DEPARTMENT OF MATHEMATICS

Programme Name: MSc Mathematics

Programme Outcomes

PO1: Inculcate critical thinking to carry out scientific investigation objectively without being biased with preconceived notions.

PO2: Equip the student with skills to analyze problems, formulate an hypothesis, evaluate and validate results, and draw reasonable conclusions thereof.

PO3: Prepare students for pursuing research or careers in industry in mathematical sciences and allied fields

PO4: Imbibe effective scientific and/or technical communication in both oral and writing.

PO5: Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in mathematical sciences.

PO6: Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges.

Programme Specific Outcomes

SPO1: Understanding of the fundamental axioms in mathematics and capability of developing ideas based on them.

SPO2: Inculcate mathematical reasoning.

SPO3: Provide knowledge of a wide range of mathematical techniques and application of mathematical methods/tools in other scientific and engineering domains.

SPO4: Provide advanced knowledge on topics in pure mathematics, empowering the students to pursue higher degrees at reputed academic institutions.

SPO5: Strong foundation on algebraic topology and representation theory which have strong links and application in theoretical physics, in particular string theory.

SPO6: Good understanding of number theory which can be used in modern online cryptographic technologies.

SPO7: Nurture problem solving skills, thinking, creativity through assignments, project work.

SPO8: Assist students in preparing (personal guidance, books) for competitive exams e.g. NET, GATE, etc.

SPO9: Prepare and motivate students for research studies in mathematics and related fields.

SEM I

PAPER – I Abstract Algebra

After the completion of the course, Students will be able to

CO1: Define the external direct product and be able to compute the direct product of groups.
CO2: Define normal subgroups and be able to prove that given subgroups are normal.
CO3: Concept of group action and theorems about group actions.
CO4: Structure of permutation groups.
CO5: Polynomial rings, EDs, PIDs, & UFDs, and relations among them. Universality of Polynomial rings
CO6: Solving problems using the powerful concept of group action.
CO7: Facility in understanding the structure of a problem where the problem involves a permutation group
CO8: Ability to understand a large class of commutative rings by regarding them as quotients of polynomial rings by suitable ideals.
CO9: Apply Lagrange's theorem.

Paper – II Mathematical Analysis

After the completion of the course, Students will be able to

CO1: Describe fundamental properties of the real numbers that lead to the formal development of mathematical analysis.
CO2: Comprehend regions arguments developing the theory underpinning mathematical analysis.
CO3: Demonstrate an understanding of limits and how that is used in sequences, series and differentiation.
CO4: Construct rigorous mathematical proofs of basic results in mathematical analysis.
CO5: Appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.

Paper – III Ordinary & Partial Differential Equation

After the completion of the course, Students will be able to

CO1: Classify partial differential equations and transform into canonical form.
CO2: Solve linear partial differential equations of both first and second order
CO3: Apply partial derivative equation techniques to predict the behavior of certain phenomena.
CO4: Apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of specialization.
CO5: Extract information from partial derivative models in order to interpret reality.
CO6: Identify real phenomena as models of partial derivative equations. Demonstrate familiarity with emerging mathematical techniques appropriate in banks and other financial institutions.
CO7: Demonstrate an ability to select and apply numerical methods appropriate for the solution of financial problems.
CO7: The principles of mathematical reasoning and their use in understanding analyzing and developing formal arguments.
CO8: The connect lens between the mathematical series and other scientific and humoristic disciplines.

Paper – IV Elementary Number Theory

After the completion of the course, Students will be able to

CO1: Prove results involving divisibility and greatest common divisors. Solve systems of linear congruence's.
CO2: Find integral solutions to specified linear Diophantine Equations.
CO3: Apply Euler-Fermat's Theorem to prove relations involving prime numbers.
CO4: Apply the Wilson's theorem.
CO5: Demonstrate knowledge and understanding of topics including, but not limited to divisibility, prime numbers, congruences, quadratic reciprocity, Diophantine equations. □
CO6: Learn methods and techniques used in number theory. □
CO7: Write programs/functions to compute number theoretic functions. □
CO8: Use mathematical induction and other types of proof writing techniques.

Paper – V Discrete Mathematics

After the completion of the course, Students will be able to

CO1: Understand the basic principles of sets and operations in sets.

