# New Scheme of Examination

**Master of Science (Mathematics)**  
**Two Year Programme (Annual)**

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## Second Year (Final)

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**Choose either of the group:-**

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MASTER OF SCIENCE (MATHEMATICS)

M.Sc. (Previous)
ADVANCED ABSTRACT ALGEBRA
PAPER CODE: MM1001

Marks: 100 Time: 3Hrs

Note: Examiner will be required to set NINE questions in all. Question No. 1 will be compulsory which consists of 12 short-answer type questions each of 2 marks covering the entire syllabus out of which candidate will be required to attempt ten questions. In addition to Q.No. 1, candidate will be required to attempt four more questions from the remaining eight questions each carrying 20 marks.

Section I

Section II

Section III

Section IV

REAL ANALYSIS
PAPER CODE: MM1002

Marks: 100 Time: 3Hrs

Note: Examiner will be required to set NINE questions in all. Question No. 1 will be compulsory which consists of 12 short-answer type questions each of 2 marks covering the entire syllabus out of which candidate will be required to attempt ten questions. In addition to Q.No. 1, candidate will be required to attempt four more questions from the remaining eight questions each carrying 20 marks.

Unit I
Sequence and series of functions, pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass’s M test, Abel’s and Dirichlefs tests for uniform convergence, uniform convergence and continuity, Uniform convergence and Riemann-Stieltjes Integration, uniform convergence and differentiation, Weierstrass Approximation theorem, Power series, Uniqueness theorem for power series, Abel’s and Tauber’s theorems.

Unit II

Unit III
Definition and existence of Riemann-Stieltjes integral, Properties of the integral, Integration and differentiation, The fundamental theorem of calculus, Integration of vector-valued functions, Rectifiable curves. Set functions, intuitive idea of measure, Elementary properties of measure, Measurable sets and their fundamental properties. Lebesgue measure of sets of real numbers, Algebra of measurable sets; Borel sets, Equivalent formulation of measurable sets in terms of open, Closed, $F_\sigma$ and $G_\delta$ sets, Non measurable sets.
Unit IV

Unit V
Vrtale’s covering Lemma, Differentiation of monotonic functions, Functions of bounded variation and its representation as difference of monotonic functions, Differentiation of Indefinite Integral, Fundamental Theorem of Calculus, Absolutely continuous functions and their properties. L spaces, convex functions, Jensen’s inequalities, Measure space, Generalised Fatun, Lemma, Measure and outer measure, Extension of a measure, caratheodory Extension Theorem.

TOPOLOGY

MARKS: 100

TIME: 3Hrs

NOTE: Examiner will be required to set NINE questions in all. Question No. 1 will be compulsory which consists of 12 short-answer type questions each of 2 marks covering the entire syllabus out of which candidate will be required to attempt ten questions. In addition to Q.No. 1, candidate will be required to attempt four more questions from the remaining eight questions each carrying 20 marks.

Unit-I

Unit-II
Compactness, continuous functions and compact sets. Basic properties of compactness and finite intersection property. Sequentially and countably compact sets, Local compactness and one point compactification. Separation axioms T₀, T and T₃ spaces, Their characterisation and basic properties, Convergence on T₀ spaces first and second countable spaces, Lindelof’s Theorems, Separable spaces and separability.

Unit-III

Unit-IV

Unit-V
PROGRAMMING IN C
PAPER CODE: MM1004

Marks: 100
Time: 3Hrs

Note: Examiner will be required to set NINE questions in all. Question No. 1 will be compulsory which consists of 12 short-answer type questions each of 2 marks covering the entire syllabus out of which candidate will be required to attempt ten questions. In addition to Q.No. 1, candidate will be required to attempt four more questions from the remaining eight questions each carrying 20 marks.

