Scheme and Syllabus
Of
M.Sc. Mathematics

By
Board of Studies (Mathematics)

Maharaja Ranjit Singh State Technical University, Bathinda
(Established by Govt. of Punjab vide Punjab Act No. 5 of 2015 and Section 2(f) of UGC)
M. Sc. Mathematics is a post graduate level course of the Department of Mathematics which is a 2 years course. It is consisting of semester system (4 semesters) with two semesters per year.

Programme Code: MMS  (Masters in Mathematical Sciences)

Eligibility: B.A/B.Sc. with Honours in Mathematics or B.A./B.Sc. (pass course) with Mathematics as one of the subjects having at least 50% marks in aggregate and at least 55% marks in Mathematics subject.

### First Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Load Allocation</th>
<th>Marks Distribution</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMS-101</td>
<td>Algebra-I</td>
<td>4</td>
<td>1</td>
<td>0</td>
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<tr>
<td>MMS-102</td>
<td>Real Analysis-I</td>
<td>4</td>
<td>1</td>
<td>0</td>
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<tr>
<td>MMS-103</td>
<td>Complex Analysis</td>
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<td>1</td>
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<tr>
<td>MMS-104</td>
<td>Ordinary Differential Equations &amp; Special functions</td>
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<td>1</td>
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<tr>
<td>MMS-105</td>
<td>Fundamentals of Computer and C Programming</td>
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<td>0</td>
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<td>MMS-106</td>
<td>Fundamentals of Computer and C Programming Lab</td>
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**Total** 20 04 02 300 500 800 25

### Second Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Load Allocation</th>
<th>Marks Distribution</th>
<th>Credits</th>
</tr>
</thead>
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<tr>
<td>MMS-201</td>
<td>Algebra-II</td>
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<td>1</td>
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<tr>
<td>MMS-202</td>
<td>Real Analysis-II</td>
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<td>MMS-203</td>
<td>Mechanics</td>
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<td>MMS-204</td>
<td>Tensors and Differential Geometry</td>
<td>4</td>
<td>1</td>
<td>0</td>
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<td>MMS-205</td>
<td>Numerical Analysis</td>
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<td>MMS-206</td>
<td>Numerical Analysis Lab</td>
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<td>0</td>
<td>2</td>
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</tbody>
</table>

**Total** 20 05 02 300 600 800 26
Elective – I MMS XXX (Any one subject to be opted)

MMS-501 Fluid Mechanics
MMS-502 Solid Mechanics
MMS-503 Coding Theory
MMS-504 Advanced Complex Analysis

Note1: Student is to adopt one course from the list of Elective II and one course from list of Elective III

Elective – II Courses: MMS 505, MMS 506, MMS 510, MMS 512

Elective – III Courses: MMS 507, MMS 508, MMS 509, MMS 511

MMS-505 Advanced Operations Research
MMS-506 Advanced Fluid Mechanics
MMS-507 Advanced Solid Mechanics
MMS-508 Number Theory and Cryptography
MMS-509 Theory of Linear Operators
MMS-510 Advanced Numerical Methods
MMS-511 Topological Vector Spaces
MMS-512 Fractional Calculus

Note 2:

Instructions for paper setters and candidates:

(a) Eight questions are to be set preferably two questions from the each unit.
(b) The students are required to attempt any five questions. All questions carry equal marks.
(c) Duration of examination is three hours.
MMS-101: ALGEBRA-I

Unit-I

Review of basic concept of groups, automorphisms and inner automorphisms of a group, Normalizer and Centralizer, Conjugate elements and conjugacy classes, class equation of a finite group and its applications, Cauchy’s theorem, Sylow’s theorems, Review of Permutation Groups, Alternating Group $A_n$, simplicity of $A_n$, Direct Products, fundamental theorem of finitely generated abelian groups, Invariants of finite abelian groups.

Unit-II

Normal and sub normal series, Composition series, Zassenhaus’s Lemma, Scherer’s refinement theorem and Jordan-Holder theorem, Derived group, Solvable groups, Nilpotent groups, fundamental theorem of arithmetic.

Unit-III

Rings, Subrings, ideals, Sum and direct sum of ideals, Maximal, Prime, Nilpotent & Nil ideals, Statement of Zorn’s Lemma, Rings of Fractions, Field of quotients of an integral domain.

Unit-IV

Factorization Theory in Integral Domains, Divisibility, Rings of Gaussian integers, Unique Factorization Domain (UFD), Principal Ideal Domain (PID), Euclidian Domain(ED) and their relationships, Polynomial rings over unique factorization domains.

