Department of Mathematics (SF)
M.Sc. Mathematics

PROGRAM OUTCOMES (PO)

PO1: Advanced Knowledge and Understanding
Graduates will possess an in-depth understanding of fundamental and advanced concepts across various disciplines, enabling them to apply this knowledge to solve complex problems and conduct innovative research. This encompasses advanced mathematical techniques, theoretical and classical physics, and comprehensive understanding in fields such as condensed matter physics, statistical mechanics, and thermodynamics.

PO2: Analytical and Problem-Solving Skills
Graduates will develop strong analytical skills, allowing them to critically assess and solve problems using various methodologies. They will be adept at utilizing mathematical and computational techniques, including numerical analysis, algorithm development, and programming, to model and solve intricate problems in their respective fields.

PO3: Research Proficiency and Methodological Expertise
Graduates will be equipped with advanced research skills, including literature review, research design, data collection, analysis, and interpretation. They will be capable of conducting independent research, presenting findings, and contributing to the academic community through publications and conferences.

PO4: Experimental and Practical Skills
Graduates will demonstrate proficiency in conducting advanced experiments, utilizing modern laboratory techniques, and adhering to safety protocols. They will be skilled in error analysis, data validation, and the application of practical knowledge to verify theoretical concepts.

PO5: Computational and Numerical Proficiency
Graduates will develop expertise in computational methods and numerical techniques, enabling them to perform simulations and solve complex problems in physics, mathematics, and other related fields. This includes proficiency in programming languages and software tools relevant to their discipline.

PO6: Interdisciplinary Integration and Application
Graduates will integrate knowledge from various disciplines to address complex research questions and practical challenges. They will be able to apply concepts from fields such as genetics, bioinformatics, physiology, and immunology to interdisciplinary problems, fostering innovation and collaboration.

PO7: Communication and Presentation Skills
Graduates will enhance their communication skills, both written and verbal, to articulate complex concepts clearly and concisely. They will be proficient in presenting research findings, conducting seminars, and participating in comprehensive viva voce examinations.

PO8: Professional Development and Ethical Practices
Graduates will demonstrate professional development, ethical practices, and a commitment to lifelong learning. They will be prepared for professional roles in academia, industry, and beyond, with an understanding of the ethical implications of their work and the importance of continuous professional growth.

PO9: Cultural Sensitivity and Global Awareness
Graduates will cultivate cultural sensitivity and global awareness by engaging with diverse perspectives and traditions. They will appreciate the richness and diversity of their field, enabling them to navigate cultural differences with empathy and understanding.

PO10: Strategic Decision-Making and Management Skills
Graduates will develop strategic decision-making and management skills, enabling them to evaluate financial, organizational, and marketing strategies effectively. They will be adept at financial analysis, investment management, and applying quantitative techniques to support strategic decisions.

PO11: Adaptability to Emerging Trends and Technologies
Graduates will stay abreast of the latest trends and developments in their field, including emerging technologies and contemporary tools. They will be prepared to adapt to new advancements and incorporate innovative techniques into their research and professional practice.

PO12: Environmental and Societal Impact Awareness
Graduates will be aware of the environmental and societal impacts of their work, promoting sustainability and responsible practices. They will be equipped to contribute to conservation efforts, environmental management, and the development of solutions that address societal challenges.

Program Specific Outcomes (PSO)

Program Specific Outcomes (PSO)	Students will be able to…..	Mapped Program Outcomes (PO)

Advanced Algebraic Proficiency	demonstrate proficiency in abstract algebra, including the application of fundamental theorems, isomorphism theorems, and concepts related to factor groups, homomorphisms, and rings, enabling them to analyze and solve complex algebraic problems.	PO1, PO2, PO5
Linear Algebraic Understanding	possess a deep understanding of linear transformations, matrices, determinants, eigenvalues, and eigenvectors, allowing them to apply linear algebra concepts to various mathematical and scientific contexts.	PO1, PO2, PO6
Topological Insight	gain insight into basic and advanced concepts in topology, including the transition from metric spaces to topological spaces, properties of topological spaces, connectedness, compactness, and the application of topology to modeling real-world problems.	PO1, PO2, PO6
Analytical Skills in Real Analysis	develop strong analytical skills in real analysis, including the analysis of functions, curves, integrals, convergence, continuity, and properties of complex fields, enabling them to rigorously analyze mathematical	PO1, PO2