Unit I

Unit II

Unit III

Unit IV

Unit V

DIFFERENTIAL EQUATIONS
PAPER CODE: MM1005

Marks: 100
Time: 3Hrs

Note: Examiner will be required to set NINE questions in all. Question No. 1 will be compulsory which consists of 12 short-answer type questions each of 2 marks covering the entire syllabus out of which candidate will be required to attempt ten questions. In addition to Q.No. 1, candidate will be required to attempt four more questions from the remaining eight questions each carrying 20 marks.

Unit I
Linear integral equations, some basic identities, initial value problems reduced to Volterra integral equations, Methods of successive substitutions and successive approximation to solve Volterra integral equations of second kind. Iterated kernels and Neumann series for Volterra equations. Resolvent kernel as a series in l, Laplace transform method for a difference kernel, Solution of a Volterra integral equation of the first kind. Boundary value problems reduced to Fredholm integral equations, methods of successive approximation and successive substitutions to solve Fredholm equations of second kind. Iterated kernels and Neumann series for Fredholm equations. Resolvent kernel as a sum of series. Fredholm resolvent kernel as a ratio of two series. Fredholm equations with separable kernels, approximation of a kernel by a separable kernel, Fredholm Alternative. Green’s function, use of method of variation of parameters to construct the Green’s function for a non homogeneous linear second order BVP, Basic four
properties of the Green’s function, Alternate procedure for construction of the Green’s function by using its basic four properties. Reduction of a BVP to a Fredholm integral equation with kernel as Green’s function, Hilbert-Schmidt theory for symmetric kernels. (Relevant topics from Jerri’s book).

**Unit II**
-approximate solution, Cauchy-Euler construction of an -approximate solution, Equicontinuous family of functions, Ascoli- Arzela lemma, Cauchy-Peano existence theorem. Uniqueness of solutions, Lipschitz condition, Picard-Lindelof existence and uniqueness theorem for \( \frac{dt}{dy} = f(t,y) \), solution of initial-value problems by Picard method. Sturm-Liouville BVPs, Sturms separation and comparison theorems, Lagrange’s identity and Green’s formula for second order differential equations, properties of eigenvalues and eigenfunctions, Pruffer transformation, adjoint systems, self-adjoint equations of second order.
Linear systems, Matrix method for homogeneous first order system of linear differential equations, fundamental set and fundamental matrix, Wronskian of a system, Method of variation of constants for a non homogeneous system with constant coefficients, nth order differential equation equivalent to a first order system (Relevant topics from the books by Ross, and Coddington and Levinson).

**Unit III**
Nonlinear differential system, plane autonomous systems and critical points, classification of critical points – rotation points, foci, nodes, saddle points. Stability, asymptotical stability and unstability of critical points, almost linear systems, Liapunov function and Liapunov’s method to determine stability for nonlinear systems.
Periodic solutions and Floquet theory for periodic systems, limit cycles, Bendixson non-existence theorem, Poincare-Bendixson theorem (Statement only), index of a critical point. (Relevant topics from the books by Ross, and Coddington and Levinson).

**Unit IV**
Motivating problems of calculus of variations, shortest distance, minimum surface of revolution, Branchistochrone problem, isoperimetric problem, geodesic. Fundamental lemma of calculus of variations, Euler’s equation for one dependant function and its generalization to ‘n’ dependant functions and to higher order derivatives, conditional extremum under geometric constraints and under integral constraints (Relevant topics from the book by Gelfand and Fomin).
M.Sc. (Final)

INTEGRATION THEORY AND FUNCTIONAL ANALYSIS
PAPER CODE: MM2001

Marks: 100 Time: 3Hrs

Note: Examiner will be required to set NINE questions in all. Question No. 1 will be compulsory which consists of 12 short-answer type questions each of 2 marks covering the entire syllabus out of which candidate will be required to attempt ten questions. In addition to Q.No. 1, candidate will be required to attempt four more questions from the remaining eight questions each carrying 20 marks.

