M.A. / M.Sc. Mathematics

(2 years program)

Program Educational Objectives (PEO):

PEO1: To provide students Mathematical knowledge so that they are able to work as professionals in the subject.
PEO2: To prepare them to go for higher studies and pursue research
PEO3: To train students to handle the problems faced by industry through Mathematical knowledge and scientific computational techniques.
PEO4: To introduce the fundamentals of Mathematics to strengthen the students' logical and analytical ability.

PROGRAMME OUTCOMES (PO):

After the completion of the program, students will able to:

PO1: Pursue research in reputed institutions and solve the existing mathematical problems using the knowledge of pure and applied mathematics.

PO2: Acquire the strong foundation of basic concepts which will benefit them to become good academicians.

PO3: Apply the concept of mathematical tools to address real life problems

PO4: Gain the knowledge of software which will be useful in Industry

PO5: Qualify various competitive exams like CSIR-UGC NET, SET, GATE, MPSC, UPSC, etc

PROGRAM SPECIFIC OUTCOMES (PSO):

PSO 1: To imbibe problem-solving and computational skills

PSO 2: To understand the motivation behind the statements and proofs

PSO 3: To enhance self learning and improve own performance.

PSO 4: To inculcate abstract mathematical thinking.

M.A./ M.Sc. Mathematics Programme: Course objectives and outcomes

Course code	Course Name	Course Objectives	Course Outcomes (CO)
MTU 101	Group Theory	To introduce the concepts and to develop working knowledge on Groups, so that strong foundation for subsequent algebra courses can be developed.	CO1: Verify group properties, study cyclic groups. CO2: Decide whether given two groups are isomorphic or not. CO3: Understand solvability of groups. CO4: Gain command over Sylow theorems and thereby simplicity of groups.
MTU 102	Real Analysis	To learn the concepts of basic topological objects such as open sets, closed sets, compact sets and the concept of sequence of functions, Arzela - Ascoli Theorem	CO1: Attain mastery in Archimedean property, LUB axioms, and Sequence of real numbers CO2: Acquire the knowledge of Open, closed, and connected sets and continuous functions CO3: Study Compact metric space , Uniform Continuity, Continuous functions on Compact domains CO4: Study in detail sequence of functions, Arzela - Ascoli Theorem
MTU 103	Complex Analysis	This course is aimed to provide an introduction to the theories for functions of a complex variable. Some of the objectives of the course is to study and understand the topics like Cauchy–Riemann Equations, Cauchy Integral Formula and its applications, Poles and residues, Mobius Transformation.	CO1: Explain the concepts of C-R Equations, Analytic Functions, and Elementary Functions. CO2: Construct the proofs of Cauchy Integral Formula, Liouvellis Theorem, and solve problems related to Taylor and Laurent series. CO3: Identify different types of singularities, zeros of analytic function, Evaluate improper integrals and apply the Rouche's theorem to solve the problems. CO4: Understand Mobius Transformation and mappings of regions under some special transoframtions.
MTU 104	Differential Equations	The aim of the course is to introduce various methods to solve first order differential equations. Also to study qualitative properties such as existence and uniquesness of their solutions.	On successful completion of this course, the student will be able to: CO1: Solve first order differential equations. CO2: Understand orthogonal trajectories and linear differential equations. CO3: Study existence and uniqueness of solutions CO4: Analyse system of differential equations

