Program- MSc Mathematics			
Program Outcome	**Course Name**	**Course Code**	**Course Outcome**
To inculcate and develop mathematical aptitude and the ability to think abstractly in the student. To develop computational abilities and programming skills. To develop in the student the ability to read, follow and appreciate mathematical text. Train students to communicate mathematical ideas in a lucid and effective manner. To train students to apply their theoretical knowledge to solve problems. To encourage the use of relevant software such as MATLAB and MATHEMATICA.	**ALGEBRA**	**MSc-Math-101**	**1:** automorphisms for constructing new groups from the given group. **2:** external direct product $Z_{2\otimes}Z_2$applies to data security and electric circuits. **3:** group actions, Sylow theorems and their applications to check nonsimplicity **4:** appreciate the significance of unique factorization in rings and integral domains. **5:** identify and construct examples of fields, distinguish between algebraic and transcendental extensions.
	REAL ANALYSIS	**MSc-Math-102**	**1:** the conceptual variations when advancing in calculus from one variable to multivariable discussions. **2:** applications of multi variable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc. **3:** understand the extension of the studies of single variable differential and integral calculus to functions of two or more independent variables. **4:** geometric applications of higher derivations in more than two dimensions.
	DIFFERENTIAL EQUATIONS	**MSc-Math-103**	**1:** know about existence, uniqueness and continuity of solutions of first order ODE's, properties of zeros of solutions of linear second order ODE's, Liouville systems. **2:** be well equipped to undertake any advanced course on ordinary as well as partial differential equations. **3:** understand the key ideas, concepts and definitions of the computational algorithms, origins of errors, convergence theorems.

			4: decide the best numerical method to apply to solve a given differential equation and quantify the error in the numerical (approximate) solution.
	MATHEMATICAL METHODS	**MSc-Math-104**	**1:** derive a Fourier series of a given periodic function by evaluating Fourier coefficients. **2:** drive integral equations and their solutions. **3:** compute solutions to Volterra integral equations by method of resolvent kernel, method of successive approximations, system of Volterra integral equations and integro-differential equation. **4:** determine the solutions of Fredholm integral equations and derivation of Hilbert Schmidt theorem.
	CALCULUS OF VARIATIONS	**MSc-Math-105**	**1:** understand the formulation of variational problems, **2:** understand variational problems with moving boundaries, pencil of extremals, Transversality condition with their applications. **3:** understand the Jacobi`s condition for externals of central field. **4:** understand the variation of a functional and its properties, extremum of functional, necessary condition for an extremum.
	COMPUTATIONAL MATHEMATICS LAB-I	**MSc-Math-151**	**1:** be able to apply mathematical skills and logical reasoning for problem solving. **2:** communicate mathematical ideas effectively, in writing as well as orally. **3:** have sound knowledge of mathematical modeling, programming and computational techniques as required for employment in industry.
	METRIC SPACES	**MSc-Math-201**	**1:** understanding various physical phenomena and gives the student the foundation in mathematics. **2:** understanding of fundamental concepts in Mathematics. This will be helpful to the student in understanding pure mathematics and in research.

			3: understand students will be able to know the concepts of metric space,
	COMPLEX ANALYSIS	**MSc-Math-202**	**1:** understand analytic function as a mapping on the plane, Mobius transformation and branch of logarithm. **2:** understand Cauchy's theorems and integral formulas on open subsets of the plane. **3:** understand how to count the number of zeros of analytic function giving rise to open mapping theorem and Goursat theorem as a converse of Cauchy's theorem. **4:** know about the kind of singularities of meromorphic functions which helps in residue theory and contour integrations. **5:** handle integration of meromorphic function with zeros and poles leading to the argument principle and Rouche's theorem
	MATHEMATICAL STATISTICS	**MSc-Math-203**	**1:** understand the basic knowledge of probability and Mathematical Expectation with their applications. **2:** understand the Discrete and Continuous distributions with their applications. **3:** apply Central limit theorem for distributions to calculate probability. **4:** understand Correlation and regression and their properties. **5:** understand test of significance for large sample tests for proportion and mean, small sample test based on t, F and Chi-square statistics.
	OPERATIONS RESEARCH	**MSc-Math-204**	**1:** the student will be able to solve various problems based on convex sets and linear programming. **2:** the students to apply the basic concepts of transportation problems and its related problems to apply in further concepts and application of operations research.

