Courses Offered by Department of Mathematics for Program Outcome of M.Sc. Mathematics

Program Outcomes, Program Specific Outcomes, Course Outcomes

Program Outcomes	Program Outcome of M.Sc. Mathematics
PO1.	Knowledge of advanced methods of mathematics, including some from the research frontier of the field, and expert knowledge of a well-defined field of study, based on recent trends of research in mathematics
PO2.	Analysing, Mathematical Modelling and logical arguments power will be developed with mathematical concepts.
PO3.	Communicate mathematical ideas with clarity and coherence, both written and verbally.
PO4.	Perform research in conjunction with others as well as individually.
PO5.	Enhance the job prospect
Program Specific Outcomes	**PSOs of M.Sc. Mathematics Program**
PO1.	After completing the program student will be able to write Dissertation/Project work in Mathematics
PO2.	They will be able to write computer program for solve real world problems.

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Program Outcomes, Program Specific Outcomes, Course Outcomes

Course Outcomes	**Analysis - I (MATH-521)** CO 01: Understand thing of Uncountability of the reals. Metric spaces, compact and connected sets, separability, equivalent metrics. CO 02: Understanding of Subsequences. Cauchy sequences. Upper and lower limits of a sequence of real numbers. Series, absolute convergence and rearrangement of series. CO 03: Idea of Limits of functions (in metric spaces) and continuity. CO 04: Understanding the concept of Continuous functions on compact domains and on connected domains. CO 05: Knowledge about Discontinuities and monotonic functions on intervals. CO 06: Integration of vector-valued functions and rectifiable curves., Uniform convergence of sequences and series of functions, its relation to continuity, integrability and equicontinuity. CO 07: Application of Stone-Weierstrass theorem.
Credits	LTP:3/1/0
Course Outcomes	**Complex Analysis (MATH-522)** CO 01: Effectively write mathematical solutions in a clear and concise manner. CO 02: Effectively locate and use the information needed to prove theorems and establish mathematical results. CO 03: Demonstrate the ability to integrate knowledge and ideas of complex differentiation and complex integration in a coherent and meaningful manner and use appropriate techniques for solving related problems and for establishing theoretical results. CO 04: Demonstrate ability to think critically by proving mathematical conjectures and establishing theorems from complex analysis. CO 05: In addition, students will be able to: Operate with complex numbers, use the complex derivatives function, use and operate analytic functions, demonstrate knowledge of integration in the complex plane,

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	CO 06: Students apply Cauchy's theorem and Cauchy integral formula in practical problem. CO 07: Manipulate and use power series, understand residues and their use in integration. CO 08: Demonstrate the understanding of conformal mappings.
Credits	LTP:3/1/0
Course Outcomes	**Algebra (MATH-523)** CO 01: Student will get the knowledge about the groups, permutation group. CO 02: Student will get the knowledge about Jordan Holder series, nilpotent group, simple group, solvable group. CO 03: Students will get the knowledge about the rings, integral domain, polynomial ring CO 04: Students will apply their knowledge in the area principal ideal domain, unique factorization domain. CO 05: Students will get the knowledge about the irreducible criteria about polynomial ring. CO 06: Students will get the knowledge about field, prime field, sun field, algebraic extension, finite field extension CO 07: Student will get the knowledge about normal extension, inseparable extension CO 08: Students will get the knowledge about the field module, submodule, linear operator, characteristic polynomial, minimal polynomial.
Credits	LTP:3/1/0

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Program Outcomes, Program Specific Outcomes, Course Outcomes

Course Outcomes	**Numerical Methods (MATH-524)** CO 01: They will be able to find roots of linear and nonlinear algebraic and transcendental equations using different numerical methods CO 02: They get knowledge about solution of a system of non-linear equations by fixed point method and Newton-Raphson methods. CO 03: Analyze the rate and order of Convergence of different numerical methods. CO 04: Application of of differential equations in real life and solution of initial-value problem by single and multistep methods such as Taylor series, Euler's, Euler's modified, Picard, Runge-Kutta, Predictor-Corrector, Milne-Thomson. CO 05: Application of differential equations in Science and Technology. Solution of linear and non-linear boundary-value problems, Rayleigh-Ritz, Galerkin, Shooting methods, Solution of Characteristics value problems, CO 06: Application and solution of Laplace and Poisson equations in two variables by five point formula, Solution of Laplace equation in two variables by ADI method, Solution of mixed boundary value problem, CO 07: Solution of problems using Computer Algorithm for elliptic equation in three variables, Solution of parabolic partial differential equation in two variables by explicit and implicit methods. CO 08: Idea of solution of parabolic equation in three variables by different method such as ADE and ADI methods. CO 09: Knowledge about Solution of hyperbolic equation in two variables by explicit and implicit methods and algorithm for hyperbolic equation in three variables, CO 10: Idea about Stability of finite difference schemes for parabolic and hyperbolic equations
Credits	LTP:3/0/1
Course Outcomes	**Ordinary Differential Equations (MATH-525)** CO 01: Understand the concepts of real function theory. CO 02: Study of existence and uniqueness theorem for higher-order equations,

