Programme Name: MSc Mathematics

Programme Outcomes

The Program Objectives are the knowledge skills and attributes which the students have at the time of post-graduation. At the end of the program, the student will be able to**:**

- To provide comprehensive curriculum to groom the students into qualitative scientific man power .
- Enable students to enhance mathematical skills and understand the fundamental concepts of pure and applied mathematics.
- To provide qualitative education through effective teaching learning processes by introducing projects, participative learning and latest software tools.
- To inculcate innovative skills, team work, ethical practices among students so as to meet societal expectations.
- To encourage collaborative learning and application of mathematics to real life situations.
- To inculcate the curiosity for mathematics in students and to prepare them for future**.**

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Programme Specific Outcomes

- Understanding of the fundamental axioms in mathematics and capability of developing ideas based on them.
- Inculcate mathematical reasoning.
- Prepare and motivate students for research studies in mathematics and related fields.
- Provide knowledge of a wide range of mathematical techniques and application of mathematical methods/tools in other scientific and engineering domains.
- Provide advanced knowledge on topics in pure mathematics, empowering the students to pursue higher degrees at reputed academic institutions.
- Strong foundation on algebraic topology and representation theory which have strong links and application in theoretical physics, in particular string theory.
- Good understanding of number theory which can be used in modern online cryptographic technologies.
- Nurture problem solving skills, thinking, creativity through assignments, project work.
- Assist students in preparing (personal guidance, books) for competitive exams e.g. NET, GATE, etc.

Course Outcomes

Semester-I		
Course Code	**Course Name**	**Course Outcomes**
MM 1.1	**Real analysis**	Knowledge gained: • Basic definition of metric space, norm linear space and inner product space. • Series and sequence of continuous functions. • Equi continuous families, Arzela - Ascoli Theorem and Stone-Weierstras Theorem. • Function of several variables and differentiation in Rn. • Inverse and Implicit function theorem. • Sub manifolds of Rn and Rank theorem. Skills gained: • Continuous functions on [0,1] as a metric space. • The notion of convergence in C[0,1] as a metric space. • Differentiability of functions in several variables and their relation to partial derivatives. • Realizing the differentials in terms of geometric properties. Competency developed: • Ability to handle convergence of series and sequence of functions. • Ability to differentiate functions in Rn. Apply Implicit and inverse function theorem, moving towards calculation manifolds.
MM 1.2	**Algebra- I**	Knowledge gained: • Groups , dihedral groups, cyclic groups and their properties • Isomorphism, check digits sylow's theorem and their applications • Fields ring homeomorphisms • Eigen values, diagonalization of matrices and reduction of systems of linear equations into simpler systems of easily tractable nature. • Vector theory: subspace, basis, linear independence, inner product spaces etc. • Applications of matrix algebra. • Matrix manipulations. • Handing of systems of linear equations Skills gained: • Matrix manipulations. • Handing of systems of linear equations.

		• Use mathematical software to solve problems on linear systems. • Ability to go abstract from concrete: from concrete notion of solution spaces to vector spaces. • Linear modelling problems Competency developed: • Solving Systems of linear equations. Qualitative analysis of systems of linear equations
MM 1.3	**Discrete Mathematics**	Knowledge gained: • Basic statements and notations ,concepts of connectiveness • Basic combinatorics, induction, inclusion exclusion, pigeon hole principle. • More advance topics in combinatorics : recurrence relations, generating functions, counting principles, principle of inclusion and exclusion • Four color problems , multigraphs , eulerian ,Hamiltonian graphs • Application to real life problems such as network theory, data structure, optimization etc. • Monoids and groups ,coding, decoding and error correction Skills gained: • Efficiency in handling with discrete structures. • Efficiency in Set theory and handling formal of notions of size. • Efficiency in notions of matching, ordering, planarity. • Efficiency in solving concrete combinatorial problems whose presence is ubiquitous in science and engineering. Competency developed: • Ability to deal with notions of mapping and via that notion ability to tackle various notions of infinity like countable, uncountable etc. • Ability to use graphs as unifying theme for various combinatorial problems.
MM-1.4	**Ordinary Differential Equations**	Knowledge gained: • Differential equations , and their types • Fundamental concepts about their existence and uniqueness • Concepts and applications of eigen value problem • Sturm Liouville problem • Power series • Critical points and stability