			3: to understand project planning and control with PERT/CPM and their applications. **4:** the students understand the use of game theory in daily life and solutions by linear programming.
	MECHANICS	**MSc-Math-205**	**1:** apply fundamental conservation principles to analyze mechanical systems. **2:** introduce advanced theoretical techniques including variational principles and Hamilton Jacobi theory and develop the capability to apply these techniques to analyze elementary mechanical systems. **3**: these entire courses are important in engineering and industrial applications for solving boundary value problem. **4:** understand method of separation of variables in Hamilton Jacobi equation and its simple applications.
	COMPUTATIONAL MATHEMATICS LAB-II	**MSc-Math-251**	**1:** be able to perform a wide range of data management tasks in Excel and SPSS application and understand the basic workings of SPSS, and perform basic statistical analyses. **2:** perform database management tasks, descriptive statistics and graphics, and basic inferential statistics for comparisons and correlations. **3:** perform data checking and create simple tables and charts. **4:** perform advanced analysis in Excel and SPSS.
	TOPOLOGY	**MSc-Math-301**	**1:** determine interior, closure, boundary, limit points of subsets and bases and subbasis of topological spaces. **2:** check whether a collection of subsets is a basis for a given topological spaces or not, and determine the topology generated by a given basis.

			3: determine the connectedness and path connectedness of the product of an arbitrary family of spaces. **4:** find Hausdorff spaces using the concept of net in topological spaces and learn about 1st and 2nd countable spaces, separable and Lindelof spaces. **5:** learn Bolzano-Weierstrass property of a space and prove Tychonoff theorem.
	MEASURE AND INTEGRATION	**MSc-Math-302**	**1:** be able to verify whether a given subset of R or a real valued function is measurable. **2:** be able to understand the requirement and the concept of the Lebesgue integral (a generalization of the Reimann integration) along its properties. **3:** be able to demonstrate understanding of the statement and proofs of the fundamental integral convergence theorems, and their applications. **4:** be able to introduce the concepts of functions of bounded variations and the absolute continuity of functions with their relations. **5:** be able to learn and apply Holder and Minkowski inequalities in Lp-spaces, completeness of L_p-spaces and convergence in measures.
	NUMERICAL ANALYSIS	**MSc-Math-303**	**1:** some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision. **2:** interpolation techniques to compute the values for a tabulated function at points not in the table. **3:** applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions. **4:** find the consequences of finite precision and the inherent limits of numerical methods.

			5: solve first order initial value problems of ODE's numerically using Euler methods.
	OPTIMIZATION TECHNIQUES	**MSc-Math-304**	**1:** have studied notions of sub-gradients and directional derivative for non-differentiable functions. **2:** understand the use of conjugate functions to develop the theory of conjugate duality. **3:** know numerical methods like gradient descent method, gradient projection method, Newton's method and conjugate gradient method. **4:** deal with dynamic programming approach to solve some problems including stage coach problem, allocation problem and linear programming problem. **5:** know both classical and modern approaches in the study of optimal control problems.
	GRAPH THEORY	**MSc-Math-305**	**1:** model problems using different types of basic graphs like trees, bipartite graphs and planar graphs. **2:** understand and identify special graphs like Euler graphs and Hamiltonian graphs. **3:** have increased ability to understand various forms of connectedness in a graph **4:** appreciate different graph-coloring problems and their solutions. **5:** model simple problems from real life as graph-coloring problems.
	PROGRAMMING IN C	**MSc-Math-306**	**1:** understand the basic terminology used in computer programming **2:** write, compile and debug programs in C language. **3:** use different data types in a computer program. **4:** design programs involving decision structures, loops and functions **5:** evaluate the usability of File and preprocessors of c Programming terminology.

	DIFFERENTIAL GEOMETRY	**MSc-Math-307**	**1:** understand the concepts of graphs, level sets as solutions of smooth real valued functions vector fields and tangent space. **2:** comfortably familiar with orientation, Gauss map, geodesic and parallel transport on oriented surfaces. **3:** learn about linear self-adjoint Weingarten map and curvature of a plane curve with applications in geometry and physics. **4:** know line integrals, be able to deal with differential forms and calculate arc length and curvature of surfaces. **5:** study surfaces with boundary and be able to solve various problems and the Gauss- Bonnet theorem.
	DISCRETE MATHEMATICS	**MSc-Math-308**	**1:** understand the logic and FSM and their transition diagram. **2:** understand the Lattices and their types **3:** understand the Boolean algebra, switching circuits and their applications **4:** understand the Graphs, their types and its applications in study of shortest path algorithms **5:** understand the matrix representation of graphs.
	DATA STRUCTURES	**MSc-Math-309**	**1:** develop programs using basic data structures: sets, lists, stacks, queues, trees, graphs and advanced data structures like balanced trees and skip lists. **2:** understand the behavior and application of advanced data structures like Tries, Prefix- and Suffix-trees. **3:** identify best suited data structure for the problem at hand. **4:** identify the programming constructs to optimize the performance of the data structure in different scenarios.
	COMPUTATIONAL MATHEMATICS LAB-III	**MSc-Math-351**	**1:** be able to apply mathematical skills and logical reasoning for problem solving.