	concepts and solve mathematical problems.	
Graph Theory and Problem-Solving	master the fundamental concepts of graph theory and its applications, including modeling real-world problems, determining graph properties such as Hamiltonian and Eulerian paths, and solving problems related to connectivity and planarity.	PO1, PO2, PO6
Computational Mathematics Proficiency	demonstrate proficiency in numerical analysis, complex analysis, and numerical optimization techniques using Python, enabling them to apply computational methods to solve mathematical problems efficiently and accurately.	PO2, PO5, PO11
Research and Presentation Skills	develop advanced research skills, critical thinking abilities, and effective communication skills through seminar assignments and projects, enabling them to conduct rigorous research, analyze data, and present findings effectively in both written and verbal forms.	PO3, PO7, PO8

Course Outcomes (CO)

Course	Course Outcome (CO)	Bloom's Taxonomy	Mapped PSO
Abstract Algebra	CO1: Apply the fundamental theorem of finitely generated abelian groups.	Apply	PSO1
	CO2: Examine isomorphism theorems concerning isomorphic factor groups.	Analyze	PSO1
	CO3: Apply the concept of G-sets to counting.	Apply	PSO1
	CO4: Make use of Sylow's theorem to find the properties of subgroups of a finite group.	Apply	PSO1
	CO5: Analyze Fermat's and Euler's theorems.	Analyze	PSO1
	CO6: Explain the concepts of prime ideals, maximal ideals, homomorphism and factor rings.	Understand	PSO1
Linear Algebra	CO1: Understand the basic concepts of linear transformation and its algebra.	Understand	PSO2
	CO2: Identify a linear transformation by a matrix.	Apply	PSO2
	CO3: Relate matrices of linear transformations with respect to different bases.	Apply	PSO2
	CO4: Analyze determinant function and its properties.	Analyze	PSO2
	CO5: Determine characteristic values and characteristic vectors of a linear transformation.	Analyze	PSO2
	CO6: Understand the basic theory of invariant subspaces and direct sum decompositions.	Understand	PSO2

Basic Topology	CO1: Understand the transition from metric spaces to topological spaces.	Understand	PSO3
	CO2: Examine whether a given family of subsets is a topology or not.	Analyze	PSO3
	CO3: Develop basic concepts in metric spaces to topological spaces.	Understand	PSO3
	CO4: Explain smallness conditions defined in topological spaces.	Understand	PSO3
	CO5: Distinguish between connected and disconnected spaces.	Analyze	PSO3
	CO6: Discuss the concepts of local connectedness and path connectedness.	Understand	PSO3
Real Analysis	CO1: Remember monotone functions and explore its properties.	Remember	PSO4
	CO2: Understand the concepts of bounded variation and total variation.	Understand	PSO4
	CO3: Explain curves, paths and arc length.	Understand	PSO4
	CO4: Develop the idea of Riemann Integral to Riemann Stieltjes Integral.	Apply	PSO4
	CO5: Analyze the relation between uniform convergence and continuity.	Analyze	PSO4
	CO6: Discuss the algebraic completeness of complex field.	Understand	PSO4
Graph Theory	CO1: Explain the basic concepts of graph theory.	Understand	PSO5
	CO2: Identify induced subgraphs, cliques, vertex cuts, edge cuts and spanning trees.	Analyze	PSO5
	CO3: Model real world problems using graph theory.	Apply	PSO5
	CO4: Determine whether graphs are Hamiltonian and/or Eulerian.	Analyze	PSO5

	CO5: Discuss problems involving vertex and edge coloring.	Understand	PSO5
	CO6: Solve problems involving vertex and edge connectivity and planarity.	Apply	PSO5
Advanced Abstract Algebra	CO1: Analyze extensions of fields.	Analyze	PSO1
	CO2: Analyze the properties of unique factorization domain and Euclidean Domain.	Analyze	PSO1
	CO3: Understand the concept of splitting fields.	Understand	PSO1
	CO4: Understand the concepts of isomorphisms and automorphisms of Fields.	Understand	PSO1
	CO5: Develop rigorous proofs for theorems arising in the context of abstract algebra.	Create	PSO1
	CO6: Illustrate Galois theory.	Apply	PSO1
Advanced Topology	CO1: Understand the significance of the classic theorems characterizing Normality.	Understand	PSO3
	CO2: Define topology on the product of an arbitrary collection of topological spaces.	Understand	PSO3
	CO3: Identify whether a given topological property is productive.	Analyze	PSO3
	CO4: Explain the concept of evaluation functions and embedding lemma.	Understand	PSO3
	CO5: Apply the concept of nets.	Apply	PSO3
	CO6: Discuss variations of compactness.	Understand	PSO3
Numerical Analysis with Python 3	CO1: Understand symbols and symbolic operations in Python.	Understand	PSO6