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	CO 03: Basic knowledge of Homogeneous Linear System and Nonhomogeneous Linear System. CO 04: Application of Sturm-Liouville Problems. CO 05: Knowledge about Orthogonality of Characteristic Functions and expansion of function in orthonormal form. CO 06: Analyze separation theorem, Sturm's fundamental theorem Modification due to Picone, Conditions for Oscillatory or non-oscillatory solution. CO 07: Study of First and Second comparison theorems. CO 08: Application to Sturm Liouville System, Phase Plane, Paths, and Critical Points. Critical Points and paths of Linear Systems. CO 09: Understand the Critical Points and Paths of Nonlinear Systems. Limit Cycles and Periodic Solutions.
Credits	LTP:3/1/0
Course Outcomes	**Analysis - II (MATH-531)** CO 01: Student will understand about linear transformation from one space to another space. CO 02: They will understand the inverse function theorem, implicit function theorem and also gain the basic idea of matric space. CO 03: Student will analyze the measurable theory and apply in practical problems CO 04: They will understand the integration and differentiation of measurable functions. CO 05: Student will analyze the convergence and divergence in measure.
Credits	LTP:3/1/0
Course Outcomes	**Programming In C (MATH-533)**

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	CO 01: Student will understand about basic concepts, algorithm and flow chart in C language. CO 02: They will apply different loops in practical problems. CO 03: They will apply arithmetic expression in different problems. CO 04: Student will understand about data type and functions. CO 05: They will apply logical expressions and control statements in practical problems CO 06: Student will apply bit level operation and application of pointer.
Credits	LTP:3/0/1
Course Outcomes	**Curves and Surfaces (MATH - 535)** CO 01: Students will be able to understand basic concept of curves in R^2 and R^3. CO 02: They will apply arc length, reparametrization, Curvature, torsion and Serret-Frenet formula in real life problems. CO 03: They will understand about first and second fundamental theorems. CO 04: Student will understand about Geodesics curvature and Gauss's theorem CO 05: They will apply the knowledge to calculate area, volume integrals, and surface area.
Credits	LTP:3/1/0
Course Outcomes	**Partial Differential Equations (MATH-551)** CO 01: Understand the Classification of Second order Partial Differential Equations. CO 02: Conversion of PDE in Canonical forms: Canonical form for Hyperbolic equation, Canonical form for Parabolic equation, Canonical form for elliptic equation. CO 03: Analysis and Derivation of Laplace Equation, Derivation of Poisson equation. CO 04: Application of Boundary Value Problems. Some important mathematical tools. Properties of Harmonic Functions. CO 05: Students understand the Dirac Delta Function.

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	CO 06: Application and solution of one dimensional, and two-dimensional Heat and Wave equation by variable separation method. CO 07: Application and Analysis of Initial Value Problem; D'Alemberts Solution. Vibrating String – Variables Separable solution, Forced Vibrations – Solution of Nonhomogenous Equation. CO 08: Study of Boundary and Initial Value problem for one and two-dimensional Wave equation in Cylindrical Coordinates and Spherical Polar Coordinates.
Credits	LTP:3/1/0
Course Outcomes	**Mathematical Statistics (MATH-552)** CO 01: Effectively express themselves in statistical terms either in written or oral form. CO 02: Demonstrate ability to integrate knowledge and idea in a coherent and meaningful manner by implementing the basic regression analysis theory in solving "real world" problems. CO 03: Locate and use information from the output of statistical software to draw conclusion. CO 04: Work effectively with others in class discussions or small group projects. CO 05: To understand the mathematical theory behind common methods of statistical inference, such as point estimation, confidence intervals, and hypothesis testing. CO 06: To apply statistical methods learned to help solve interesting and realistic problems across a variety of fields. CO 07: Introductory probability and Bayes' theorem CO 08: Discrete random variables and their probability distributions CO 09: Continuous random variables and their probability distributions CO 10: Multivariate random variables and their probability distributions CO 11: Sampling distributions and the central limit theorem Interval estimation;
Credits	LTP:3/1/0

