

**M.Sc. Mathematics**  
**4 Semester Course**  
**List of Courses**

Sl. No.	Name of the Course	Semester	Course Code	Credit	Marks	Programme	Programme Code	Course Outcome	Activities with direct bearing on Employability/ Entrepreneurship/ Skill development	Introducti on year of new course	BoS Date	Percentag e of Revision	BoS Date
1	Abstract Algebra I	1	MTM-P1	4	50	M. Sc Mathematics	MTM	To learn the basic concepts of cyclic group, normal subgroup, group homomorphism, direct products of groups, Sylow theorems and applications, ideal and ring homomorphism, ring embedding, ED, PID, UFD, prime and irreducible elements, maximal and prime ideal, Noetherian ring, Hilbert Basis Theorem. This is required for further courses in algebra.	Skill development: Skill of algebra is developed by group discussion or free participation of students related to nontrivial problems in class.			30	10.10.2018

2	Linear Algebra I	1	MTM-P2	4	50	M. Sc Mathematics	MTM	<p>The student will learn the concepts of Vector spaces; linear transformations; dual spaces; triangulation and diagonalization of matrices and linear transformations; direct sum decompositions of vector spaces. Further, the student will learn about inner product spaces, projections; isometries; Reisz representation theorem; normal, self-adjoint, unitary and orthogonal operators; unitarily diagonalizable matrices; spectral theorem; various canonical and bilinear forms. Thus, they will be ready to use linear algebra for various applications in multivariable analysis, numerical analysis, functional analysis, calculus, differential geometry, mechanics, linear programming problems, etc.</p>	<p>Skill development : Analytical and reasoning skills are developed by group discussion or free participation of students related to nontrivial problems in class. . Employability : Class room discussions, problem solving sessions helps them to stress on the important areas of Linear algebra, which in turn improves their skills for Teaching jobs at College Level. Also, this course will help students to get a job in software companies like math works and Two pi-radian infotech private limited and others.</p>	2015-16	03.06.2015		
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3	Real Analysis I	1	MTM-P3	4	50	M. Sc Mathematics	MTM	<p>The student will review the various concepts of analysis on Real line (studied in the undergraduate courses). Additionally, they will learn Taylor's and Maclaurin's series; and some concepts of metric topology, viz. Completeness, Baire Category Theorem, Compactness and Connectedness. This will enable the student to take up studies on Multivariable analysis, Measure theory, Numerical Analysis. Also, this course will suffice as the one of the basic requirement courses for the courses - Functional Analysis, Ordinary Differential equations, etc.</p>	<p>Skill development : Analytical and reasoning skills are developed by group discussion or free participation of students related to nontrivial problems in class. .</p> <p>Employability : Class room discussions, problem solving sessions helps them to stress on the important areas of Real Analysis, which in turn improves their skills for Teaching jobs at College Level.</p>	2015-16	03.06.2015		
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4	General Topology	1	MTM-P4	4	50	M. Sc Mathematics	MTM	<p>The student will learn about basics of topological spaces, countability axioms, continuous functions and homeomorphisms, separation axioms, compactness, local compactness and one point compactification, connectedness, product topology. This will enable the student for any course requiring basic topology, such as algebraic topology, multivariable analysis, differential geometry, partial differential equations, fluid mechanics, mechanics of continua, etc.</p>	<p>Skill development : Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class. .</p> <p>Employability : Class room discussions, problem solving sessions helps them to stress on the important areas of Topology, which in turn improves their skills for Teaching jobs at College Level.</p>				
5	Complex Analysis	1	MTM-P5	4	50	M. Sc Mathematics	MTM	<p>To learn the concept of contour integration, Maximum modulus and relevant theorems, Taylor series, Laurent series, singularities, residue, argument principle, Rouches' theorem and its applications, conformal mapping, bilinear transformation. This will enable the student to take up studies in complex analysis, harmonic analysis, applied mathematics, physics, etc.</p>	<p>Skill development : Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class. .</p> <p>Employability : Class room discussions, problem solving sessions helps them to stress on the important areas of complex analysis, which in turn improves their skills for Teaching jobs at College Level.</p>				

6	Abstract Algebra II	2	MTM-P6	4	50	M. Sc Mathematics	MTM	To learn the concept of normal and sub normal series, various field extension, Galois theory. This course is required for higher course in field extension theory.	Skill development: Algebraic skills is developed by group discussion or free participation of students related to nontrivial problems in class.				
7	Linear Algebra II	2	MTM-P7	4	50	M. Sc Mathematics	MTM	The student will learn about module theory. This will enable him to take up studies in commutative algebra.	Skill development : Analytical and reasoning skills are developed by group discussion or free participation of students related to nontrivial problems in class. . Employability : Class room discussions, problem solving sessions helps them to stress on the important areas of Linear Algebra, which in turn improves their skills for Teaching jobs at College Level.	2015-16	03.06.2015		

