M.Sc. Mathematics – I,II,III & IV Semesters

Code	Course Name	Course Outcomes
M.Sc.Mathematics – I Semester		
PMTT11	**Linear Algebra**	Upon successful completion of this course students will be able to: **CO1:** Determine relationship between coefficient matrix invertibility and solutions to a system of linear equations and the inverse matrices. **CO2:** Find a basis for the row space, column space and null space of a matrix and find the rank and nullity of a matrix. **CO3:** Students completing this course will be able to find the matrix representation of a linear transformation given bases of the relevant vector spaces. **CO4:** Use computational techniques and algebraic skills essential for the study of systems of linear equations, matrix algebra, vector spaces, eigenvalues and eigenvectors, orthogonality and diagonalization. (Computational and Algebraic Skills). **CO5:** Work collaboratively with peers and instructors to acquire mathematical understanding and to formulate and solve problems and present solutions.
PMTT12	**Real Analysis- I**	**Upon the successful completion of the course, students will be able to** **CO1:** Students will be able to demonstrate competence with elementary properties of sets by proving identities involving union and intersection and Cartesian Products of sets. **CO2:** Students will be able to demonstrate competence with elementary properties of functions by proving results involving composite functions and inverse functions. **CO3:** Students will be able to demonstrate competence with the algebraic and order properties of real numbers.

		CO4: Students will be able to demonstrate competence with properties of real numbers by finding supremum and infimum of sets and using the completeness property of real numbers. **CO5:** Students will be able to demonstrate ability to use Taylor Theorem, the Mean value Theorem, and use L'Hôpital's Rule to compute limits of functions.
PMTT13	**Differential Equations**	**Upon the successful completion of the course, students will be able to** **CO1:** Recognize differential equations that can be solved by each of the three methods – direct integration, separation of variables and integrating factor method – and use the appropriate method to solve them **CO2:** Use an initial condition to find a particular solution of a differential equation, given a general solution **CO3:** Check a solution of a differential equation in explicit or implicit form, by substituting it into the differential equation CO4: Understand the terms 'exponential growth/decay', 'proportionate growth rate' and 'doubling/halving time' when applied to population models, and the terms 'exponential decay', 'decay constant' and 'half-life' when applied to radioactivity
PMTT14	**Graph Theory**	**Upon the successful completion of the course, students will be able to** **Course Outcomes:** **CO1:** State all of the technical definitions covered in the course (such as a graph, tree, planar graph, colouring, digraph, generating function, linear extension, and other terms). **CO2:** State all of the relevant theorems covered in the course. **CO3:** Formulate graph theoretic models to solve real world problems (e.g., scheduling problems). **CO4:** 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).

Code	Course Name	Course Outcomes
M.Sc.Mathematics – II Semester		
PMTT21	**Algebra**	**Upon the successful completion of the course, students will be able to** **CO1:** Students will have a working knowledge of important mathematical concepts in abstract algebra such as definition of a group, order of a finite group and order of an element. **CO2:** Students will be introduced to and have knowledge of many mathematical concepts studied in abstract mathematics such as permutation groups, factor groups and Abelian groups. **CO3:** Students will actively participate in the transition of important concepts such homomorphisms & isomorphisms from discrete mathematics to advanced abstract mathematics. **CO4:** Students will gain experience and confidence in proving theorems. A blended teaching method will be used requiring the students to prove theorems give the student the experience, knowledge, and confidence to move forward in the study of mathematics.
PMTT22	**Real Analysis-II**	**Upon the successful completion of the course, students will be able to**

		CO1: Investigate the ideas of continuity and inverse images of open and closed sets, functions continuous on compact sets **CO2:** Differentiate the concepts of connectedness and implement them on various sets. **CO3:** Examine the derivatives of functions and apply few theorems based on it. **CO4:** Investigate properties of monotonic functions. **CO5:** Learn the properties of Riemann- Stieltjes integral.
PMTT23	**TOPOLOGY**	**Upon the successful completion of the course, students will be able to** **CO1:** Know how the topology on a space is determined by the collection of open sets, by the collection of closed sets, or by a basis of neighbourhoods at each point, and you know what it means for a function to be continuous. **CO2:** Know the definition and basic properties of connected spaces, path connected spaces, compact spaces, and locally compact spaces. **CO3:** Know what it means for a metric space to be complete, and you can characterize compact metric spaces. **CO4:** Familiar with the Urysohn lemma and the Tietze extension theorem, and you can characterize metrizable spaces. **CO5:** Familiar with the construction of the fundamental group of a topological space and applications to covering spaces and homotopy theory.
PMTT24	**Optimization Techniques**	**CO1:** The students will be able to analyze the real life systems with limited constraints **CO2:** Identify the mathematical nature of a given optimization problem