Unit I

Unit II
Normed linear spaces, Metric on normed linear spaces, Holder’s and Minkowski’s inequality, Completeness of quotient spaces of normed linear spaces. Completeness of \( l^p, l^q, \mathbb{R}^n, \mathbb{C}^n \), and \( C[a,b] \). Bounded linear transformation. Equivalent formulation of continuity. Spaces of bounded linear transformations, Continuous linear functional, Conjugate spaces, Hahn-Banach extension theorem (Real and Complex form), Riesz Representation theorem for bounded linear functionate on \( V \) and \( C[a,b] \).

Unit III
Second conjugate spaces, Reflexive spaces, Uniform boundedness principle and its consequences, Open mapping theorem and its application, projections, Closed Graph theorem, Equivalent norms, weak and strong convergence, their equivalence in finite dimensional spaces.

Unit IV

Unit V

PARTIAL DIFFERENTIAL EQUATIONS AND MECHANICS
PAPER CODE: MM2002

Marks: 100 Time: 3Hrs

Note: Examiner will be required to set NINE questions in all. Question No. 1 will be compulsory which consists of 12 short-answer type questions each of 2 marks covering the entire syllabus out of which candidate will be required to attempt ten questions. In addition to Q.No. 1, candidate will be required to attempt four more questions from the remaining eight questions each carrying 20 marks.

Unit I
Solution of three-dimensional Laplace equation by using the method of separation of variables in terms of Cartesian, cylindrical and spherical coordinates. Method of separation of variables to solve three-dimensional wave equation in Cartesian and spherical coordinates. Use of the method of separation of variables to find steady-state temperature in a rectangular plate, in a disk, in a bar with ends at different temperatures, in a semi-infinite bar, in an infinite plate, in an infinite cylinder, in a solid sphere (Relevant topics from the books by Sneddon, and O’Neil).
Unit II
Kinematics of a rigid body rotating about a fixed point, Euler’s theorem, general rigid body motion as a screw motion, moving Coordinate system — rectilinear moving frame, rotating frame of reference, rotating earth.
Moments and products of inertia, Angular momentum of a rigid body, principal axes and principal moment of inertia of a rigid body, kinetic energy of a rigid body rotating about a fixed point, Momental ellipsoid and equimoment systems, coplanar mass distributions, general motion of a rigid body. Two- dimensional rigid body dynamics – problems illustrating the laws of motion and impulsive motion. (Relevant topics from the book of Chorlton).

Unit III
D’Alembert’s principle: Constraints, holonomic and non-holonomic systems, Degree of freedom and Generalised coordinates, virtual displacement and virtual work, statement of principle of virtual work (PVW), possible velocity and possible acceleration, D’ Alembert’s principle.
Lagrangian Formulation : Ideal constraints, general equation of dynamics for ideal constraints, Lagrange’s equations of the first kind, independent coordinates and generalised forces, Lagrange’s equations of the second kind, generalized velocities and accelerations. Uniqueness of solution, variation of total energy for conservative fields. Lagrange’s variable and Lagrangian function L(t, q, \dot{q}) , Lagrange’s equations for potential forces, generalised moment p, Hamiltonian variable and Hamiltonian function H(t, q, p), Donkin’s theorem, ignorable coordinates.

Unit IV
Hamilton canonical equations, Routh variables and Routh function R, Routh’s equations, Poisson Brackets and their simple properties, Poisson’s identity, Jacobi – Poisson theorem. Hamilton action and Hamilton’s principle, Poincare – Carton integral invariant, Whittaker’s equations, Jacobi’s equations, Lagrangian action and the principle of least action. Canonical transformation, necessary and sufficient condition for a canonical transformation, univalent Canonical transformation, free canonical transformation, Hamilton-Jacobi equation, Jacobi theorem, method of separation of variables in HJ equation, Lagrange brackets, necessary and sufficient conditions of canonical character of a transformation in terms of Lagrange brackets, Jacobian matrix of a canonical transformation, conditions of canonicity of a transformation in terms of Poison brackets, Invariance of Poisson Brackets under canonical transformations.