8	Real Analysis II	2	MTM-P8		50	M. Sc Mathematics	MTM	<p>The student will learn about sequences and series of functions with special stress on Fourier series; review of Reimann integration theory with introduction to beta and gamma functions; Multivariable analysis with applications to maxima-minima problems. These will enable the student to solve problems arising in differential equations, mechanics and develop various numerical models. Also, this course partially fulfils the basic requirements for courses on numerical analysis, partial differential equations, mathematical methods, differential geometry, mechanics, etc.</p>	<p>Skill development: Analytical and reasoning skills are developed by group discussion or free participation of students related to nontrivial problems in class.</p>	2015-16	03.06.2015	20	27.11.2017
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9	Measure Theory	2	MTM-P9	4	50	M. Sc Mathematics	MTM	<p>The student will learn about Sigma-field and field of subsets of a set; Countably additive nonnegative measure on a sigma-field, Continuity from above and below; Measurable functions; Integration theory; <math>L_p</math> spaces of a measure space; Jensen's inequality for a probability space; product sigma-fields, product measures. This will enable the student to take up courses on functional analysis, advanced functional analysis, etc.</p>	<p>Skill development: Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class.</p>				20	03.06.2015
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10	Numerical Analysis-I	2	MTM-P10	4	50	M. Sc Mathematics	MTM	<p>(Theory) A student will learn about interpolation techniques; solving algebraic, transcendental and system of linear equations using numerical methods; finding approximate eigenvalues of matrices.</p> <p>(Practical) The student will learn to code the aforesaid numerical methods using MATLAB or C programming language. This will enable the student for advanced studies in numerical analysis. Also, this will prepare the student for any employment where numerical techniques are required, for example in research labs, software industries, etc.</p>	<p>Employability :Class room discussions, problem solving sessions helps them to stress on the important areas of Numerical Analysis, which in turn improves their skills for Teaching jobs at College Level. Also, the hand-on problem solving sessions using computer in class will prepare them for the jobs that require numerical modeling like software development etc.</p> <p>Skill development : Analytical and reasoning skills are developed by group discussion or free participation of students related to nontrivial problems in class. . Hands on problem solving session in class using computer will help them to learn to apply various analytical methods to solve real life problems using numerical</p>	2017-18	13.05.2017		
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11	Classical Mechanics	3	MTM-P11	4	50	M. Sc Mathematics	MTM	<p>To learn the concepts of Lagrangian, Hamiltonian, Hamilton's principle, principle of least action, Noether's theorem, Brackets, Euler's dynamical equation, Eulerian angles, motion of a symmetrical top, small oscillation. This course serves as the basics required by the student to work on physical problems arising in the mechanical world. Further, this will help a student to take up studies in advanced mechanics.</p>	<p>Skill development: Analytical and reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class.</p>	2017-18	13.05.2017		
12	Ordinary Differential Equations	3	MTM-P12	4	50	M. Sc Mathematics	MTM	<p>This will help the student to solve various problems arising in the physical world which can be expressed in terms of ODEs (for example problems in kinematics, evolution, etc.). This forms one of the basic requirements for partial differential equations, further studies in mechanics, etc.</p>	<p>Skill development : Analytical and reasoning skills are developed by group discussion or free participation of students related to nontrivial problems in class. Employability : Class room discussions, problem solving sessions helps them to stress on the important areas of Ordinary Differential Equations, which in turn improves their skills for Teaching jobs at College Level.</p>				