		CO3: Analyze a range of classes of optimization problems **CO4:** Identify solution methods for the optimization problems studied **CO5:** The students will be able to depict the systems in a mathematical model form**.**

Code	Course Name	Course Outcomes
M.Sc.Mathematics – III Semester		
PMTT31	**Complex Analysis**	**Upon the successful completion of the course, students will be able to** CO1: Explain and apply Cauchy's integral formula and some of its consequences CO2: explain the convergence of power series and develop analytical capabilities in Taylor or Laurent series in a given domain CO3: Define the fundamental concepts of complex numbers and its properties, Exponential, logarithmic, trigonometric and hyperbolic complex functions . CO4: Describe Holomorphic and harmonic complex functions and list different examples. CO5: State Complex integral on a path – Cauchy theorem

		and Cauchy integral formula name zeros and singularities of a Complex function and the Residue theorem .
PMTT32	**Measure Theory**	**Upon the successful completion of the course, students will be able to** **CO1:** Master in an abstract context, the fundamental theorems of integration learned during the previous courses of analysis for the case of the Euclidean spaces, harmonizing the latter with the example of the outer Lebesgue measure. **CO2:** Build a measure starting from a countable additive set function defined on a semi-algebra of subsets or starting from a sequence of suitably chosen measures. **CO3:** Integrate a measurable function with respect to a measure
PMTT33	**Classical Dynamics**	**Upon the successful completion of the course, students will be able to** **Course Outcomes:** **CO1:** Be able to solve the Lagrange's equations for simple configurations using various methods. **CO2:** Understand the concept of Hamilton Jacobi Theory. **CO3:** Be able to understand the concept canonical Transformations CO4: **To develop skills in formulating and solving physics problems** **CO5: Able to get idea of dynamical systems are of relatively recent origin, the concept of motion in phase-space and its geometrical depiction is simple.**
PMTT34	**Calculus Of Variations And Integral Equations**	**Upon the successful completion of the course, students will be able to** **CO1:** Determine asymptotes for rational expressions (we will not go into these graphs in much detail) **CO2:** Apply the techniques from the previous section to graph a fourth degree polynomial or higher

		CO3: On successful completion of the course students will be able to recognize difference between Volterra and Fredholm Integral Equations, First kind and Second kind, homogeneous and inhomogeneous etc. **CO4:** They apply different methods to solve Integral Equations.

Code	Course Name	Course Outcomes
M.Sc.Mathematics – IV Semester		
PMTT41	**Functional Analysis**	**CO1:** To learn to recognize the fundamental properties of normed spaces and of the transformations between them. **CO2:** To be acquainted with the statement of the Hahn-Banach theorem and its corollaries. To understand the notions of dot product and Hilbert space. **CO3:** To apply the spectral theorem to the resolution of integral equations and Sturm-Liouville problems. **CO4:** The learner will gain knowledge normed linear space, Banach spaces, Hahn-Banach theorem(open and closed) and (general and structure) banach algebra.
PMTT42	**Differential Geometry**	**CO1:** After completing this course, students should be able to: Determine and calculate curvature of curves in different coordinate systems. **CO2:** Treat geodesic curves and parallel translation Calculate and analysis curvature of surfaces in different settings. **CO3:** Know the concept of tensor and recognize tensors that are used in mechanics, image processing and theory of relativity. **CO4:** Apply geometry of curves and surfaces to computer aided graphics.

Elective Papers 1	**Algebraic Number Theory**	**CO1:** Demonstrate knowledge and understanding of topics including, but not limited to divisibility, prime numbers, congruence, quadratic reciprocity, Diophantine equations. **CO2:** Learn methods and techniques used in number theory. **CO3:** Write programs/functions to compute number theoretic functions. **CO4:** Use mathematical induction and other types of proof writing techniques.
Elective Papers 2	**Automata Theory**	**CO1:** Acquire a fundamental understanding of the core concepts in automata theory and formal languages. **CO2:** An ability to design grammars and automata (recognizers) for different language classes. **CO3:** An ability to identify formal language classes and prove language membership properties. **CO4**: An ability to prove and disprove theorems establishing key properties of formal languages and automata. **CO5: To** solve the sums based on automata and grammar.
Elective paper 3	**Probability Theory And Statistics**	**CO1:** Able to understand the concepts of various parameter estimation methods, like method of moments, maximum likelihood estimation and confidence intervals **CO2:** Able to apply the appropriate Chi-Squared test for independence and goodness of fit **CO3:** Students will frame problems using multiple mathematical and statistical representations of relevant structures and relationships and solve using standard techniques. **CO4:** The learner to know constructing the probability distribution of a random variable based on the real-world situation and compute mean and variance and