		• non-linear autonomous system Skills gained: • Apply various power series methods to obtain series solutions of differential • Ability to Solve problems of ordinary differential equations arising in various fields. • Ability to stabilized the given equations Competency developed: • Apply various power series methods to obtain series solutions of differential • Ability to Solve problems of ordinary differential equations arising in various fields. • Ability to stabilized the given equations • Solving Systems of linear & equations. • Qualitative analysis of systems of linear & equations. • Ability to find critical points and phase plane
MM-1.5	**Classical Mechanics**	Knowledge gained: • the concept of functional and determine stationary paths of a functional to deduce the differential equation for stationary paths • Use Euler-Lagrange equation to find stationary paths and its applications in some classical fundamental problems • Define and understand basic mechanical concepts related to discrete and continuous mechanical systems. • describe and understand the motion of a mechanical system using Lagrange- Hamilton formaliszation. Skills gained: • Understand the concept of functional and determine stationary paths of a functional to deduce the differential equation for stationary paths. • Use Euler-Lagrange equation to find stationary paths and its applications in some classical fundamental. • describe and understand the motion of a mechanical system using Lagrange- Hamilton formalism.. Competency developed: • Demonstrate good experimental practice, including accurate record keeping,

		The planning and execution of experiments
II Semester		
Course Code	**Course Name**	**Course Outcomes**
MM-2.1	**Complex Analysis**	Knowledge gained: • Introduce and develop a clear understanding of the fundamental concepts of Complex Analysis such as analytic functions, Cauchy- Riemann relations and harmonic functions • make students equipped with the understanding of the fundamental concepts of complex variable theory • enable students to acquire skill of contour integration to evaluate complicated real integrals via residue calculus • . Skills gained: • Know the fundamental concepts of complex analysis. • Evaluate complex integrals and apply Cauchy integral theorem and formula • Evaluate limits and checking the continuity of complex function & apply the concept of analyticity and the Cauchy-Riemann equations. Competency developed: • Establish the capacity for mathematical reasoning through analysing, proving and explaining concepts from complex analysis • Extend their knowledge to pursue research in this field explaining concepts from complex analysis
MM 2.2	**Algebra II**	Knowledge gained: • Solving polynomial equations using formulas for roots • How to test if a polynomial is irreducible Finite Field • Understanding which equations can be solved using radials Skills gained: • Ability to understand/obtain the roots of a polynomial equation if the same has (or can be reduced to) degree less than five. • Facility in working with finite fields

		• Applying the concept of a field extension to various mathematical problems Competency developed: • Facility in handling problems involving polynomial equations • Applying mathematical methods to the real-life problems including cryptography. • Highly developed reasoning ability
MM 2.3	**Partial Differential Equations**	Knowledge gained: • first and higher order partial differential equations and their classification. This course explains various • analytic methods for computing the solutions of various partial differential equations. It also first and higher • wave equation of string, diffusion equations and heat flow equation to students Skills gained: • Understand partial differential equations of first order (linear and nonlinear), second and higher order. • Apply various analytic methods for computing solutions of • various PDEs. • Determine integral surfaces passing through a curve, characteristic curves of second order PDE and compatible systems Competency developed: • Understand the formation and solution of some significant PDEs like wave equation, heat equation and diffusion equation. Apply the knowledge of PDEs and their solutions in order to understand physical phenomena.
MM 2.4	**Topology**	Knowledge gained: • Topological Spaces and their importance • Base and sub base of topology • Compact space • Equivalence of countability • Lindelof property Skills gained • the concepts of topological spaces and the basic definitions of open sets, neighbourhood, interior, exterior, closure and their axioms for defining topological space. • the concept of Bases and Sub bases, create new topological spaces by using subspace. • Understand continuity, compactness, connectedness

		homeomorphism and topological properties. Competency developed: • Understand how points of space are separated by open sets, Housdroff spaces and their importance. Understand regular and normal spaces and some important theorems in these spaces
MM 2.5	**Introduction to computers and C programming**	Knowledge gained: • concept of C fundamental • concept of I/O operations • concept of control statement Skills gained: • c programming skills • switch over to any language in future • ability to work with arrays of complex objects • understanding of code organization Competency developed: • ability to handle possible errors during program execution • able to develop applications in daily life
III Semester		
Course Code	**Course Name**	**Course Outcomes**
MM 3.1	**Functional Analysis**	Knowledge gained: • Concept of normed linear spaces and inner product spaces. • Concept of bounded linear operators between these spaces. • Concept of the dual space of a normed linear space. • Concept of compact, self-adjoint and normal operators. Concept Skills gained: • Using topology to work with infinite dimensional vector spaces. • Using careful analysis to show that certain spaces of functions are complete. • Comparing the differences between finite and infinite dimensional spaces. • Comparing the differences between Banach and Hilbert spaces. • Analysing the structure of the spectrum of certain operators Competency developed: • Working with a complete orthogonal set a.k.a. Schauder basis in a Hilbert space.