Books Recommended
O’Neil, Peter V., Advanced Engineering Mathematics, ITP.
M.R. Speigal, Theoretical Mechanics, Schaum Outline Series.

COMPLEX ANALYSIS
PAPER CODE: MM2003

Marks: 100
Time: 3Hrs

Note: Examiner will be required to set NINE questions in all. Question No. 1 will be compulsory which consists of 12 short-answer type questions each of 2 marks covering the entire syllabus out of which candidate will be required to attempt ten questions. In addition to Q.No. 1, candidate will be required to attempt four more questions from the remaining eight questions each carrying 20 marks.

Unit I

Unit-II

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Unit III

Unit IV

Unit V

Group-I (Pure Group)
ADVANCED DISCRETE MATHEMATICS
PAPER CODE: MM2004

Marks: 100 Time: 3Hrs

Note: Examiner will be required to set NINE questions in all. Question No. 1 will be compulsory which consists of 12 short-answer type questions each of 2 marks covering the entire syllabus out of which candidate will be required to attempt ten questions. In addition to Q.No. 1, candidate will be required to attempt four more questions from the remaining eight questions each carrying 20 marks.

Unit I
Formal Logic: Statement, Symbolic representation, totologies, quantifiers, predicates and validity, propositional logic. Semigroups and Monoids: Definitions and examples of semigroups and monoids (including those pertaining to concentration operations). Homomorphism of semigroups and monoids, Congruence relation and quotient semigroups, sub semigroups and sub monoids, Direct products basic homomorphism theorem. Lattices: Lattices as partially ordered sets, their properties. Lattices and algebraic systems. Sub lattices, direct products and homomorphism. Some special lattices for example complimented and distributive lattices.

Unit II

Unit III

Unit IV

Unit V
ANALYTICAL NUMBER THEORY
PAPER CODE: MM2005

Marks: 100 Time: 3Hrs

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Unit I

Unit II

Unit III
Riemann Zeta Function E,(s) and its convergence. Application to prime numbers. \( \zeta (s) \) as Eider’s product. Evaluation of \( \zeta (2) \) and q(2k). Dirichlet series with simple properties. Dirichlet series as analytic function and its derivative. Euler’s products. Introduction to modular forms.

Unit IV
Diophantine equations, \( x_2 + y_2 = z_2 \) and \( x_4 + y_4 = z_4 \). The representation of number by two or four squares. Waring’s problem. Four square theorem. The number g(k) and G(k). Lower bounds for g(k) and G(k).
Algebraic number and Integers ; Gaussian integers and its properties. Primes and fundamental theorem in the ring of Gaussian integers. Integers and fundamental theorem in Q (w) where w3 = 1, algebraic fields. Primitive polynomials. The general quadratic field Q(\( \sqrt{m} \)), Units of Q (\( \sqrt{2} \)). Fields in which fundamental theorem is false. Real and complex Euclidean fields. Fermat’s theorem in the ring of Gaussian integers. Primes of Q(2) and Q(5). Luca test for the normality of the Mersenne number.

Unit V
Arithmetical function (j)(n), u,(n), d(n) and a(n), Mobius inversion formulae. Perfect numbers. Order and average order of d(n), \( <\!(n) \). The functions S(x), vy(x) and A(x). Betrand postulate. Sum p”” and product 1 +p””. Merten’s theorem Selberg’s theorem. Prime number Theorem.

Group-II (Applied Group)
MECHANICS OF SOLIDS
PAPER CODE: MM2006

Marks: 100 Time: 3Hrs

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Unit I

Unit II
Unit III

Unit IV

Unit V

FLUID DYNAMICS
PAPER CODE: MM2007

Marks: 100

Time: 3Hrs

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UNIT I

UNIT II

UNIT III

UNIT IV