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Course Outcomes	**Research Methodology (MATH -599)** CO 01: Student will understand about ethics of research. CO 02: They will understand how to collect data or literatures. CO 03: They will apply different statistical tools in their research work. CO 04: Student will understand about citation of work and plagiarism. CO 05: Student will understand about different experimental design such as CRD, RBD and Latin square design. CO 06: Student will apply their knowledge to write the synopsis, research paper and thesis.
Credits	LTP:3/0/0
Course Outcomes	**Discrete mathematics (MATH-533)** CO 01: Student will understand about basic concept of set theory and relations. CO 02: They will apply the knowledge in practical problems such as AND, OR, NOR gates etc. CO 03: Student will be able to understand about permutation, combination. CO 04: They will apply Pigeonhole principle in real life practical problems, CO 05: Student will understand about graph theory and apply this knowledge to solve practical problems. CO 06: They will understand about Boolean algebra and apply the circuit theory in solution of complicated problems. CO 07: They will get knowledge about trees and application in real life problems.
Credits	LTP:3/1/0
Course Outcomes	**TOPOLOGY (MATH - 561)** CO 01: Student will understand about basic concept of set theory and metric space. CO 02: They will understand about Topological Spaces, examples and its application.

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	CO 03: Student will anlyze different type space such as compact, connected, Housdorff, and separated space CO 04: They will understand different type theorems such as Urysohn's lemma, Urysohn imbedding, Tietze's extension, and Stone-Cech compactification theorems etc. CO 05: They will understand about different shapes.
Credits	LTP:3/1/0
Course Outcomes	**Functional Analysis (MATH-563)** CO 01: Student will understand about Normed linear space and Banach space and its applications. CO 02: they will analyse Hahn-Banach, Banach-Steinhaus, Open Mapping and Closed Graph Theorems. CO 03: Student understand about dual spaces and reflexivity, weak and weak star convergence. CO 04: They will be able to understand different type operators such as adjoint operator, self-adjoint, normal and unitary operators on Banach and Hilbert spaces.
Credits	LTP:3/1/0
Course Outcomes	**Number theory-I (MATH- 562)** CO-01: Students will get the knowledge about divisibility, g.c.d. the fundamental theorem of arithmetic. CO-02: Students will gain the knowledge in the field Chinese remainder theorem, Fermat's theorem, and Wilson's theorem. CO-03: students will check their knowledge in the field residue class, Euler's theorem. CO-04-students will gain the knowledge in the field quadratics residue, Legendre symbol, jacobi symbol, Diophantine equation.

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Credits	LTP:3/1/0
Course Outcomes	**Difference Equation (MATH-564)** CO 01: Students will be able to apply Euler's summation formula and Bernoulli polynomials in practical problems. CO 02: Students understand about linear and non-linear difference equations and be able to solve. CO 03: Students will be able to analyze the stability of linear and Nonlinear system. CO 04: Students will understand Volterra summation equation and Fredholm summation equation. CO 05: Students apply Z-Transform as a mathematical tool for solving difference equation.
Credits	LTP:3/1/0
Course Outcomes	**Coding Theory (MATH-565)** CO 01: They understand about linear code and encoding and decoding techniques. CO 02: They will apply this technique to remove noisy data. CO 03: Students will be able to apply this technique in security analysis. CO 04: They understand about Hamming code, perfect code and Latin square
Credits	LTP:3/1/0
Course Outcomes	**Non-Commutative Rings (MATH-566)** CO 01: Student will understand basic knowledge about rings, module amd submodule theory. CO 02: Student will analyze direct sums and direct products of rings and modules and its application. CO 03: They will understand Injective modules and divisible modules CO 04: Student will apply the knowledge of module theory in coding and decoding theory and security system etc.

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Credits	LTP:3/1/0
Course Outcomes	**Calculus of Variations and Analytical Mechanics (MATH-567)** CO 01: Students understand about Euler's equation and its application. CO 02: They apply Generalized coordinates, Holonomic and Non-Holonomic systems in physical problems. CO 03: Students understand about Lagrange's equations of first and second kind and Choice of Lagrangian. CO 04: Students will be able to apply Lagrange brackets and Poisson brackets under canonical transformations.
Credits	LTP:3/1/0
Course Outcomes	**Operations Research (MATH568)** CO01: Understand the basic definitions and the properties of Hyperplane and hyperspheres, convex sets convex, concave functions and their properties. CO02: Formulate the problem in Mathematical form and solve the Linear programming problem using different existing method. CO03: Mathematically formulate and solve Transportation and Assignment problems. CO04: Formulate mathematical model in Goal Programming and be able to solve using existing method. CO05: Understand the concept of Duality and be able to solve by Dual simplex algorithm. CO06: Apply different existing method to solve integer programming problem. CO07: Apply Game theory to make decision in practical managerial problems. CO08: Able to find shortest path of Spanning tree. CO09: Able to solve Maximal flow problem.