		• Investigating the best approximation of a given vector by vectors in a given subspace. • Computing the dual spaces of certain Banach spaces. Working with weak and weak* topologies on normed linear spaces
MM 3.2	**Differential Geometry**	Knowledge gained: • basic concepts of differential geometry • deal with geometry of curves and spaces using the methods of differential calculus Skills gained: • Understand the basic concepts and results related to space curves, tangents, normal and surfaces. • Explain the geometry of different types of curves and spaces. • Explain the physical properties of different curves and spaces. Competency developed: • Understand principal directions and curvatures, asymptotic lines and then apply their important theorems and results to study various properties of curves and surfaces
MM 3.3	**Numerical Analysis I**	Knowledge gained: • The knowledge of Numerical Mathematics to solve problems efficiently arising in science, engineering and economics etc. • Identity and analyze different types of errors encountered in numerical computing. • Create, select and apply appropriate numerical techniques with the understanding of theirlimitationssothatanypossiblemodificationinthesetechnique scouldbecarried out in further research. Skills gained : • Utilize the tools of the Numerical Mathematics in order to formulate the real-world problems from the view point of numerical mathematics. • the basic concepts of Numerical Mathematics in order to solve the problems arising in various fields of application • , analysis and application of different numerical methods to solve the problems, viz. system of linear & nonlinear equations, numerical initial and boundary value problems of ordinary differential equations etc. Competency developed: • Design, analyze and implement of numerical methods for solving different types of problems, viz. • Identify the challenging problems in continuous mathematics (which are difficult to deal with analytically) and find their

		appropriate solutions accurately and efficiently.
MM 3.4	**Fluid Mechanics I**	Knowledge gained: • Understand the concept of rotational and ir-rotational flow, stream functions, velocity potential, sink, source, vortex etc. • analyze simple fluid flow problems (flow between parallel plates, flow through pipe etc.) with Navier- Stoke's equation of motion. Skills gained: • understand the phenomenon of flow separation and boundary layer theory • understand the concept of thermal conductivity. Competency developed: • learn about the fundamental equations of the flow and energy
MM 3.5	**Graph Theory I**	Knowledge gained: • Concept of fundamental circuits • Eulerian graph • Solve problems using basic graph theory Skills gained: • Identify induced sub graphs • Determine whether graphs are eulerian / Hamiltonian • Solve problems involving vertex connectivity and edge connectivity Competency developed: • Model real world problem using graph theory
IV Semester		
Course Code	**Course Name**	**Course Outcomes**
MM 4.1	**Measure Theory**	Knowledge gained: • Definition and properties of the exterior measure on R^d. • Measurable sets and Lebesgue measure, construction of non-measurable sets. • Measurable functions. • Lebesgue integration, convergence theorems for Lebesgue integrals and Fubini's theorem. • L^p spaces and Fourier inversion formula • .Connection between differentiation and integration in the context of Lebesgue theory Skills gained: • Computation of Lebesgue measures. • Establishing measurability or non-measurability of sets and

		functions. • Approximating measurable functions by simple and step functions. • Computation of Lebesgue integrals, applications to volume calculations and Fourier analysis. • Deciding under which conditions the fundamental theorem of calculus is applicable in the context of Lebesgue integration Competency developed: • Understanding that Lebesgue integration can solve certain problems.
MM 4.2	**Advanced Mathematical Methods**	Knowledge gained: • Definition of tensor. • Application of laplace transform of PDE • First and second kind of fredholem volterra • Perturbation method • Concept of linear programming • Concept of duality Skills gained: • Computation of covariant and its derivatives. • Establishing linear integral equations. • Approximating measurable functions by simple and step functions. • Computation of asymptotic series . Competency developed: • Understanding graphical method and standard LLP and their solutions
MM 4.3	**Numerical Analysis II**	Knowledge gained: • Concept of single steps and multi steps method • Concept of hyperbolic, parabolic, elliptic • The differential equations and its solutions Skills developed: • Numerical methods for initial value problems for ODE and PDE • Practical solution of problems using C++ • Exact , approximate , and numerical methods to solve to solve the resulting equations • System of linear equation by direct method Competency developed: • Simpler methods • Ability to use iterative methods to solve system of non linear equations

MM 4.4	**Graph Theory II**	Knowledge gained: • Concept of geometric dual of the graph • Concept of combinatorial of the graph • Concept of planar graph • Concept of colouring, covering • Concept of factorization Skills gained • Able to color the graph • Able to define four color problem • Ability to represent the graph in a computer Competency developed: • Model real world problem using graph theory
El 4.5	**Fluid Mechanics II**	Knowledge gained: • Understand the basic principles of fluid mechanics, such as Lagrangian and Eulerian approach, conservation of mass etc. • Stress and strain components • Concept of pi theorem with its application Skills gained • Use thermal conductivity of flow • The concept of rotational and ir rotational flow, stream functions, velocity potential, sink, source, vortex etc. • Analyse simple fluid flow problems (flow between parallel plates, flow through pipe etc.) with Navier - Stoke's equation of motion. Competency developed: • the phenomenon of flow separation and boundary layer theory.