Department of Mathematics

M.Sc. Mathematics

PROGRAM OUTCOME (PO): -

Program outcomes describe what students are expected to know or be able to do by the time of post-graduation. It represents the knowledge, skills and attitudes the students should have at the end of a course completion of their respective program "M.Sc. in Mathematics".

PO1 Various branches of Mathematics are so selected and designed for M.Sc. Mathematics course aiming at mathematical reasoning, sophistication in thing and acquaintance with enough number of subjects including application-oriented ones to suit the present needs of various allied branches in Engineering and Science as well as provision of opportunities to pursue research in higher mathematics.

PO2.Problem Solving Skills- This program also offers training in problem solving skills.

PO3.Analytical & Logical thinking- The student will be able to develop logical reasoning techniques and Techniques for analyzing the situation.

PO4.Advanced Algebra The students shall appreciate the necessity of various Algebraic structures with binary operations such as Group, Ring, Non-commutative ring that lead to new ideas in algebra for their future research in advanced topics of algebra.

PO5.Analysis The student shall get an insight in the behavior of curves defined on a closed and bounded interval and some important properties of continuous, monotonic and differentiable functions defined on a closed and bounded interval and also their metric space analogues.

PO6.Numerical Techniques The student will be able to learn some useful approximation and interpolation techniques in Mathematics.

PO7.Advanced Discrete Mathematics The student will learn concepts like finite state machine, Boolean algebra, lattice, graph theory which develop more useful logic in the development of theories of electronic computers, networks, switching circuits that are applicable in Physics and applied mathematics.

PO8.Learning Number theoretical concepts Student will learn some important concepts in Number theory that are useful in Cryptography related to the advanced area of research namely Network security.

PO9.Understanding Ability Student will develop ability for generation of mathematical model to a given real life situation as well as learning new areas of mathematics in future either for teaching or for research.

PO10 Getting Abilities Demonstrate the ability to conduct research independently and pursue higher studies towards Ph.D. degree in mathematics.

PO11Evaluating capability- The student shall acquire capability to evaluate hypothesis, methods and evidence within their proper contexts in any situation.

PO12Application of knowledge- The student shall able to apply the knowledge acquired in mathematics in science, technology as well as research and its extensions.

PROGRAM SPECIFIC OUTCOMES (PSO): -

PSO1- Understanding of the fundamental axioms in mathematics and capability of developing ideas based on them.

PSO2- Inculcate mathematical reasoning.

PSO3- To develop one's own learning capacity.

PSO4- Prepare and motivate students for research studies in mathematics and related fields.

PSO5- Develop abstract mathematical thinking.

PSO6- Assimilate complex mathematical ideas and arguments.

COURSE OUTCOMES (CO): -

S.N.	Name of course/Paper	Course Outcomes
1	Advanced Abstract Algebra(I)	➢ Understand the basic concepts of groups with Solvable and nilpotent groups, Normal and composition series and their applications, Jordan-holder theorem. ➢ Fundamental properties of finite field extensions, and classification of finite fields. ➢ How to test if a polynomial is irreducible Galois Fields. ➢ Learn to find the solution of polynomial equations by radicals.
2	Real Analysis (I)	➢ Demonstrate an understanding of sequences and series of functions, uniform convergence, differentiation and integration and various test to check the convergence of functions. ➢ Construct rigorous mathematical proofs of basic results in real analysis. ➢ Understand power series, Abel's and Tauber's theorem, rearrangements of terms of series, Riemann theorem. ➢ Learn about function of several variables and their partial order derivatives, higher order derivatives, Chain Rule of differentiability. ➢ Illustrate Taylor's theorem, Inverse function theorem and Implicit function theorem. ➢ Understand the concept of Jacobian and related theorems. ➢ Illustrate how to find the extremum of functions, Lagrange's Multiplier method and differentiation of integrals. ➢ Discuss about the Stoke's theorem, Differential forms.