CO2: Apply counting principles to determine probabilities Demonstrate different traversal methods for trees and graphs.

CO3: Write model problems in computer science using tree and graphs.

CO4: Write an argument using logical notation and determine if the argument is or is not valid.

CO5: Determine when a function is one-one and onto.

CO6: Demonstrate the ability to write and evaluate a proof.

SEM II

PAPER – I Galois's Theory

After the completion of the course, Students will be able to

CO1: Explain the fundamental concepts of Golois Theory and their role in modern mathematics applied contexts.

CO2: Explain Demonstrate accurate and efficient use of advanced algebraic techniques.

CO3: Demonstrate capacity for mathematical reasoning through analyzing, proving and concepts from advanced algebra.

CO4: Apply problem solving using Galois Theory techniques applied to diverse situations in physics, engineering and other mathematical finance.

Paper – II Lebesgue Measure and Integrations

After the completion of the course, Students will be able to

CO1: Read analyze and write logical arguments to prove mathematical concepts.

CO2: Communicate mathematical ideas with clarity and coherence both written and verbally.

CO3: Fundamental objects, techniques and theorems in the mathematical sciences including the fields of analysis.

CO4: Master the object material in the four required core course that forms the academic pillars of the program.

CO5: Demonstrate a competence in formulating, analyzing and solving problems in several core areas of mathematics at a detailed level, including analysis.

Paper – III Complex Analysis

After the completion of the course, Students will be able to

CO1: Students will be able to understand the concept of limit for real functions and be able to

CO2: calculate limits of standard functions and construct simple proofs involving this concept;

CO3: Student will be introduced to the concept of continuity and be familiar with the statements and proofs of the standard results about continuous real functions;

CO4: Student will understand the concept of the differentiability of a real valued function and be

CO5: familiar with the statements and proofs of the standard results about differentiable real functions.

CO6: Student will have a working knowledge of differentiability for complex functions and be familiar with the Cauchy-Riemann equations;

CO7: Student will evaluate integrals along a path in the complex plane and understand the statement of Cauchy's Theorem.

CO8: Justify the need for a Complex Number System and explain how is related to other existing number systems.

CO9: Define a function of complex variable and carry out basic mathematical operation with complex numbers.

CO10: Know the condition(s) for a complex variable function to be analytic and/or harmonic functions

CO11: Equation and use it to show that a function is analytic define singularities of a function, know the different types of singularities, and be able to determine the points of singularities of a function

CO12: Demonstrate familiarity with a range of examples of these concepts.

CO13: Apply the methods of complex analysis to evaluate definite integrals and infinite series.

Paper – IV Topology

After the completion of the course, Students will be able to

CO1: Demonstrate an understanding of the concepts of metric spaces and topological spaces, and their role in mathematics.

CO2: Demonstrate familiarity with a range of examples of these structures.

CO3: Prove basic results about completeness, compactness, connectedness and convergence within these structures.

CO4: Use the Banach fixed point theorem to demonstrate the existence and uniqueness of solutions to differential equations.

CO5: Demonstrate an understanding of the concepts of Hilbert spaces and Banach spaces, and their role in mathematics.

CO6: Demonstrate familiarity with a range of examples of these structures.

CO7: Prove basic results about Hilbert spaces and Banach spaces and operators between such spaces.

CO8: Apply the theory in the course to solve a variety of problems at an appropriate level of difficulty.

Paper – V Theory of Ordinary Differential Equations

After the completion of the course, Students will be able to

CO1: The study of Differential fcourse on the existence and uniqueness of solutions and also analysis the rigorous justification of methods for approximating solutions in pure and applied mathematics.

CO2: Theory of ordinary differential equations is widely used in formulating many fundamental laws of physics and chemistry.

CO3: Theory of differential equation is used in economics and biology to model the behaviour of complex systems.

CO4: Differential equations have a remarkable ability to predict the world around us.

CO5: They can describe exponential growth and decay population growth of species or change in investment return over time.

CO6: Analyze real world scenarios to recognize when ordinary differential equations (ODEs) or systems of ODEs are appropriate, formulate problems about the scenarios, creatively model these scenarios (using technology, if appropriate) in order to solve the problems using multiple approaches, judge if the results are reasonable, and then interpret and clearly communicate the results.