BOOKS RECOMMENDED

UNIT-I
Elementary set theory, finite, countable and uncountable sets. Metric spaces: definition and examples, open and closed sets, compact sets, elementary properties of compact sets, \( k \)-cells, compactness of \( k \)-cells, compact subsets of Euclidean space \( \mathbb{R}^k \). Perfect sets, Cantor set, separated sets, connected sets in a metric space, connected subsets of real line.

UNIT-II
Convergent sequences (in Metric spaces), Cauchy sequences, subsequences, complete metric space, Cantor's intersection theorem, category of a set and Baire’s category theorem. Examples of complete metric space, Banach contraction principle.

UNIT-III
Limits of functions (in Metric spaces), continuous functions, continuity and compactness, continuity and connectedness, discontinuities, monotonic functions, uniform continuity.

UNIT-IV
Riemann Stieltje's Integral: definition and existence of integral, properties of integral, integration and differentiation, Fundamental theorem of Calculus, 1st and 2nd mean value theorems for Riemann Stieltje’s integral.

BOOKS RECOMMENDED
MMS 103: COMPLEX ANALYSIS

Unit-I


Unit-II


Unit-III

Zero's, Singularities, residue at a pole and at infinity. Cauchy's Residue theorem, Jordan's lemma, integration round unit circle, Evaluation of integrals.

Unit-IV

Conformal transformations, bilinear transformations, critical points, fixed points, Problems on cross-ratio and bilinear transformation.

BOOKS RECOMMENDED

MMS 104: ORDINARY DIFFERENTIAL EQUATIONS AND SPECIAL FUNCTIONS

UNIT-I

UNIT-II
Homogeneous Linear systems with constant coefficients, Complex eigenvalues, repeated eigenvalues, Fundamental Existence and Uniqueness theorem, existence and Uniqueness theorem for system and Higher order equations, Linear homogeneous boundary value problems: Eigenvalues and eigen functions.

UNIT-III
Bessel equation and Bessel functions, Recurrence relations and orthogonal properties., Series expansion of Bessel Coefficients, Integral expression, Integral involving Bessel functions, Modified Bessel function, Ber and Bei functions, Asymptotic expansion of Bessel Functions , Legendre’s differential equations, Legendre Polynomials ,Rodrigue’s formula, Recurrence relations and orthogonal properties.

UNIT-IV
The Hermite polynomials, Chebyshev’s polynomial, Laugrre’s polynomial: Recurrence relations, generating functions and orthogonal properties

BOOKS RECOMMENDED
3. I N Sneddon, Special Functions of Mathematical Physics and Chemistry, Edinburg, Oliver & Boyd (1956)
5. L Andrews, Special Functions for Engineers and Applied Scientists, Mcmillan (1985)
6. W W Bell, Special Functions for Scientists and Engineers, Dover, (1986)
Unit 1

Computer’s general concepts: historical overview, technological advantages in computers, shape of today’s computer as a system, CPU, primary memory, secondary storage devices, input devices, output devices, significance of software system, categories of software system software, applications software, compiler, interpreter, utility program, binary arithmetic for integer and fractional numbers, operating system and its significance.

Unit II

Character sets for C, constants and variables, arithmetic expressions input and output statements, comments, data types, statement labels, built in functions and libraries, logical if-else and nested if-else statement, switch, break, continue, go to statements, preprocessor in C

Unit III

While, for and do while loops in C, arrays, array variables, syntax rules, use of multiple subscripts in arrays, reading and writing multi-dimensional arrays, storage classes, structures and union.

Unit IV

Function definition, function prototypes, Arguments, call by value, call by reference, passing array variable to a function, pointer variables, relationship of pointer and array, passing pointer variable to a function, strings handling, and file processing operations in C

BOOKS RECOMMENDED

The following programs are to be practiced:

1. Determination of roots of quadratic equations, $A x^2 + Bx + C = 0$.
2. Arranging given set of numbers in increasing/decreasing order, calculation of Mean, Mode, Median.
3. Evaluation of sum of power series eg. $e^x$, $\sin x$, $\cos x$, $\log (1 + x)$.
5. Evaluation of factorial of a positive integer and evaluation of binomial coefficients.
7. Calculation of Coefficient of Correlation.
11. Inversion of matrices.
13. Writing a given number in words using function.
14. Arranging a set of names in alphabetical order.

BOOKS RECOMMENDED


Candidates are required to perform at least 10-12 practicals.
Unit-I
Modules, sub modules, free modules, Quotient modules, Isomorhism theorem, Direct sums, Modules associated with a linear operator, Cyclic modules, Noetherian and Artinian modules and rings.

Unit-II

Unit-III
Galois extensions, Galois group of an extension and Fundamental theorem of Galois Theory

Unit-IV
Review of vector spaces, Dual space, Dual basis, Reflexivity, Annihilators, inner product spaces, orthogonal and orthonormal basis, Gram schmidt orthogonalisation process.