13	Functional Analysis	3	MTM-P13	4	50	M. Sc Mathematics	MTM	<p>A student will review the concepts of metric spaces; learn about the basics of functional analysis – normed linear spaces, Banach spaces, Hahn Banach theorems, Hilbert spaces, Riesz representation theorem, operators on Hilbert spaces. This will enable the student to take up advanced courses on operator theory, functional analysis, partial differential equations, numerical PDEs, etc.</p>	<p>Skill development: Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class.</p>			40	17.12.2016
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14	Numerical Analysis-II	3	MTM-P14	4	50	M. Sc Mathematics	MTM	<p>(Theory) A student will learn about numerical techniques to approximate integrals; solve ordinary and partial differential equations.</p> <p>(Practical) The student will learn to code the aforesaid numerical methods using MATLAB or C programming language. This course will enable the student for advanced studies in numerical analysis, numerical methods in partial differential equations. Also, this will enhance the opportunities of the student to find employment in the areas where numerical techniques are required, for example in research labs, software industries, weather forecasting departments, signal processing units, etc.</p>	<p>Employability: Class room discussions, problem solving sessions helps them to stress on the important areas of Numerical Analysis, which in turn improves their skills for Teaching jobs at College Level. Also, the hand-on problem solving sessions using computer in class will prepare them for the jobs that require numerical modeling like software development etc.</p> <p>Skill development: Analytical and reasoning skills are developed by group discussion or free participation of students related to nontrivial problems in class. Hands on problem solving session in class using computer will help them to learn to apply various analytical methods to solve real life problems using numerical</p>	2017-18	13.05.2017	35	10.10.2018
15	Algebraic Number theory	3	MTM-P15-ALNT	4	50	M. Sc Mathematics	MTM	<p>The students will learn the basic concept of Cyclotomic fields, Kummer-Dedekind criterion, Dirichlet's Unit theorem, completion of number fields. This will enable the student to take up further studies/research in this area.</p>	<p>Skill development: Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class.</p>	2014-15	17.06.2014		

16	Analytic Number theory	3	MTM-P15-AnNT	4	50	M. Sc Mathematics	MTM	<p>A student will learn about basics of number theory - unique factorization, Chinese remainder theorem and its applications, p-adic numbers, structure of <math>U(\mathbb{Z}/n\mathbb{Z})</math>, finite Abelian groups and their Characters: Dirichlet's Characters, Quadratic Gauss Sum and Quadratic Reciprocity Law; Arithmetical functions, Dirichlet product, Mobius inversion, Derivatives, Generalized convolutions, Euler's summation formula, Average growth of Arithmetic functions: Big oh, small oh notations, Application: Lattice points visible from origin, Abel's summation formula, Elementary theorems on the Distribution of Primes: Growth of <math>\pi(x)</math>, Tchebychef's theorem, Shapiro's Tauberian theorem, Selberg's identity and Asymptotic formula; Continued (Finite &amp; Infinite) Fractions and Pell's equations. This will enable the student to take up higher</p>	<p>Skill development: Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class.</p>	2015-16	05.12.2015		
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17	Commutative Algebra	3	MTM-P15-CAL	4	50	M. Sc Mathematics	MTM	A student will learn about rings and ideals, Jacobson Radicals, Extension and contraction; modules, Noetherian and Artinian Rings; Prime decomposition, Integral Dependence, The Hilbert Nullstellensatz, Noether normalisation; Completion, Valuation rings. This will enable the student to take up further research in the area of commutative algebra.	Skill development: Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class	2014-15	17.06.2014		
18	Operations Research	3	MTM-P15-OR	4	50	M. Sc Mathematics	MTM	A student will learn the basic concept of simplex method, duality and sensitivity analysis, network analysis, dynamic programming, integer programming, elementary queuing theory, inventory models, nonlinear programming. This will enable the student to take up further research in the area of operation research.	Skill development : Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class. Employability : Class room discussions, problem solving sessions helps them to stress on the important areas of Operation Research, which in turn improves their skills for Teaching jobs at College Level and jobs involving market research.				