3	Topology	➢ Understand terms, definitions and theorems related to topology, axiom of choice. ➢ Define topological spaces, product topology, metric topology, quotient space, cantor's theorem, Zorn's lemma and well-ordering theorem. ➢ Discuss the continuous functions, connected space, compact space and complete metric space. ➢ Demonstrate knowledge and understanding of concepts such as open and closed sets, interior, closure and boundary. ➢ Describe closed sets and limit points, components and path components. ➢ Prove Urysohn's lemma and Titze extension theorem. ➢ Understand the separation axiom, a space filling curve. Distinguishing spaces up to homeomorphisms ➢ Create new topological spaces by using subspace, product and quotient topologies. ➢ Use continuous functions and homeomorphisms to understand structure of topological spaces.
4	Complex Analysis (I)	➢ Basic concept of complex numbers with Complex integration. ➢ Development of functions into power series, classifying singularities. ➢ Prove the maximum modulus principle, Residue theorem. ➢ Evaluate the integral using Cauchy's integral formula and Residue theorem. ➢ Find the Taylor's and Laurent's series expansion of given function. ➢ Viewing analytic functions as conformal mappings. ➢ Evaluation of indefinite real integrals using contour integration. ➢ Constructing Mobius transformations mapping given circles to given circles. ➢ Illustrate space of analytic functions, Hurwitz theorem, Montel's theorem, Riemann mapping theorem.
5	Advanced Discrete Mathematics (I)	➢ Define Semigroups, Monoids, Homomorphism, Isomorphism and basic homomorphism theorem. ➢ Describe the Lattice, Boolean algebra as lattices and various Boolean identities. ➢ Illustrate Tautology, Tautological implication, Truth Tables. ➢ Discuss the application of Boolean algebra to switching theory. ➢ Interpret the Karnaugh Map, Switching Circuits, grammar and language.
6	Advanced Abstract Algebra (II)	➢ Module theory as linear algebra over general rings. ➢ Linear transformation, Nilpotent transformation and index of nilpotency. ➢ Theory of modules over PID and its application to Jordan and Rational canonical forms.

7	Real Analysis (II)	➢ Learn some of the properties of Integrals and Riemann-Stieltjes integration, and the applications of the fundamental theorems of calculus. ➢ Explain uniform convergence and almost uniform convergence. ➢ Concept of Measure theory, Outer measure, Lebesgue measure, extension of measure, measure space. ➢ Understand the concept of four derivatives, function of bounded variation. ➢ Learn about L^p -spaces, completeness of L^p -space, Holder and Minkowski Inequalities
8	General and Algebraic Topology	➢ Understand the Concept of Product spaces and Tychonoff product topology, Tychonoff theorem. ➢ Concept of Embedding and metrization with paracompactness, Nagata-Smirnov metrization theorem, Uryshon's metrization theorem. ➢ Learn about Net and filters with their properties. ➢ Understand the fundamental group and covering spaces, ➢ Concept of path homotopy and fundamental theorem of Algebra and groups.
9	Complex Analysis (II)	➢ Learn about Gamma function and its properties, Weierstrass factorization theorem, Runge's theorem, Mittag-Laffler's theorem. ➢ Understand the concept of analytic continuation, Power series method, Schwarz Reflection principle, Monodromy theorem and its consequences. ➢ Know about harmonic functions, Dirichlet region and problem and Green's function. ➢ Learn to evaluate order of an entire function. ➢ Understand the canonical products. ➢ Show Jensen's formula, exponent of convergence, Borel's theorem. ➢ Understand the range of an analytic functions through theorems, univalent functions, Bieberbach Conjecture.
10	Advanced Discrete Mathematics (II)	➢ Learn about graph theory with definition and properties of graphs, circuits, trees, planar graph, complete bipartite graph, Kuratowski's theorem and its use. ➢ Understand the concept of Spanning tree, cut sets, minimal spanning tree and Kruskal's algorithm. ➢ Learn about Search trees, tree traversal, Dijkstra's and Warshall's algorithm. ➢ Learn about the computability theory-Finite state machines. ➢ Understand the Finite automata, Moore and Mealy Machines, Turing Machine.
11	Integration theory and Functional Analysis(I)	➢ Understand the concept of Signed Measure with theorems. ➢ Learn about Banach spaces, Normed Linear spaces and basic properties.

