepts of systems of linear equations, matrix operations, and vector spaces.

CO2: Utilize linear transformations and the rank-nullity theorem, along with operations involving dual spaces.

CO3: Examine eigenvalues, eigenvectors, and properties of linear transformations, including diagonalizability and the Cayley-Hamilton theorem.

CO4: Assess direct-sum decompositions, invariant subspaces, and the primary decomposition theorem.

CO5: Develop orthonormal bases using the Gram-Schmidt process and solutions related to Jordan forms.

Course Objective:

Understand the fundamental concepts of vector space, matrices and linear transformation. Explore the concepts of inner products, orthogonality and orthonormal sets. Apply linera algebra concepts to real-world problems in various field such as engineering and computer science.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Systems of linear equations, Matrices, Elementary row operations, Row-reduced echelon matrices. Vector spaces Subspaces, Bases and dimension, Ordered bases and coordinates.	24	1- 4
II	Linear transformations, Rank-nullity theorem, Algebra of linear transformations, Isomorphism, Matrix representation, Linear functionals, Annihilator, Double dual, Transpose of a Linear Transformation.	24	5-8
III	Characteristic values and characteristic vectors of linear transformations, Diagonalizability, Minimal polynomial of a linear transformation, Cayley-Hamilton theorem, Invariant subspaces.	18	9-11
IV	Direct-sum decompositions, Invariant direct sums, The primary decomposition theorem, Cyclic subspaces and annihilators, Cyclic decomposition, Rational, Jordan forms.	12	12-13
V	Inner product spaces, Orthonormal bases, Gram-Schmidt process**.**	6	14

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Revision Week	15

Books And References:

- **Linear Algebra,** K. Hoffman and R. Kunze (2nd edition), Prentice Hall of India, New Delhi (1997).
- **Algebra,** M.Artin , Prentice – Hall of India, 2005.

Website and e-Learning Source:

- http://mathforum.org
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- http://www.opensource.org
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NUMERICAL ANALYSIS

SUB. CODE-MSMT- 2202

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand the key concepts in numerical analysis, including error analysis and numerical methods.

CO2: Apply the numerical techniques to solve linear and nonlinear equations and perform integration and differentiation.

CO3: Examine the stability and convergence of numerical methods in various applications.

CO4: Evaluate the accuracy and efficiency of different numerical algorithms.

CO5: Develop and implement numerical algorithms for solving complex problems.

Course Objective:

The objective of this syllabus is to provide students with a comprehensive understanding of numerical methods and computational techniques for solving mathematical problems encountered in scientific and engineering applications. Through theoretical study and practical implementation, students will develop the skills to analyze, design, and apply numerical algorithms effectively, with a focus on accuracy, efficiency, and error analysis.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Numerical computation and Error analysis: Numbers and their accuracy, Floating point arithmetic Errors in numbers, Error estimation, General error formulae, Error propagation in computation.Inverse problem of error analysis and Numerical instability. Algebraic and transcendental equations: Bisection method, Iteration method, Regula-Falsi method, Secant method, Newton-Raphson's method. Convergence of these methods. Lin-Bairstow's method, Muller's method, Graeffe's root squaring method, Solution of system of nonlinear equations, Complex roots by Newton-Raphson's method.	24	1-4
II	System of linear algebraic equations: Gauss elimination method without pivoting and with pivoting, Gauss-Jordon method, LU-factorization method, Jacobi and Gauss-Seidal methods, Convergence of iteration methods, Round-off errors and refinement, ill-conditioning, Partitioning method, Inverse of matrices. Eigen values and eigen vectors: Rayleigh Power	18	5-8

	method, Given's method and Householder's method.		
III	Interpolation: Finite differences, Newton's interpolation formulae, Gauss, Stirling's and Bessel's formulae, Lagrange's, Hermite's and Newton's divided difference formulae. Numerical differentiation and integration: differentiation at tabulated and non-tabulated points, Maximum and minimum values of tabulated function,	18	9-11
IV	Newton-Cotes Formulae-Trapezoidal, Simpson's, Boole's and Weddle' rules of integration with errors, Romberg integration, Gaussian integration, Double integration by Trapezoidal and Simpson's rules. Ordinary differential equations: Taylor series and Picard's methods, Euler's and modified Euler methods, Runge-Kutta methods, Predictor-Corrector methods:	12	12-13
V	Adams-Bashforth's and Milne's methods. Error analysis and accuracy of these methods. Solution of simultaneous and higher order equations, Boundary value problems: Finite difference and Shooting methods.	6	14
Revision Week			15