19	Rings of Continuous functions	3	MTM-P15-Rc	4	50	M. Sc Mathematics	MTM	<p>A student will learn about C-embedding and <math>C^*</math>-embedding, Urysohn's extension theorem; Ideals of <math>C(X)</math> and <math>z</math>-filters on <math>X</math>, <math>z</math>-ideals and prime ideals; the result that <math>C(X)</math> is isomorphic to <math>C(Y)</math> for a completely regular space <math>Y</math> and any space <math>X</math>; Fixed and free ideals; <math>C(X)</math> determines <math>X</math> when <math>X</math> is compact; Convex and absolutely convex ideals; Real compact spaces; Stone-Cech compactification. This will enable the student to take up research in the area of Rings of continuous function.</p>	<p>Skill development : Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class.</p>				
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20	Topology and geometry	3	MTM-P15-TG	4	50	M. Sc Mathematics	MTM	<p>A student will learn the basics of algebraic topology – homotopy, fundamental groups, convexity, simplex, simplicial complex, free groups, covering spaces, lifting of homotopy maps; and differential geometry – co-ordinate charts, smooth manifolds, Ck manifolds, tangent spaces, cotangent spaces, submersion, immersion, tangent bundle, vector fields, exterior algebra, differential forms, simplicial homology, homology for familiar spaces (circle, torus, projective space and Klain bottle etc), coboundary maps and cohomology computations induced maps and its functoriality. This will prepare a student for further studies in geometry and subjects like differential equations, mechanics, where these topics have applications. This course will also enhance the job opportunities in the areas of computational geometry.</p>	<p>Skill development : Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class.</p>	2014-15	17.06.2014		
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21	Mathematical Methods	4	MTM-P16	4	50	M. Sc Mathematics	MTM	<p>This will help student to learn about Fourier transformation, generalized functions and integral equation. This is required for study in advance course in the respective topics and it is useful in various applied mathematics courses. Also, this will enhance the opportunities of the student to find employment in the areas where differential equations is needed like in research labs, software industries, signal processing units, etc.</p>	<p>Skill development : Analytical and reasoning skills are developed by group discussion or free participation of students related to nontrivial problems in class.</p> <p>Employability : Class room discussions, problem solving sessions helps them to stress on the important areas of Mathematical Methods, which in turn improves their skills for Teaching jobs at College Level. Also, this will enhance the opportunities of the student to find employment in the areas where differential equations is needed like in research labs, software industries, signal processing units, etc.</p>				
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22	Graph Theory & Combinatorics	4	MTM-P17	4	50	M. Sc Mathematics	MTM	<p>A student will learn about counting Theory and its applications , fundamental concepts , graphs with special properties, trees, directed graphs, coloring of graphs, planarity of graphs, combinatorics. This will help students in cryptology, logic and advance study in graph theory.</p>	<p>Skill development : Analytical and reasoning skills are developed by group discussion or free participation of students related to nontrivial problems in class.</p> <p>Employability : Class room discussions, problem solving sessions helps them to stress on the important areas of Graph Theory and Combinatorics, which in turn improves their skills for Teaching jobs at College Level. Also, this course will help students to get a job in software companies like math works and Two piradian infotech private limited and others.</p>			40	17.12.2016
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23	Partial Differential Equations	4	MTM-P18	4	50	M. Sc Mathematics	MTM	<p>A student will learn about first order quasi-linear, second order semi linear and linear partial differential equations; Cauchy problem, Dirichlet and Neumann problems; particularly Laplace, heat and wave equations in one and two dimensions. Also they learn about some special functions like Hermite, Legendre polynomials, Bessel, harmonic and Hyper geometric functions. This course is required for various courses in applied mathematics and further study in the respective area. Also, this will enhance the opportunities of the student to find employment in the areas where differential equations is needed like in research labs, software industries, weather forecasting departments, signal processing units, etc.</p>	<p>Skill development : Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class. . Employability : Class room discussions, problem solving sessions helps them to stress on the important areas of Partial Differential equations, which in turn improves their skills for Teaching jobs at College Level. Also, this will enhance the opportunities of the student to find employment in the areas where differential equations is needed like in research labs, software industries, weather forecasting departments, signal processing units, etc.</p>	2014-15	17.06.2014		
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24	Algebraic Topology	4	MTM-P19-ALT	4	50	M. Sc Mathematics	MTM	A student will learn about Identification space, Fundamental Groups and covering spaces, Van Campen Theorem, Homology, The Equivalence of Simplicial and Singular Homology. Degree, Cellular Homology. This will enable the student to take up further studies/research in this area.	Skill development : Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class.				
25	Probability theory and statistics	4	MTM-P19-PS	4	50	M. Sc Mathematics	MTM	A student will learn about probability spaces, random variables, distributions, correlation, regression, central limit theorem, measures, conditional probability, estimation and hypothesis testing. This will enable a student to go for further studies in probability, statistics, quantum mechanics, probability measures, economics, etc. This course will also enhance the employment opportunity of a student in the areas where statistical inferences are required, for example in economic planning, market survey, future estimation and trend, share market, etc.	Skill development : Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class. Employability : Class room discussions, problem solving sessions helps them to stress on the important areas of Probability and Statistics, which in turn improves their skills for Teaching jobs at College Level. Also, this course will help students to get a job in software companies like math works andTwo piradian infotech private limited and others.	2014-15	17.06.2014		