MTU 105	Advanced Discrete Mathematics	The mission of the course is to study objects that are of discrete nature. Understand the application in real life communication models, computer sciences, electronic circuits.	On successful completion of this course, the student will be able to: CO1: Understand Formal Logic, Prepositional Logic, Semi groups and Monoids, Congruence relation CO2: Study Complemented and Distributive Lattices. CO3: Analyse Boolean Algebras CO4: Apply Boolean algebra to switching theory
MTU 106	Probability and Statistics	The focus of this course is to study the concepts like Axioms of Probability, Conditional probability, Random Variables, Distribution functions, types of random variables with examples and their properties, inequalities, modes of convergences, Law of Large Numbers.	CO1: Solve the problems using Baye's formula and identify independent events. CO2: Able to identify the correct distribution to the real life problem CO3: Explain joint distributions and derive the marginal distributions. Find the expectation,variance, MGF of random variables. CO4: Apply inequalities and law of large numbers to solve real life problems
MTU 107	LaTex Typesetting	The objective of this course is to introduce latex for research paper preparation, project, book etc and beamer for beautiful presentations.	CO1: Install Latex and execute small documents CO2: Typeset any type of document which involve more math CO3: Prepare presentation using beamer class and create handouts from it.
MTU 201	Linear Algebra	This course is aimed to provide an introduction to the theories, concepts and to develop working knowledge of vector spaces, linear transformations and canonical forms.	CO1: Assimilate the concept of linear dependence, basis etc. CO2: Analyse properties of linear transformations, their matrices etc. CO3: Study eigen value, eigen vectors of linear transformation. CO4: Understand geometric properties via study of inner product spaces. Develop knowledge of canonical forms.
MTU 202	Measure and Integration	This course will help to learn basic elements of measure theory such as measurable sets, functions ,Lebesgue integration and differentiation. Also understand the concepts of abstract measure theory with the help of classical Banach spaces.	CO1: Gain knowledge of measurable sets and measurable functions CO2: Acquire mastery on Lebesgue Integral CO3: Study Differentiation and integration concepts CO4: Learn Classical Banach spaces and approximation in Lp Spaces
MTU 203	Topology	The goal of the course is to provide in depth knowledge of this fundamental core course in mathematics to show various techniques from analysis , set theory ,	CO1: Understand basics of Topological Spaces CO2: Study Connected Spaces, Limit Point Compactness, Local Compactness. CO3: Achieve the zenith in treating Countable Axioms, Separable, Regular and

		logic that are used in topological spaces to obtain their properties , to demonstrate application in physics.	Normal spaces. CO4: Understand theorems like The Urysohn's Lemma, Urysohn's Metrization Theorem.
MTU 204	Partial Differential Equations	This course aims to introduce classification of partial differential equations and to learn various methods to solve them.	CO1: Find solutions of partial differential equations and determine the existence, uniqueness of solution of partial differential equations. CO2: Classify partial differential equations. CO3: Find Fourier sine series, Fourier cosine series, Fourier series expansion of various functions like even, odd, periodic, piecewise continuous functions. CO4: Understand convergence of Fourier series.
MTU 205	Elementary Number Theory	The aim of the course is to provide foundation and thorough understanding of Divisibility properties, Number theoretic functions and their properties, Linear Congruences, Diophantine Equations, quadratic Congruences etc.	CO1: Tackle Division Algorithm, The Euclidean Algorithm, Fundamental Theorem of Arithmetic. CO2: Handle Theory of Congruences: Chinese Remainder Theorem, Fermat Theorem, Wilson'sTheorem. CO3: Study Mobius Inversion Formula, different number theoretic functions CO4: Understand Primitive Roots, Indices and the Quadratic Reciprocity Law, Theory of Indices.
MTU 206	Graph Theory	The objectives of the course are to discuss the concepts of graph, tree and cut set. Discuss the Chinese Postman Problem and Travelling salesman problem. Use an algorithm to produce a plane drawing of a planar graph, know whether some special graphs are planar.	CO1: solve problems involving vertex and edge connectivity CO2: Use algorithms for finding an Euler trail in a graph for solving the Chinese Postman Problem. CO3: Model and solve real world problems using graphs and trees, both quantitatively and qualitatively. CO4: Apply Ford and Fulkerson Algorithm to real life problems
MTU 207	Introduction to Scilab	Scilab, an alternate to MATLAB, is a scientific software package providing a powerful open computing environment for engineering and scientific applications. In this course, different tool boxes like related to plotting, matrices, polynomials, system of equations, etc. will be discussed.	CO1: Install Scilab and execute looping and branching commands CO2: Handle matrices and their operations in scilab; Plot and visualize 2D and 3D graphs of various functions CO3:Demonstrate various tool boxes available in scilab.