Books And References:

- **Introductory methods of Numerical Analysis,** S. S. Sastry, Prentice Hall India, 2002.
- **Methods for Engineers and Scientists,** Sharma, J.N., Numerical, 2nd Edition. NarosaPubl. House New Delhi/Alpha Science International Ltd.,Oxford UK, 2007.
- **Numerical Methods;** Balagurusamy, E., New Delhi: Tata McGraw Hill, 1999

Website and e-Learning Source:

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INTEGRAL TRANSFORM

SUB. CODE-MSMT- 2203

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcomes:

CO1: Understand the fundamental concepts of integral transforms, including Laplace and Fourier transforms.

CO2: Apply integral transforms to solve ordinary and partial differential equations.

CO3: Analyze properties and applications of different integral transforms in various mathematical contexts.

CO4: Evaluate the effectiveness of integral transforms in simplifying complex problems and their convergence properties.

CO5: Create solutions to advanced problems using integral transforms by constructing proofs and applying relevant theorems.

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Course Objective:

The objective of this syllabus is to provide students with a comprehensive understanding of integral transform techniques and their applications in solving differential equations and signal analysis problems. Through the study of Laplace, Fourier, Hankel, and Mellin transforms, students will develop analytical skills to solve a wide range of mathematical and engineering problems efficiently.

Syllabus Details:

UNIT	CONTENT	NO OF HOURS	NO OF WEEK
I	Laplace Transform, Properties of Laplace Transform, Inverse Laplace Transform, Convolution theorem, Laplace transform of periodic functions, unit step function and impulsive function, Application of Laplace Transform in solving ordinary and partial differential equations and Simultaneous linear equations**.**	24	1-4
II	Fourier transform, properties of Fourier transform, inversion formula, convolution, Parseval's equality, Fourier transform of generalized functions, application of Fourier transforms in solving heat, wave and Laplace equation. Fast Fourier transforms	24	5-8
III	Hankel Transform, Inversion formula for Hankel Transform,Some important results for Bessel Functions.	12	9-10
IV	Linearity property, Hnakel Transfrom of derivative of a		

	function, Parseval theorem**.**	12	11-12
V	Mellin Transform (Def.), The Mellin inversion Theorem, Linearity Property, Mellin Transform of derivatives, Mellin Transform of integrals, Convolution theorem for Mellin Transform	12	13-14
Revision Week			15

Books And References:

- **Fourier Transforms;** Goldberg, R.R., Cambridge University Press, 1970.
- **Laplace Transform Theory;** Smith, M.G., Van Nostrand Inc., 2000.

Website and e-Learning Source:

- http://mathforum.org
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- http://www.opensource.org
- www.mathpages.com

PROJECT /DISSERTATION

SUB. CODE-MSMT- 2204

Program Outcomes:

PO1: Understand the fundamental concepts of pure and applied mathematics.

PO2: Apply the advanced mathematical concepts in areas such as algebra, analysis, topology And differential equations.

PO3: Analyze the mathematical techniques to solve interdisciplinary problems in field like Engineering, computer sciences etc.

PO4: Synthesize the mathematical model and equation of real world phenomena with Proficiency.

PO5: Prepare to pursue further studies in mathematics or related fields such as Ph.D. or Contribute to the advancement of Mathematics.

Course Outcome

CO1: Recall relevant theories and methods for the chosen project topic.

CO2: Understand key concepts and frameworks related to the project.

CO3: Apply mathematical tools to solve project-specific problems.

CO4: Analyze data and results, identifying patterns and relationships.

CO5: Evaluate project outcomes and justify chosen methodologies.

Course Objective:

The objective of the syllabus is to provide students with the opportunity to conduct in-depth research in a specialized area of mathematics under the guidance of faculty mentors. By completing a project and dissertation, students will demonstrate their ability to apply advanced mathematical concepts, techniques, and methodologies to address research questions, solve problems, and make original contributions to the field of mathematics.

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