			2: communicate mathematical ideas effectively, in writing as well as orally. **3:** have sound knowledge of mathematical modeling, programming and computational techniques as required for employment in industry.
	FUNCTIONAL ANALYSIS	**MSc-Math-401**	**1:** verify the requirements of a norm, completeness with respect to a norm, relation between compactness and dimension of a space, **2:** distinguish between Banach spaces and Hilbert spaces, decompose a Hilbert space in terms of orthogonal complements, **3:** extend a linear functional under suitable conditions, compute adjoint of operators, check reflexivity of a space, **4:** compute the spectrum of operators and classify the set into subclasses, show the spectrum to be nonempty, give expansion of resolvent operator.
	ADVANCED GROUP THEORY	**MSc-Math-402**	**1:** prove Schreier's refinement theorem and Jordan -Holder theorem and also to prove fundamental theorem of arithmetic using Jordan-Holder theorem **2:** prove Hall's theorem, Schur's theorem and Burnside basis theorem. **3:** identify indecomposable spaces and to prove Krull -Schmidt theorem. **4:** determine distinct presentations of a group.
	BIO-MATHEMATICS	**MSc-Math-403**	**1:** learn the development, analysis and interpretation of bio mathematical models. **2:** reinforce the skills in mathematical modeling. **3:** appreciate the theory of bifurcation and chaos. **4:** learn to apply the basic concepts of probability to molecular evolution and genetics.
	NUMBER THEORY	**MSc-Math-404**	**1:** some of the open problems related to prime numbers, viz., Goldbach conjecture etc.

			2: about number theoretic functions and modular arithmetic. **3:** public crypto systems, in particular, RSA.
	MATHEMATICAL MODELING	**MSc-Math-405**	**1:** handle freely the concepts using in mathematical modeling; **2:** analyze a simple physical phenomena in order to create a mathematical model; **3:** interpret numerical results given by program in order to predict the behavior of the system in various models; **4:** understand the mechanism of mathematical modeling in chemical engineering.
	PARTIAL DIFFERENTIAL EQUATIONS	**MSc-Math-406**	**1:** use discretization methods for solution of PDEs using finite difference schemes. **2:** analyze the consistency, stability and convergence of a given numerical scheme. **3:** apply various iterative techniques for solving system of algebraic equations. **4:** know the basics of finite element methods for the numerical solution of PDEs. **5:** construct computer programme using some mathematical software to test and implement numerical schemes studied in the course.
	FUZZY SETS AND ITS APPLICATIONS	**MSc-Math-407**	**1:** use fuzzy sets for evidence theory. **2:** apply Fuzzy measures techniques for possibility theory. **3:** know the basics of fuzzy propositions for different Inferences. **4:** construct fuzzy linear programming, Methods of defuzzyfication schemes studied in the course.
	MATHEMATICAL CRYPTOGRAPHY	**MSc-Math-408**	**1:** have been introduced to the concept of secure communication and fundamentals of cryptography. **2:** know classical ciphers such as Vigenere Cipher and Hill Cipher.

			3: have insight into DES and AES. **4:** be familiar with secure random bit generator and linear feedback shift register sequences. **5:** know of RSA, attacks on RSA, Diffie−Hellman key exchange and ElGamal, public key cryptosystem.
	ALGEBRAIC CODING THEORY	**MSc-Math-409**	**1:** get an insight into matrix representation of a code as well as encoding and decoding. **2:** understand Hamming codes, MDS codes and Reed−Muller codes. **3:** learn about cyclic codes and their generator polynomial.
	FLUID DYNAMICS	**MSc-Math-410**	**1:** know about the basics of first and second law of thermodynamics, **2:** know about compressibility in real fluids, the elements of wave motion, **3:** understand the interaction between hydrodynamic process and electromagnetic phenomena in term of Maxwell electromagnetic field equation. **4:** formulate the basic equations of motion in inviscid and viscous conducting fluid flow **5:** know the concepts of boundary layer, boundary layer equations and their solutions with different concept and measurement of boundary layer thickness.
	MATHEMATICAL PROGRAMMING	**MSc-Math-411**	**1:** derive first and second order optimality conditions for a nonlinear programming problem and consider convex functions for deriving sufficient optimality conditions. **2:** understand duality theory in terms of Lagrangian function and investigate saddle point theory. **3:** understand numerical methods like Wolfe's method, convex simplex method and penalty function methods for solving different types of nonlinear programming problems.

	DATABASE MANAGEMENT SYSTEM	**MSc-Math-412**	**1:** describe the architecture of a web application. **2:** describe the issues in query optimization. **3:** develop a web-based database application incorporating security issues.
	DISSERTATION/ PROJECT	**MSc-Math-451**	**1:** develop analytical, research and computational skills. **2:** be exposed to the Mathematical Software's like MATHEMATICA, MAT Lab and will be able to use them effectively.