CO7: Recognize ODEs and system of ODEs concepts that are encountered in the real world, understand and be able to communicate the underlying mathematics involved to help another person gain insight into the situation.

CO8: Work with ODEs and systems of ODEs in various situations and use correct mathematical terminology, notation, and symbolic processes in order to engage in work, study, and conversation on topics involving ODEs and systems of ODEs with colleagues in the field of mathematics, science or engineering.

SEM III

PAPER – I Functional Analysis

After the completion of the course, Students will be able to

CO1: To learn to recognize the fundamental properties of normed spaces and of the transformations between them.
CO2: Understand the notions of dot product and Hilbert space and apply the spectral theorem to the resolution of integral equations.
CO3: Correlate Functional Analysis to problems arising in Partial Differential Equations, Measure Theory and other branches of Mathematics.
CO4: Appreciate how functional analysis uses and unifies ideas from vector spaces, the theory of metrics, and complex analysis.
CO5: Understand and apply fundamental theorems from the theory of normed and Banach spaces, including the Hahn-Banach theorem, the open mapping theorem, the closed graph theorem, and the Stone-Weierstrass theorem.
CO6: Appreciate the role of Zorn's lemma.
CO7: Understand and apply ideas from the theory of Hilbert spaces to other areas, including Fourier series, the theory of Fredholm operators, and wavelet analysis.
CO8: Understand the fundamentals of spectral theory, and appreciate some of its power.

PAPER – II General Measure & Integration

After the completion of the course, Students will be able to

CO1: Verify whether a given subset of R or a real valued function is measurable.
CO2: Understand the requirement and the concept of the Lebesgue integral (a generalization of the Reimann integration) along its properties.
CO3: Demonstrate understanding of the statement and proofs of the fundamental integral convergence theorems, and their applications.
CO4: Introduce the concepts of functions of bounded variations and the absolute continuity of functions with their relations.
CO5: Extend the concept of outer measure in an abstract space and integration with respect to a measure.
CO6: Learn and apply Holder and Minkowski inequalities in Lp-spaces, completeness of Lp-spaces and convergence in measures.

PAPER – III Linear Algebra

After the completion of the course, Students will be able to

CO1: Determine the existence and uniqueness of the solution of a linear system, A~x =~b and find all solutions by choosing an effective method such as Gaussian elimination, inverting A, a suitable factorization or diagonalization of A, etc.
CO2: Find the dimension and basis of a a given vector space.
CO3: Write down the matrix representing a linear transformation (such as projection, rotation, dilation, etc.) under a given basis, and determine how the matrix changes if the basis is changed.
CO4: Find the Gram-Schmidt orthogonalization of a matrix.
CO5: Determine the rank, determinant, eigen values and eigenvectors, diagonalization, and different factorizations of a matrix.
CO6: Solve systems of linear equations using multiple methods, including Gaussian elimination and matrix inversion.
CO7: Carry out matrix operations, including inverses and determinants.
CO8: Demonstrate understanding of the concepts of vector space and subspace.
CO9: Demonstrate understanding of linear independence, span, and basis.
CO10: Determine eigen values and eigenvectors and solve eigen value problems.

CO11: Apply principles of matrix algebra to linear transformations.
CO12: Demonstrate understanding of inner products and associated norms.

PAPER – IV A Operation Research

After the completion of the course, Students will be able to

CO1: To develop linear programming (LP) models for shortest path, maximum flow, minimal spanning tree, critical path, minimum cost flow, and transshipment problems.

CO2: To formulate a given simplified description of a suitable real-world problem as a linear programming model in general, standard and canonical forms

CO3: To sketch a graphical representation of a two-dimensional linear programming model given in general, standard or canonical form

CO4: To classify a two-dimensional linear programming model by the type of its solution

CO5: To solve a two-dimensional linear programming problem graphically

CO6: To use the simplex method to solve small linear programming models by hand, given a basic feasible point.

CO7: To Express the concepts of factorial and the basic principal of counting.

CO8: To Solve the problems about permutation, combination and Binomial Theorem.