	CO2: Calculate maxima and minima of a function using Python.	Apply	PSO6
	CO3: Verify continuity of a function at point and area between two curves.	Apply	PSO6
	CO4: Explain interpolation and curve fitting in Python.	Understand	PSO6
	CO5: Apply Python to Bisection and Newton Raphson methods to obtain the roots of an equation.	Apply	PSO6
	CO6: Illustrate numerical integration using Python.	Apply	PSO6
Complex Analysis	CO1: Explain the fundamental concepts of complex analysis and their role in modern mathematics.	Understand	PSO6
	CO2: Find parametrizations of curves and compute line integrals.	Apply	PSO6
	CO3: Apply the residue theorem to compute definite integrals.	Apply	PSO6
	CO4: Explain singularities of analytic functions.	Understand	PSO6
	CO5: Discuss local properties of analytic functions.	Understand	PSO6
	CO6: Discuss the Cauchy's theorems.	Understand	PSO6
Measure Theory & Integration	CO1: Understand Lebesgue outer measure of a set.	Understand	PSO4
	CO2: Analyze the construction of non-measurable sets.	Analyze	PSO4
	CO3: Define Lebesgue integral of a function.	Understand	PSO4
	CO4: Explain general measure spaces.	Understand	PSO4
	CO5: Apply signed measure to measurable functions.	Apply	PSO4

	CO6: Understand Radon Nikodym Theorem.	Understand	PSO4
Advanced Complex Analysis	CO1: Illustrate the concept of power series.	Apply	PSO6
	CO2: Explain infinite products and canonical products.	Understand	PSO6
	CO3: Distinguish between harmonic and subharmonic functions.	Analyze	PSO6
	CO4: Analyze Riemann Zeta function.	Analyze	PSO6
	CO5: Find the series development of analytic function.	Apply	PSO6
	CO6: Discuss the main ideas in the proof of the Riemann mapping theorem.	Understand	PSO6
Partial Differential Equations	CO1: Recall origin of first order partial differential equations.	Remember	PSO4
	CO2: Analyze Pfaffian differential equations in three variables.	Analyze	PSO4
	CO3: Solve linear and nonlinear partial differential equations.	Apply	PSO4
	CO4: Apply Charpit's/ Jacobi method to solve partial differential equations.	Apply	PSO4
	CO5: Understand compatible systems of first order equations.	Understand	PSO4
	CO6: Create an ability to identify the families of equipotential surfaces.	Create	PSO4
Multivariate Calculus & Integral Transforms	CO1: Understand Weierstrass approximation theorem.	Understand	PSO4
	CO2: Explain other forms of Fourier series.	Understand	PSO4
	CO3: Make use of Fourier integral Theorem to find definite integrals.	Apply	PSO4

	CO4: Develop the relation between beta and gamma functions using convolution theorem.	Apply	PSO4
	CO5: Evaluate extremum problems.	Evaluate	PSO4
	CO6: Discuss multivariable differential calculus.	Understand	PSO4
Functional Analysis	CO1: Make use of basic concepts of normed and inner product spaces.	Apply	PSO4
	CO2: Understand the basic theory of bounded linear operators.	Understand	PSO4
	CO3: Identify the role of Zorn's lemma.	Understand	PSO4
	CO4: Apply the theory of Hilbert spaces to other areas including Fourier Series.	Apply	PSO4
	CO5: Make use of inner product to represent functionals on Hilbert spaces.	Apply	PSO4
	CO6: Discuss Hahn-Banach theorem.	Understand	PSO4
Optimization Techniques	CO1: Recall basic concepts of simplex and revised simplex method.	Remember	PSO6
	CO2: Apply duality theorems in simplex methods.	Apply	PSO6
	CO3: Distinguish integer programming and mixed integer programming Problems.	Analyze	PSO6
	CO4: Understand the use of minimum path in a network problem.	Understand	PSO6
	CO5: Analyze the concept of maximum potential difference in a network.	Analyze	PSO6
	CO6: Understand search methods in nonlinear programming problems.	Understand	PSO6
Spectral Theory	CO1: Extend basic concepts of convergence of elements to operators and Functionals.	Apply	PSO6