BOOKS RECOMMENDED
UNIT-I


UNIT-II


UNIT-III

Vitali,s Lemma, The Four derivates, continuous non differentiable functions. Functions of bounded variation. Lebesgue differentiation theorem. Differentiation and integration. The Lebesgue set

UNIT-IV


BOOKS RECOMMENDED

MMS 203: MECHANICS

Unit-I
Generalized coordinates, Holonomic and non-holonomic systems scleronomic and rhenomic systems, Generalized potential, lagrange’s equation of first kind and second kind uniqueness of solution, Energy equation for conservative field.

Unit-II
Hamilton variables, donkin’s theorem ,Hamilton canonical equation, cyclic coordinates, Routh’s equation , Poisson bracket , Poisson’s identity , Jacobi -Poisson theorem, Hamilton’s principle, principle of least action Poicare- Cartan integral invariant, whittaker’s equations lee hwachung’s theorem.

Unit-III
Small oscillations of conservative system Lagrange's equation for small oscillations, Nature of roots of frequency equation, Principle oscillations. Normal coordinates, Canonical transformations, free canonical transformations, Hamilton- Jacobi equation, and Jacobi theorem.

Unit-IV
Method of separation of variables, lagrange’s bracket’ condition of Canonical character of transformation in terms of Lagrange’s bracket and Poisson’s Bracket. Invariance of Lagrange’s bracket and Poisson’s bracket and canonical transformation, Lagrange’s theorem on the stability of equilibrium position, Lyapunov theorem, Nadchetayev theorem, asymptotic stability of an equilibrium position.

BOOKS RECOMMENDED
MTS 204: TENSORS AND DIFFERENTIAL GEOMETRY

UNIT-I

UNIT-II
Riemannian Space - Christoffel Symbols and their properties, Covariant Differentiation of Tensors - Riemann - Christoffel Curvature Tensor - Intrinsic Differentiation.

UNIT-III
Definition of a surface - curves on a surface - Surface of revolution - Helicoids - Metric - Direction coefficients - families of curves - Isometric correspondence - Intrinsic properties.

UNIT-IV
Geodesics - Canonical geodesic equations - Normal property of geodesics - Existence Theorems - Geodesic parallels - Geodesics curvature - Gauss - Bonnet Theorem - Gaussian curvature - surface of constant curvature.

BOOKS RECOMMENDED
MTS 205: NUMERICAL ANALYSIS

Unit-I


Unit-II


Unit-III

Interpolation: Finite differences, Newton interpolation formulae, Gauss, Stirling and Bessel’sformulae, Lagrange’s, Hermits and Newton’s divided difference formulae. Numerical differentiation and integration: differentiation at tabulated and non-tabulated points, maximum and minimum values of tabulated function, Newton-Cotes formulae-Trapezoidal, Simpson’s, Booles and Weddle rules of integration, Romberg integration, Gaussian integration, Double integration by Trapezoidal and Simpson rules.

Unit-IV

Ordinary Differential Equations: Taylor series and Picard’s methods, Euler and modified Euler methods, Runge –Kutta methods, Predictor-Corrector methods: Adam-Beshforth and Miline methods. Error analysis and accuracy of these methods. Solution of simultaneous and higher order equations, Boundary values problems: Finite difference and shooting methods

BOOKS RECOMMENDED

The following programs of following methods are to be practiced:

1. To find a real root of an algebraic/ transcendental equation by using Bisection method.
2. To find a real root of an algebraic/ transcendental equation by using Regula-Falsi method.
3. To find a real root of an algebraic/ transcendental equation by using Newton-Raphson method.
4. To find a real root of an algebraic/ transcendental equation by using Iteration method.
5. Implementation of Gauss- Elimination method to solve a system of linear algebraic equations.
6. Implementation of Jacobi’s method to solve a system of linear algebraic equations.
7. Implementation of Gauss-Seidel method to solve a system of linear algebraic equations.
8. To find differential coefficients of 1st and 2nd orders using interpolation formulae.
9. To evaluate definite integrals by using Newton - Cotes integral formulae.
10. To evaluate definite integrals by using Gaussian Quadrature.
11. To evaluate double integrals by using Trapezoidal and Simpson method.
12. To compute the solution of ordinary differential equations with Taylor’s series method.
13. To compute the solution of ordinary differential equations by using Euler’s method.
14. To compute the solution of ordinary differential equations by using Runge-Kutta methods.
15. To compute the solution of ordinary differential equations by using Milne-Simpson method.

BOOKS RECOMMENDED


Instructions for paper setters and candidates:

Candidates are required to atleast perform at least 10-12 Practical's are to be completed in one semester