MTU 301	Rings and Modules	This course is aimed to provide an introduction to the theories, concepts and to develop working knowledge on Rings and Modules in order to develop a background for studying Galois Theory and Commutative algebra.	CO1: Develop abstract mathematical thinking about rings. CO2: Explain the concept of Factorisation domains, unique factorisation domains etc. CO3: Understand concept of modules, sumodules etc. CO4: Study different rings like Artin ring, Noetherian ring.
MTU 302	Functional Analysis	The motto of course is to show interconnection between linear algebra and analysis, to examine the structure of infinite dimensional vector spaces, Hilbert spaces and the spectra.	CO1: Understand Banach Spaces, The Hahn-Banach Theorem. CO2: Study the open Mapping Theorem, Hilbert Spaces. CO3: Analyse different operators and their properties CO4: Understand Finite Dimensional Spectral Theory
MTU 303	Fractional Calculus and its Applications	The main objective of this course is to introduce the basic concepts of fractional order derivatives and integrations and study the different fractional transforms, existence and uniqueness theorem to solve fractional order differential equations.	CO1: Know the relation between differential and integral equations, and how to change from one to another. CO2: Understand different kinds of kernels and use techniques for solving problems on each kind. CO3: Explain Neumann series and solve linear Volterra and singular integral equations using appropriate methods. CO4: Use Laplace transform, Fourier transform for solving a wide range of differential and integral equations.
MTU 304	Operations Research I	To develop the optimization techniques that will be useful in the personal and professional life. To learn the mathematical formulation of complex decision-making problems and arrives at optimal or near-optimal solutions using different techniques of operations research.	CO1: Understand basics and formulation of linear programming problems and appreciate their limitations; solve linear programming problems using graphical method. CO2: Apply simplex method to solve real life problems. CO3: Solve artificial variable technique, duality theory, revised simplex method, sensitivity analysis, transportation and assignment problems. CO4: Understand the concept of Game theory, PERT/ CPM, simulation, investment analysis with real life applications.
MTU 305	Analytical Number Theory	Study of distribution of prime numbers is of vital importance in mathematics. The syllabus aims to develop basic techniques to understand problems in analytic number theory viz; distribution of prime numbers, equivalent forms of Prime Number Theorem and its relation with	CO1: Understand different arithmetic functions and their convolutions CO2: Distribute prime numbers and construct the proof of prime number theorem CO3: Master Dirichlet series and its analytic properties CO4: Explore Riemann Zeta function and explain Riemann Hypothesis

		Riemann zeta function.	
MTU 306	Numerical Analysis	Numerical Analysis deals with numerical solutions of certain problems of Mathematics. This course aims to study iterative methods to solve nonlinear equations in one variable, methods to solve system of equations, interpolation problems and Numerical solutions of differential equations.	CO1: Obtain the solutions of Transcendental and Polynomial Equations. CO2: Find solutions of system of equations using direct methods and Iteration methods CO3: Attain mastery to solve problems using interpolation. CO4: Acquire knowledge of Numerical methods to find solution of Ordinary Differential Equations
MTU 307	Coding Theory	This course is aimed to provide an introduction to the theories, concepts of linear codes and their parameters. It also focuses on encoding and decoding tehniques of linear codes.	CO1: Understand the concept of encoding and decoding. CO2: Explain various bounds on linear codes. CO3: Understand various tools to obtain new linear codes out of old ones. CO4: Study BCH codes and their parameters.
MTU 308	Riemannian Geometry	The students will learn the Basic ideas of Riemannian geometry such as Riemannian metric, covariant differentiation; geodesics, curvature etc belong to the core of mathematical knowledge and are widely used in applications that range from general relativity in physics to mechanics and engineering.	CO1: Define and explain the various geometrical and algebraic concepts of tensor algebra, Riemannian metric and familiar with Christoffel symbols, transformations and covariant derivatives. CO2: Interpret the phenomenon of parallel vector fields and geodesic. CO3: Understand the geometrical and mathematical formulation of Curvature tensor, its properties and its applications. CO4: Use the theory, methods and techniques of the course to analyze and solve problems of static and non static line element.
MTU 309	Algebraic Topology	The primary objective of this course is to study the shape of geometric spaces by associating algebraic objects to them that remain unchanged under homeomorphisms and continuous deformations. Some of the topics to be discussed are fundamental groups, covering spaces, simplexes.	CO1. Appreciate the notions of homotopy and contractible spaces. CO2. Explain the construction of fundamental group and examples. CO3. Understand the concepts like path lifting and covering maps CO4. Identify the essential computational techniques for determining singular homology.
MTU 310	Representation Theory of Finite Groups	To introduce the concepts and to develop working Knowledge of group representations and character theory.	CO1: Develop abstract mathematical thinking about group representations. CO2: Determine character tables of small groups. CO3: Acquire knowledge of the most fundamental theorems and constructions in it in connection with symmetric groups.