	CO2: Understand open mapping theorem and closed graph theorem.	Understand	PSO6
	CO3: Explain spectral properties of bounded linear operators.	Understand	PSO6
	CO4: Use complex analysis in spectral theory.	Apply	PSO6
	CO5: Analyze the theory of compact linear operators and their spectrum.	Analyze	PSO6
	CO6: Discuss basic theory of Banach algebras and unbounded operator Theory.	Understand	PSO6
Analytic Number Theory	CO1: Analyze arithmetical functions.	Analyze	PSO6
	CO2: Apply Euler's summation formula.	Apply	PSO6
	CO3: Discuss elementary theorems on the distribution of prime numbers.	Understand	PSO6
	CO4: Apply congruences to prove Lagrange's theorem and Euler-Fermat Theorem.	Apply	PSO6
	CO5: Understand primitive roots and partitions of a positive integer.	Understand	PSO6
	CO6: Apply quadratic reciprocity law.	Apply	PSO6
Differential Geometry	CO1: Recall graphs, level set and orientation.	Remember	PSO4
	CO2: Understand tangent space and surface.	Understand	PSO4
	CO3: Explain gauss map and geodesics.	Understand	PSO4
	CO4: Understand parallel transport.	Understand	PSO4
	CO5: Concepts of Weingarten maps.	Understand	PSO4
	CO6: Concepts of parametrized surfaces.	Understand	PSO4

Algorithmic Graph Theory	CO1: Understand the basic concepts of graphs and algorithmic complexity.	Understand	PSO5
	CO2: Apply the theory of algorithms.	Apply	PSO5
	CO3: Analyze the properties of trees and rooted trees, Activity digraphs.	Analyze	PSO5
	CO4: Concepts of networks and Mengers theorem.	Understand	PSO5
	CO5: Basics of Matchings.	Understand	PSO5
	CO6: Block Design.	Understand	PSO5
Combinatorics	CO1: Main concepts of permutation and Combinations.	Understand	PSO5
	CO2: Explain pigeon hole principle and Ramsey numbers.	Understand	PSO5
	CO3: Concepts of Principle of inclusion and exclusions.	Understand	PSO5
	CO4: Define sterling's number.	Remember	PSO5
	CO5: Make use of results in finite fields in cyclic codes.	Apply	PSO5
	CO6: Discuss the concepts of Generating functions and recurrence relation.	Understand	PSO5
Project	CO1: Develop the ability to design rigorous research studies.	Create	PSO7
	CO2: Critically evaluate existing research, identify gaps or limitations in the literature, and situate your research within the broader scholarly discourse.	Evaluate	PSO7
	CO3: Apply statistical or qualitative analysis techniques, interpret findings, and draw conclusions based on empirical evidence.	Apply	PSO7
	CO4: Apply critical thinking skills to analyze data, interpret results, and propose innovative solutions.	Apply	PSO7

	CO5: Develop research timelines, set realistic goals, allocate resources, and meet project milestones.	Create	PSO7
	CO6: Develop research timelines, set realistic goals, allocate resources, and meet project milestones.	Create	PSO7
Seminar/Assignment	CO1: Enhance understanding and knowledge of the subject matter covered in the courses.	Understand	PSO7
	CO2: Encourage the development of critical thinking skills.	Analyze	PSO7
	CO3: Develop problem-solving skills, including the ability to identify problems, generate alternative solutions, and select the most appropriate approach to solve them.	Apply	PSO7
	CO4: Develop effective communication skills, both written and verbal.	Apply	PSO7
	CO5: Learn how to prioritize tasks, meet deadlines, and manage your workload effectively.	Apply	PSO7
	CO6: Enhance understanding and knowledge of the subject matter covered in the courses.	Understand	PSO7