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Course Outcomes	**Nonlinear Optimization (MATH571)** CO01: Understand convex hulls, Closure and interior of a set, Separation and support of sets, Separation theorems of convex sets, convex cones and polarity, polyhedral sets, Extreme points and extreme directions CO02: Knowledge of definitions and Basic properties of convex functions generalized convex functions, Differentiable convex functions, twice differentiable convex functions. CO03: Able to find Minima and Maxima of Convex functions. CO04: Apply Fritz Johnand Karush-Kuhn-Tucker optimality conditions for solving non linear programming problem. CO05: Able to solve Linear quadratic programs.
Credits	LTP:3/1/0
Course Outcomes	**Number theory-II (MATH-572)** CO-01: Students will gain the knowledge in the field Farey sequence, continued fraction, pell's equation, Minkowski's inequality. CO-02: Students will check their knowledge in the field of the prime number theorem, Euler summation formula, and Abel's identity. CO-03: Students will get the knowledge about the practical problems related to Fermat's theorem, Wilsion's theorem, Chinese remainder theorem.
Course Outcomes	**Non Commutative Rings(MATH-566):** CO 01: Students get knowledge about basic concepts of non commutative rings. CO 02: They understand about modules and submodules. CO 03: They understand about Artinian rings, Wedderburn-Artin theorem. CO 04: Students will understand basic concept of injective hulls.
Credits	LTP:3/1/0

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Course Outcomes	**Commutative Algebra (MATH-573)** CO 01: They understand about prime, semi-prime, primary, maximal in ring theory CO 02: Student will analyze Chinese reminder theorem for solution algebraic equation and also in factorization of numbers. CO 03: They will understand about Chain conditions, maximal and minimal conditions in noetherin ring theory. CO 04: Student understand about applications to principal ideal domains and Artinian rings
Course Outcomes	**Algebraic Topology (Math-574)** CO 01: Student will understand about definition and some examples of homotopies and its applications. CO 02: They will analyze fundamental group of a space and the effect of a continuous mapping on fundamental group. CO 03: Student will understand about projection of space and torus, homomorphisms and automorphisms of covering spaces. CO 04: They will understand about Brower fixed-point theorem in two dimensions.
Credits	LTP:3/1/0
Course Outcomes	**Fuzzy set theory and application (MATH575)** CO01: Understand basic definitions of fuzzy set and their properties CO02: They will know about Fuzzy numbers and relation between fuzzy number and a convex fuzzy set Operations on fuzzy numbers in terms of its membership functions as piecewise defined functions, fuzzy cardinality of a fuzzy set using fuzzy numbers, arithmetic operators on fuzzy numbers CO03: Able to solve fuzzy equations, equation A+X = B, equation A.X = B CO04: Know about Crisp and fuzzy relations

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Course Outcomes	**Stochastic Processes (MATH576)** CO01: Have a reinforced knowledge of basic probability theory and effectively express themselves in statistical terms either in written or oral. CO02: Understand and apply sequences of random variables CO03: Have a firm understanding of the central limit theorem and its applications CO04: Understand the basic concepts of continuous random processes CO05: Apply the knowledge of Poisson Process and Marcov chains in practical situations CO06: Apply the concept of Random walk-in real-world problems
Credits	LTP:3/1/0
Course Outcomes	**Applied Functional Analysis (MATH - 577)** CO 01: Student will understand about basic properties of Hilbert space and its applications. CO 02: They will analyze Minkowski functional, Separation Theorem and Kuhn-Tucker Theorems. CO 03: Student will be able to understand Spectral theory of operators and compact operations. CO 04: Student will understand L2 spaces over Hilbert spaces and its properties.
Course Outcomes	**Fluid Mechanics (MATH- 578)** CO 01: Students will understand the basic concept of fluid mechanics. CO 02: They apply Euler's equation of motion, Bernoulli's equation in real situations. CO 03: They get idea about velocity potential and stream functions.

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	CO 04: They understand about Milne Thomson Circle Theorem, and Blasius Theorem.
Credits	LTP:3/1/0
Course Outcomes	**Integral equation and transformation (MATH-554)** CO 01: Student will learn the classification of linear integral equation. CO 02: Student will be able to compute resolvent kernel. CO 03: Student will be able to solve the integral equation through different techniques.