			CO4: Understand Burnside theorem, Frobenius Reciprocity Theorem etc.
MTU 311	Difference Equations	To learn different methods to solve linear and nonlinear difference equations , use them to model real life problems. Also learn to check stability of various models.	CO1: Acquire the knowledge of Difference Calculus CO2: Attain mastery to solve Linear Difference equations CO3: Study Z-transform and stability Theory CO4: Study in detail Phase plane analysis, and floquet theory
MTU 312	Introduction to Sage Mathematics	The objective of this course is to give an overview and a brief introduction to the SAGE computer algebra system. SageMath (previously SAGE: System for Algebra and Geometry Experimentation) is a mathematical software with features covering many aspects of math, including algebra, combinatorics, numerical mathematics, number theory, calculus.	CO1: Install sage and construct basic programs using loops, conditionals and functions. CO2: Mastering the plotting of functions and curves in 2D and 3D CO3: Develop programmes to solve mathematical problems
MTU 401	Galois Theory	To introduce the concepts and to develop working knowledge of field extensions, Galois groups and interrelation between group theory and field theory.	CO1: Understand the main algebraic properties of fields. CO2: Analyze properties of algebraic, normal and separable extension CO3: Compute Galois groups in simple cases and to apply the group-theoretic information to comprehend results about fields. CO4: Develop knowledge of some classical Greek problems.
MTU 402	Integral Equations and Transforms	The aim of this course is to provide adequate knowledge of fundamentals of Fredholm,Volterra and singular integral equations and develop techniques for finding its solutions. To motivate students, how to solve problems on differential and integral equations using Laplace and Fourier transforms.	CO1: Know the relation between differential and integral equations, and how to change from one to another. CO2: Understand different kinds of kernels and use techniques for solving problems on each kind. CO3: Explain Neumann series and solve linear Volterra and singular integral equations using appropriate methods. CO4: Use Laplace transform, Fourier transform for solving a wide range of differential and integral equations.
MTU 403	Lie Groups and Lie Algebra	The aim of this course is to provide adequate and thorough knowledge of Lie groups and Lie algebra.	CO1: Study different matrix Lie groups, The polar decomposition for SL(n, R) and SL(n,C) CO2: Know the concept of matrix exponential, matrix logarithm etc. CO3: Understand Lie algebra homomorphisms, covering groups etc. CO4: Explain the Weyl group, Weight