		➢ Computing the dual spaces of certain Banach spaces and normed linear spaces. ➢ Know the basic convergence theorems for the Lebesgue integral. ➢ Understand the relation between differentiation and Lebesgue integration.
12	Partial Differential Equations and Mechanics (I)	➢ Apply a range of techniques to solve first & second order partial differential equations. ➢ Model physical phenomena using partial differential equations such as the heat and wave equations. ➢ Understand the generalized coordinates, Hamilton's and Lagrange's equations. ➢ Understand problems, methods and techniques of calculus of variations, Poisson's bracket. ➢ Learn about attraction and potential.
13	Fundamentals of Computer Science	➢ To learn about oops, creating class, objects, hiding information using abstraction ➢ How to reuse the code using inheritance. ➢ Understanding the way of organizing data and accessing it through different data structure technique. ➢ Explaining the different sorting technique of data and their analysis. ➢ Learn about different data storage purpose using tree concept
14	Operations Research (I)	➢ Identify and develop operational research models from the verbal description of the real system. ➢ Understand the mathematical tools that are needed to solve optimisation problems. ➢ Understand the Parametric linear programming and Linear goal programming. ➢ Understand the duality and sensitivity analysis. ➢ Understand the transportation and assignment problems with real life examples. ➢ Learn about Network Analysis and different algorithms with their applications. ➢ Understand the Project planning and control with PERT-CPM.
15	Programming in C (with ANSI features) (I)	➢ Defining the concept of programming language and its features to get the understanding of different data types and its usage according to needs of program. ➢ To learn about the flow of execution of a C program. ➢ Learn about operators and expressions in C programming ➢ How to use and handle array through which know about how to utilize memory location and access data location.
16	Functional Analysis (II)	➢ Understand the normed linear spaces, Banach space and Dual spaces ➢ Understand inner product spaces, orthogonally and Hilbert spaces.

		➢ Distinguish between finite and infinite dimensional spaces. ➢ Understand the concept of linear operators and projection. ➢ Apply linear operators in the formulation of differential and integral equations.
17	Partial Differential Equations and Mechanics (II)	➢ Learn about the nonlinear PDE with characteristics, Hamilton's ODE, Legendre Transform, Hamilton Jacobi equations. ➢ To derive the solutions of PDE by using separation of variables method, similarity solutions, Fourier and Laplace Transform with their applications. ➢ To learn about Hamilton's Principle. ➢ The Hamiltonian mechanics provides the framework of most modern research in frontier areas particularly the relation between symmetry proportion and conservation laws.
18	Operating System and Database Management System	➢ Understanding the basic details of data and the architecture of database, data modelling. ➢ Learn about Relational database and actual implementation of database through which we retrieve, manipulate data. ➢ Learn about SQL queries and database design. ➢ To understand the details of operating system and its functioning.
19	Operations Research (II)	➢ Learn about deterministic and probabilistic dynamic programming. ➢ Understand the Game theory and its strategies. ➢ To solve the integer programming problems (Pure and mixed) with different methods including branch and bound technique. ➢ Learn the construction of Gomory's Constraints and Fractional Cut-Method. ➢ To derive the necessary conditions (KT conditions) for constrained nonlinear optimization problems. ➢ To solve quadratic and multi-objective programming problems. ➢ Understand the concept of convex and non-convex programming. ➢ Use search technique to find the optimal solution of unconstrained optimization problems.
20	Programming in C (with ANSI features) (II)	➢ To learn about the scope, visibility of variables and storage classes. ➢ Know about Pointers so can access and manage data addresses of dynamically allocated block of memory ➢ Gain knowledge of reusing the same logic and code using functions. ➢ To learn about the mechanism of File handling and knowledge about structure and union so that memory can be used in very efficient way. ➢ Learn about different Input and output methods, streams and buffering.

B.Sc. Mathematics

COURSE OUTCOMES (CO)

Course 1: Algebra and Trigonometry

This course will enable the students

- To evaluate Inverse of matrix using elementary operation and application of Matrices to solve systems of linear equations, Canonical form of a matrix and apply the Clayey – Hamilton theorem.
- To understand the theory of equation, prove results involving divisibility and greatest common divisors. Polynomial addition, subtraction, division, multiplication, roots of polynomials, Descartes's rule of sign and Cardon's method.
- To describe the theorem in Group theory and Ring theory.
- To describe subgroups, normal subgroup, co-sets and cyclic group.
- To describe functions, their type, relations and equivalence relation.
- To apply De-Moivre's theorem to solve related problems in inverse trigonometry function and hyperbolic function, Apply and prove trigonometric identities.
- To understand the Gregory series and sum of series

Course 2: Calculus

This course will enable the students

- Verify the value of the limit of a function at a point using the definition of the limit
- To test the continuity and differentiability of functions of one variable,
- To understand the consequences of the intermediate value theorem for continuous functions, expansion of function by Taylor's and Maclaurin's series and find the nth derivative of product of two functions by Leibnitz theorem.
- To calculate and solve the definite and indefinite integrals of function, volumes, surfaces area of any curve.
- To trace curves in Cartesian as well as in Polar coordinates and acquire knowledge about asymptotes and curvature.
- To solve the differential equation of different order and degree.
- This course will provide the students an understanding about different simultaneous equations and transformation of equations.