CO9: To express the concept of probability and its features.

CO10: To Explain the concept of a random event.

CO11: To Formulate theorems about the concept of probability.

CO12: To explain the concept of a random variable and the probability distributions.

CO13: To Express the features of discrete and continuous random variables.

PAPER – IVB Mathematical Statistics

After the completion of the course, Students will be able to

CO1: Graduates should be able to critically evaluate the strengths and weaknesses of study designs and can select a study design that is appropriate for addressing a specific research question.

CO2: Graduates should be able to use statistical reasoning, formulate a problem in statistical terms, perform exploratory analysis of data by graphical and other means, and carry out a variety of formal inference procedures.

CO3: Graduates should be able to describe important theoretical results and understand how they can be applied to answer statistical questions.

CO4: Graduates should have familiarity with a standard statistical software packages and encourage study of data management and algorithmic problem solving.

CO5: Graduates should have strong communication skills which are necessary to effectively collaborate as part of interdisciplinary teams including the ability to interpret and communicate the results of a statistical analysis through oral and written reports.

PAPER – IV C Advanced Complex Analysis

After the completion of the course, Students will be able to

CO1: dentify curves and regions in the complex plane defined by simple expressions.
CO2: Describe basic properties of complex integration and having the ability to compute such integrals.
CO3: Decide when and where a given function is analytic and be able to find it series developement.
CO4: Describe conformal mappings between various plane regions.
CO5: Present the central ideas in the solution of Dirichlets problem.
CO6: Give the main ideas in the proof of the Riemann mapping theorem.

PAPER – V A Mechanics

After the completion of the course, Students will be able to

CO1: Relative motion, Inertial and non inertial reference frames.
CO2: Parameters defining the motion of mechanical systems and their degrees of freedom.
CO3: Study of the interaction of forces between solids in mechanical systems.
CO4: Centre of mass and inertia tensor of mechanical systems.
CO5: Application of the vector theorems of mechanics and interpretation of their results.
CO6: Newton's laws of motion and conservation principles.
CO7: Introduction to analytical mechanics as a systematic tool for problem solving.
CO8: Use of mechanical simulation software.

PAPER – V B Numerical Analysis

After the completion of the course, Students will be able to

CO1: Understanding the theoretical and practical aspects of the use of numerical methods
CO2: Implementing numerical methods for a variety of multidisciplinary applications
CO3: Establishing the limitations, advantages, and disadvantages of numerical methods
CO4: It is used for solving a system of equations
CO5: It has application in all branches of engineering.
CO6: To know how to find the roots of transcendental equations.
CO7: To learn how to interpolate the given set of values
CO8: To understand the curve fitting for various polynomials To learn numerical solution of differential equations

PAPER – VC

Differential Geometry

After the completion of the course, Students will be able to

CO1: Explain the concepts and language of differential geometry and its role in modern mathematics.
CO2: Analyse and solve complex problems using appropriate techniques from differential geometry.
CO3: Apply problem-solving with differential geometry to diverse situations in physics, engineering or other mathematical contexts.
CO4: Apply differential geometry techniques to specific research problems in mathematics or other fields.

SEM IV

PAPER – I
Integral equations & Calculus of Variation

After the completion of the course, Students will be able to

CO1: Understand the methods to reduce Initial value problems associated with linear differential equations to various integral equations.
CO2: Categorise and solve different integral equations using various techniques.
CO3: Describe importance of Green's function method for solving boundary value problems associated with nonhomogeneous ordinary and partial differential equations, especially the Sturm-Liouville boundary value problems.
CO4: Learn methods to solve various mathematical and physical problems using variational techniques.
CO5: understand what functionals are, and have some appreciation of their applications
CO6: apply the formula that determines stationary paths of a functional to deduce the differential equations for stationary paths in simple cases
CO7: use the Euler-Lagrange equation or its first integral to find differential equations for stationary paths
CO8: solve differential equations for stationary paths, subject to boundary conditions, in straightforward cases.