			diagrams, Complete reducibility and semisimple Lie Algebras.
MTU 404	Algorithms and their Analysis	This course aims to introduce students to the design of algorithm as a means of problem solving and to analyze the efficiency of algorithms.	CO1: To learn basic concepts of Algorithms CO2: Attain mastery to design various algorithms CO3: To learn Complexity of algorithms CO4: Design and compare different algorithms
MTU 405	Algebraic Gemetry	The course aims at giving an introduction to classical algebraic geometry, that is, the theory of algebraic varieties, elliptic curve, and cubic surfaces.	CO1: Understand the proof of Hilbert Nullstellensatz and the concept of rational maps CO2: Deduce the algebraic characterizations of the dimension of a variety. CO3: Classify the smooth cubics and understand the group structure of elliptic curve. CO4: Configuration of lines on cubics and rationalize the cubics.
MTU 406	Classical Mechanics	To demonstrate knowledge and understanding of the fundamental concepts in the dynamics of system of particles and motion of rigid body. Also learn to represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics.	CO1: Learn D-Alemberts principle and formulate Laganges equation of motion CO2:Understand Calculus of variation and solve different problems CO3:Formulate Hamiltonian equation and understand its physical significance CO4:Gain knowledge of Eulerian angles and Cayley Klein parameters
MTU 407	Theory of Relativity	The students shall be familiar with the fundamental principles of the special and general theory of relativity. They shall know the meaning of basic concepts like inertial frames and how gravity is understood as a manifestation of a curved space-time. They shall also be familiar with some of the main contents of the theory: Einstein's field equations, three crucial tests for general relativity and Schwarzschild solutions.	CO1: Describe physical phenomena in different coordinate systems, Galilean and Laurentz transformations. Analyze the conflict between Newtonian theory of gravitation and special theory of relativity. CO2: Define energy momentum tensor of various fluids and understand gravity due to curved space-time. CO3: Obtain Einstein's field equations by different approach and prove Newtonian theory as a first approximation. CO4: Solve Einstein's field equations for static spherically symmetric Schwarzschild spacetime and calculating the advances of perihelion, relativistic frequency shifts for sources moving in a gravitational field, as well as the bending of light passing a spherical mass distribution.
MTU 408	Cryptography	To introduce the concepts and to develop working knowledge of encryption, decryption and cryptanalysis.	CO1: Understand the main essence of how cryptography helps to achieve common security goals. CO2: Analyse the notions of public-key cryptography, Study different primality tests

			and their gradual development. CO3: Study discrete logarithm problem and various methods to solve this problem. CO4: Develop knowledge of elliptic curves, Elliptic curve cryptosystems, Elliptic curve primality test etc.
MTU 409	Algebraic Number Theory	Algebraic number theory is the study of zeros of polynomials with rational or integral coefficients. These numbers used to lie in algebraic structures having many similar properties to those of the set of integers. The very motivation for learning this subject was solving certain Diophantine equations	CO1: solve certain Diophantine equations by applying methods developed in this course. CO2: perform basic computations with algebraic integers in number field, such as addition and multiplication, finding inverses etc. CO3: compute class numbers and class groups of some simple number fields. CO4: Synthesize the main ideas of algebraic number theory.
MTU 410	Operations Research - II	To learn advanced methods in operations research course that are used in the systems approach to Engineering and Management, so as to provide them with the requisite tools for the mathematical representation of decision-making problems, in particular emphasizing the roles of uncertainty and risk.	CO1: Solve real life problem using integer programming. CO2: Use dynamic programming in multistage solution problem. CO3: Deal with inventories of various goods with and without shortages. CO4: Understand and deal with queuing theory, Non-linear (concave) real life optimization problems, Quadratic programming problems.
MTU 411	Multivariate Calculus	The aim of this course is to introduce basic concepts such as tangent spaces, double integral, triple integral etc.	CO1: Find the tangent space, maxima and minima CO2: Solve problems related to surface integral CO3: Use Stokes theorem , divergence theorem to solve triple integral CO4: Study Geometry of surfaces in three dimensions.
MTU 412	Commutative Algebra	Commutative Algebra is the study of commutative rings, and their modules and ideals. This course will give the student a solid grounding in commutative algebra which is used in both algebraic geometry and number theory.	On completion of the course the student should have the following learning outcomes defined in terms of knowledge, skills and general competence: CO1: Understand the proof of snake lemma and construction of tensor product CO2: Explain localization of rings and master the concepts like extended and contracted ideals in ring of fractions CO3: Construct the proof of the primary decomposition of ideals, going up and going down theorems. CO4: Identify the relation between Artin and Noetherian rings; relate with Dedekind domains.