Course 3: Vector Analysis and Geometry

By the end of this course, students will be able

- To determine and calculate (vector and scalars) dot and cross products of three and four vectors and acquire knowledge about the gradient, divergence and curl.
- To use Greens, divergence, and Stokes theorems by combining vector differential calculus and vector integral calculus.
- To solve Vector Integration and differentiation.
- To calculate the directional derivatives of functions of several variables.
- To describe Cone, Sphere, Cylinder, Generating Lines, Straight line, Plane etc. and to find equation of spheres, cylinders and cones.
- To find nature of general conics and to learn to trace curve of conicoid (hyperboloid, paraboloid, ellipsoid).

Course 4: Advanced Calculus

Upon successful completion of Advanced Calculus, the student will be able to

- To determine the series and alternating series and different types of tests to find convergence of the series.
- To determine the Jacobian of two, three and more variables.
- To find the limit of a function of one and two variables and test its continuity, differentiability and partial derivatives of functions.
- Apply the chain rule for functions of several variables
- Solve problems involving tangent planes and normal lines.
- To change the variables from independent to dependent and solve maxima and minima of function of two or more variables.
- Use the Lagrange multiplier method to find extrema of functions with constraints.
- Evaluation and Properties of Beta and Gamma Function as well as evaluation of double and triple integration.

Course 5: Differential Equations

On completion of this course students will be expected

- Understand the difference between ordinary & partial differential equations and to solve the ordinary and partial differential equations and series solution of differential equation.
- To compute the Laplace and Inverse Laplace transformation of the given equation and solve the differential equation with the use of Laplace transformation.
- To solve differential equations, by Charpit's method and Monge's method.
- To understand and solve boundary value problems.

Course 6: Mechanics

This course will enable the students

- To find the velocity and acceleration of a moving particle.
- To understand and compute the equilibrium condition of particles and acquire knowledge about catenary.
- To describe and solve Capler's law of motion, central axis and knowledge about the Law of conservation of energy.
- To find projectile motion and motion of a particle on rough and smooth planes.

Course 7: Analysis

Upon successful completion of this course the student will be able:

- To determine the Fourier series of full and half range of any function of one variable.
- Understand the concept of Fourier series and Riemann Integrability.
- To apply Schwarz and Young's theorem on various functions.
- To analyze the convergence of all type of trigonometric real functions.
- To understand and describe the complex numbers, elementary transformation and conformal mapping.
- Elaborate on the topological concepts of the real numbers: open sets, closed sets, accumulation points, closure, open covers, compact sets.
- Work with completeness;
- Deal with various examples of metric spaces;
- Apply the ideas of metric spaces to other areas of mathematics

Course 8: Abstract Algebra

Upon successful completion of this course students will be able

- To use various forms of "Sylow theorem" and identify the whole structure of group.
- To analyze ring, polynomial ring, homomorphism, isomorphism of ring and Modulus.
- To analyze Vector space, homomorphism, isomorphism, Kernel of homomorphism of function, Dimension of vector spaces, and acquire knowledge about the linearly dependent and independent set of vectors.
- To analyze linear transformation, Canonical forms, bilinear forms and Dual spaces.
- To determine inner product of two Vectors, Inner product space and Gram-Schimdt orthogonalization process.

Course 9: Advanced Discrete Mathematics

Upon successful completion of this course the student will be able:

- To understand the basic concepts of graph theory, Trees, circuits, Computability theory.
- To describe Graphs, Trees, Spanning Trees, Circuits, finite state machine and their types.
- To describe the difference between Mealy and Moore machine.
- To compute the output of a finite state machine corresponding to their next state of the given input.
- To understand about Logic circuits, propositions, its types and logical equivalence relation.
- To describe conjunctive normal form and disjunctive normal form of given function.
- To understand the concept of Boolean Algebra.

Dewangan

(Nidhi Dewangan)
Asst. prof. (Mathematics)

22.6.22
Principal
प्रभारी प्राचार्य
शासकीय पं. श्यामाचरण शुक्ल मह