		many Distributions
Elective paper 4	**Matlab & Latex**	**CO1:** Able to use Matlab for interactive computations. **CO2:** Familiar with memory and file management in Matlab**.** **CO3:** Able to generate plots and export this for use in reports and presentations. **CO4:** Cooperating and working with others using subversion **CO5:** Debugging and optimising their programs
Elective paper 5	**Fuzzy Sets And Their Applications**	**CO1:** Be able to distinguish between the crisp set and fuzzy set concepts through the learned **CO2:** Differences between the crisp set characteristic function and the fuzzy set membership function. **CO3:** Be able to draw a parallelism between crisp set operations and fuzzy set operations through the use of characteristic and membership functions respectively. **CO4:** Become aware of the use of fuzzy inference systems in the design of intelligent
Elective paper 6	**Neural Networks**	**CO1:** Understand the differences between networks for supervised and unsupervised learning. **CO2:** Design single and multi-layer feed-forward neural networks. **CO3:** Develop and train radial-basis function networks. **CO4:** Program linear and nonlinear models for data mining. **CO5:** Analyze the performance of neural networks
Elective Paper 7	**Stochastic Process**	**CO1:** The student has basic knowledge about stochastic processes in the time domain. **CO2:** The student has acquired more detailed knowledge about Markov processes with a discrete

		state state space, including Markov chains, Poisson processes and birth and death presses. **CO3:** The student also knows about queuing systems and Brownian motion, in addition to mastering the fundamental principles of simulation of stochastic processes and the construction of Markov chain Monte Carlo (MCMC) algorithms. **CO4:** The student is able to formulate simple stochastic process models in the time domain and provide qualitative and quantitative analyses of such models.
Elective paper 8	**Fluid Dynamics**	**CO1:** Solve hydrostatic problems. **CO2:** Describe the motion of fluids. **CO3:** Identify derivation of basic equations of fluid mechanics and apply **CO4:** Make dimensional analysis and similitude
Elective paper 9	**Non Linear Differential Equations**	**CO1:** After completed course, the students are expected to be able to. **CO2:** Give account for existence and uniqueness of the solutions of ordinary differential equations solutions. **CO3:** Make use of the phase plane to analyse two-dimensional systems with emphasis on equilibrium, existence of limit cycles and linearisation. **CO4:** Summarise theorems that related to the existence of periodical solutions, and apply them to simple systems. **CO5:** Explain important terms in asymptotic theory, such as, order symbols, asymptotic sequences and asymptotic series, and give account for truncation and convergence of asymptotic series.
Elective paper 10	**Financial Mathematics**	**CO1:** On successful completion of this course students will be able to: **CO2:** Demonstrate understanding of basic concepts in linear algebra, relating to linear equations, matrices,

		and optimization. **CO3:** Demonstrate understanding of concepts relating to functions and annuities. **CO4:** Employ methods related to these concepts in a variety of financial applications. **CO5:** Apply logical thinking to problem solving in context.
Elective paper 11	**Control Theory**	**CO1:** Be able to understand Reconstruction Kernal, streaming Function **CO2:** Able to analyze the stability of linear systems **`CO3:** Problem solving skillsare developed in linear time invariant systems
Elective paper 12	**Fractal Analysis**	**CO1:** Understand the contraction mappings on the space of Fractals **CO2:** Able to analyze fractal dimensions **CO3:** Understand The Structured Walk Technique and the Divider Dimension **CO4:** The learner will able to understand the basic concepts of fractals and measure recognize the space of fractals and fractal dimension **CO5:** Find the Hausdorff, box-counting and other dimensions understand the self – similar sets properties of fractals recognize the concepts fractal interpolation.
Elective paper 13	**Tensor Analysis And Special Theory Of Relativity**	**CO1:** Use tensor notation in relativity theory. **CO2:** Apply the concepts of length contraction and time dilation as well as use Lorentz transformations. **CO3:** Solve simple kinematical problems. **CO4:** Analyze Maxwell's equations and use their relativistic invariance

Elective paper 14	**Mathematical Biology**	**CO1:** Formulate and solve mathematical models of evolution in terms of optimisation and game theory problems; **CO2:** Use techniques from stochastic processes to describe population genetics; **CO3:** Use techniques from partial differential equations to describe spread of genes, disease and other biological material; **CO4:** Explain how these techniques are applied in scientific studies and applied in ecology and epidemiology.