PAPER – II Elementary Operator Theory

After the completion of the course, Students will be able to

CO1: This is an introductory course in Operator Theory. It will introduce the student to terms, concepts and results for bounded linear operators which are commonly used in this particular area of Mathematics.
CO2: It will also introduce the students which are relevant to current research and prepare the student to persue such a career.
CO3: special classes of bounded linear operator and study why each of them is important and significant.
CO4: a parallel study of unbounded linear operator is also done to give the student a complete perspective

PAPER – III Analytical Number Theory

After the completion of the course, Students will be able to

CO1: Demonstrate an understanding of Analytic Number Theory by proving unseen results using the
CO2: methods of the course.
CO3: Correctly state the main definitions and theorems in the course.
CO4: Produce examples and counterexamples illustrating the mathematical concepts presented in the
CO5: course.
CO6: Explain their reasoning about rigorous Analytic Number Theory clearly and precisely,using appropriate
CO7: technical language.
CO8: Understand better the distribution of prime numbers
CO9: Know the basic theory of zeta- and L-functions
CO10: Understand the proof of Dirichlet's Theorem

PAPER – IV A Integral Transforms

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

CO1: Solve differential & integral equations with initial conditions using Laplace transform.
CO2: Evaluate the Fourier transform of a continuous function and be familiar with its basic properties.
CO3: Solution of integral equation and their application.
CO4: Have understanding regarding different kind of integral transforms.
CO5: Understand Fourier transform and its properties and will be able to solve the examples based on it.
CO6: Have deep understanding of Laplace Transformation and its real life application.
CO7: Solve initial value problem and boundary value problem using Laplace Transform.
CO8: Derive Fourier series representation of Periodic functions.

PAPER – IVB Graph Theory

After the completion of the course, Students will be able to

CO1: State all of the technical definitions covered in the course (such as a graph, tree, planar
CO2: graph, colouring, digraph, generating function, linear extension, and other terms).
CO3: State all of the relevant theorems covered in the course.
CO4: Use these definitions and theorems from memory to construct solutions to problems and/or proofs.
CO5: Formulate graph theoretic models to solve real world problems (e.g., scheduling problems).
CO6: Analyze combinatorial objects satisfying certain properties and answer questions related to existence (proving the existence or non-existence of such objects), construction (describing how to create such objects in the case they exist), enumeration (computing the number of such objects), and optimization (determining which objects satisfy a certain extremal property).

PAPER – IV C Cryptography

The student who successfully completes this course will be able to:

CO1: classify the symmetric encryption techniques
CO2: Illustrate various Public key cryptographic techniques
CO3: Evaluate the authentication and hash algorithms.
CO4: Discuss authentication applications
CO5: Summarize the intrusion detection and its solutions to overcome the attacks.
CO6: Basic concepts of system level security

PAPER – V A Fluid Mechanics

After the completion of the course, Students will be able to

CO1: The student will understand stress-strain relationship in fluids, classify their behavior and also establish force balance in static systems. Further they would develop dimensionless groups that help in scale-up and scale-down of fluid flow systems. (Unit I)
CO2: Students will be able to apply Bernouli principle and compute pressure drop in flow systems of different configurations (Unit II)
CO3: Students will compute power requirement in fixed bed system and determine minimum fluidization velocity in fluidized bed (Unit III)
CO4: Students will be able to describe function of flow metering devices and apply Bernoulli equation to determine the performance of flow-metering devices
CO5: Students will be able to determine and analyze the performance aspects of fluid machinery specifically for centrifugal pump and reciprocating pump

PAPER – V B Advanced Operations Research

After the completion of the course, Students will be able to

CO1: Identify and develop operational research models from the verbal description of the real system.
CO2: Understand the mathematical tools that are needed to solve optimisation problems.
CO3: Use mathematical software to solve the proposed models.
CO4: Develop a report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.

PAPER – VC Finite Difference Method

After the completion of the course, Students will be able to

CO1: Ability to solve the system of linear equations and finding eigenvalues of the matrices.
CO2: Perform polynomial interpolations using various techniques.
CO3: Perform Cubic-spline interpolation and approximations.
CO4: To understand numerical errors and obtain roots of system of nonlinear equations.
CO5: Perform Numerical Differentiation, Numerical Integration.
CO6: Solve IVP, BVP and numerical solutions of parabolic, elliptic and hyperbolic partial
CO7: differential equations.
CO8: Apply various numerical techniques in real life problems.