26	Advanced Functional Analysis	4	MTM-P19-AdFA	4	50	M. Sc Mathematics	MTM	<p>A student will learn about the distribution theory, Sobolev spaces, trace theorems; Second order elliptic equations, weak formulation, maximum principles, elementary variational inequalities, linear evolution problems, energy methods. This will prepare the students for solving physical, chemical and socio-economic problems that can be formulated using partial differential equations. Thus, it will help students to find employment in various areas like research labs, industrial researches, market analysis, etc.</p>	<p>Skill development : Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class. Employability : Class room discussions, problem solving sessions helps them to stress on the important areas of Advanced Functional analysis, which in turn improves their skills for Teaching jobs at College Level. Further, it will help students to find employment in various areas like research labs, industrial researches, market analysis, etc.</p>	2018-19	27.11.2017		
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27	Harmonic Analysis	4	MTM-P19-Har	4	50	M. Sc Mathematics	MTM	<p>A student will learn about Fourier series on the Circle group, its convergence; decay conditions, regularity conditions; Cesaro summability, Abel summability and its application to Dirichlet's problem on a disc; Fourier series of an <math>L_p</math> function, Euclidean Fourier transform, Interpolation theorem, Schwartz Space, tempered distributions. This will help the student to take up studies in the advanced topics on partial differential equations, numerical analysis, etc. This course will also enhance a student's opportunity in employment in various research labs, software industries, industries involving solving of differential equations (like automobile, hydraulic, petroleum, etc.).</p>	<p>Skill development: Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class.</p>	2018-19	27.11.2017		
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28	Advanced Numerical Analysis	4	MTM-P19-AdNA	4	50	M. Sc Mathematics	MTM	<p>A student will learn about advanced techniques on finite element and finite volume methods and to develop MATLAB codes to solve real life problems using these techniques. This will prepare the students for solving physical, chemical and engineering problems that can be formulated using partial differential equations. Thus, it will help students to find employment in various areas like research labs, industrial researches, software industries, etc.</p>	<p>Employability : Class room discussions, problem solving sessions helps them to stress on the important areas of Numerical Analysis, which in turn improves their skills for Teaching jobs at College Level. Also, the hand-on problem solving sessions using computer in class will prepare them for the jobs that require numerical modeling like software development etc.</p> <p>Skill development :Analytical and reasoning skills are developed by group discussion or free participation of students related to nontrivial problems in class. Hands on problem solving session in class using computer will help them to learn to apply various analytical methods to solve real life problems using numerical</p>	2018-19	27.11.2017		
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29	Non-relativistic quantum mechanics	4	MTM-P19-NQM	4	50	M. Sc Mathematics	MTM	A student will learn the basic concepts of the postulates of quantum mechanics, solution of Schrodinger's equation (1dimension), use of operators to solve different mechanical problems and symmetry in quantum mechanics. This course is the basic requirement for higher studies in quantum mechanics.	Skill development: Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class.	2018-19	27.11.2017		
30	Banach algebra and operator theory	4	MTM-P19-Banop	4	50	M. Sc Mathematics	MTM	The main content of this course is basic Banach Algebra theory and as its application spectral theory of a normal operator on Hilbert space. This is an extremely important subject in Advanced functional analysis and operator theory. Besides the Banach algebra theory has many remarkable applications in Harmonic analysis and complex analysis. So the course is useful for anyone who is intended to do research in these areas.	Skill development: Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class.				

31	Differential Manifolds	4	MTM-P15-DM	4	50	M. Sc Mathematics	MTM	<p>A student will learn about basics of differential geometry; manifolds, smooth structures, smooth maps, tangent, cotangent and vector bundles; submersion, immersion, embeddings; Lie groups; abstract tensors on manifolds. This will prepare the student for advanced courses in Riemannian Geometry, partial differential equations, fluid mechanics, theory of relativity, numerics on geometrical shapes, theory of relativity, etc. This course will also be helpful to the students who seek employment in research labs and industries involving geometrical structures of physical and biological objects, for example in the areas of molecular biology (pharmacy), engineering problems, etc.</p>	<p>Skill development : Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class. Employability : Class room discussions, problem solving sessions helps them to stress on the important areas of Differential Manifolds, which in turn improves their skills for Teaching jobs at College Level. This course will also be helpful to the students who seek employment in research labs and industries involving geometrical structures of physical and biological objects, for example in the areas of molecular biology (pharmacy), engineering problems, etc.</p>				
32	Mechanics of Continua	4	MTM-P19-MCON	4	50	M. Sc Mathematics	MTM	<p>The student will learn the concept of stress and strain and their analysis for solid bodies. Also students will have the concept of fluid dynamics, kinematics of fluid flow. This course will help the students in advance courses on solid mechanics and fluid mechanics.</p>	<p>Skill development: Reasoning skills is developed by group discussion or free participation of students related to nontrivial problems in class.</p>	2016-17	05.12.2015		