

M.Sc. (Mathematics) I Semester (CBCS)

Session 2020-21

The examination shall consist of five theory papers.

S. No.	Paper Code	CC	Title	Hrs./ week	Internal Exam.	External Exam.	Total	Credit
					Max.	Max.		
1	MSCM-101	CC	Algebra – I	5	30	70	100	5
2	MSCM-102	CC	Real Analysis	5	30	70	100	5
3	MSCM-103	CC	Differential Equations & Calculus of Variation	5	30	70	100	5
4	MSCM-104	CC	Mechanics-I	5	30	70	100	5
5	MSCM-105	CC	Differential Geometry-I	5	30	70	100	5
	Total						500	25

Note:

CC - Core Course

M.Sc. (Mathematics) I Semester (CBCS)**PAPER-I****ALGEBRA-I (MSCM-101)****UNIT I**

External and Internal direct product of two and finite number of subgroups; Commutator subgroup; Cauchy's theorem for finite abelian and non abelian groups.

UNIT II

Sylow's three theorem and their easy applications, Subnormal and Composition series, Zassenhaus lemma and Jordan Holder theorem.

UNIT III

Solvable groups and their properties, Nilpotent groups, Fundamental theorem for finite abelian groups.

UNIT IV

Annihilators of subspace and its dimension in finite dimensional vector space, Invariant, Projection, Adjoints.

UNIT V

Singular and Nonsingular linear transformation, Quadratic forms and Diagonalization.

Books Recommended:

1. Surjeet Singh and QuaziZameeruddin : Modern Algebra.
2. Herstein, I.N. : Topics in algebra.
3. Agrawal, R.S. : Algebra.
4. Jacobson, N. : Basic Algebra Vol. I, II.
5. Lang, S. : Algebra IIIrd Edition.
6. Bhattacharya, P.B., Jain, S.K. and Etc. : Basic Abstract Algebra (IIrd Edition).

M.Sc. (Mathematics) I Semester (CBCS)

PAPER-II

REAL ANALYSIS (MSCM-102)

UNIT I

Measure Theory: Length of an interval, outer measure of a subset of \mathbb{R} , Lebesgue outer measure of a subset of \mathbb{R} , Existence, non-negativity and monotonicity of Lebesgue outer measure, Translation Invariance of outer measure, Countable sub-additivity of Lebesgue outer measure, the relation between outer measure and length of an interval.

UNIT II

Lebesgue outer Measure: σ - algebra, Definition of measures with equations, signed measure, measurable space, measurable sets (Lebesgue), Complement, Lebesgue measure, union intersection and difference of measurable sets, Denumerable union and intersection of measurable sets, countable additivity of measure, counting measure, Haar measure, Borel measure, Measures of infinite union of measure sets (intersection), convergence in measure, F_σ and G_σ sets, the measure of the intersection of a decreasing sequence of measure sets.

UNIT III

Measurable functions; Different equivalent definition of a measurable function; almost everywhere Scalar multiple constant function, modules f/g , inverse image of a measurable function, sum, difference and product of measurable functions of measurable function. Measurability of a continuous function and measurability of a continuous image of measurable function. Supremum, Infimum, limit superior, limit inferior and limit of a sequence of measurable functions. Convergence pointwise and convergence in measure of a sequence of measurable functions.

UNIT IV

Convergence of sequence of Measurable function: Convergence pointwise, uniform Convergence, Convergence almost everywhere (a.e.), Convergence in measure of a sequence of measurable functions, characteristic function of a set, simple function, step function, pointwise Convergence, theorem of measure functions.

UNIT V

Lebesgue Integral; Characteristic function of a set; Simple functions, Lebesgue integral of a Simple function; Lebesgue integral of a bounded measurable function; Lebesgue integral and Riemann integral of a bounded function defined on a closed interval; Lebesgue integral of a Non-negative function; Lebesgue integral of a measurable function; Properties of Lebesgue

Integral. Convergence Theorems and Lebesgue integral; the bounded convergence theorem; Fatou's Lemma: Monotone convergence theorem; Lebesgue convergence theorem.

Books Recommended:

1. Pal R. Halmos : Measure Theory, (D.VanNostrand Company, INC),
6th Edition, Univ. of Chikago.
2. Murray R. Spiegel : Theory and Problems of Real Variables (Schaum's
Outline series, McGraw-Hill Book)
3. P.K. Jain & V.P. Gupta : Measure and Integration (New age International
Publishers)
4. M.E. Munroe : Introduction to Measure and Integration (Dept. Of
Mathematics, Univ. of Illinoi's)
5. G.D. Barra : Measure and Integration (New age International
Publishers)

M.Sc. (Mathematics) I Semester (CBCS)
PAPER-III
DIFFERENTIAL EQUATIONS & CALCULUS OF VARIATION
(MSCM-103)

UNIT I

Partial differential equation: Lipchitz condition and question based on it. Existence and Uniqueness theorem and Existence and uniqueness solutions of I.V.P. $\frac{dy}{dx} = f(x, y)$, $y(x_0) = y_0$, Solution of second order partial differential equation through Mange's method.

UNIT II

Canonical forms and reduction of second order Semilinear partial differential equations to canonical forms. Classification of second order partial differential equations having more than two independent variables. Cauchy's problem.

UNIT III

Boundary value problems of second order ordinary differential equations. Orthogonality, Sturm-Liouville B.V.P. Lagrange's Identity. Relevant theorems and properties based on Eigen values and Eigen functions. Expansion of function in terms of Eigen functions. Periodic Sturm problem.

UNIT IV

Solution of second order P.D. equations by the method of separation of variables. Green's function and its construction and solution of second order Homogenous B.V.P's through Green's function. Dirac delta function and its important properties.

UNIT V

Calculus of variations: Functionals, Euler- Lagrange differential equation for externals and its alternative forms. Variational problems involving several dependent variables, several in dependent variables and higher order derivatives.

Books Recommended:

- | | |
|----------------------------------|---|
| 1. Sneddon, I.N. | : Element of Practical differential equation. — |
| 2. Forsyth, A.R. | : A Treatise of Differential equations. |
| 3. Gupta, A.S. | : Calculus of variations with Applications. |
| 4. Bansal, J.L. | : Differential equations Vol. II. |
| 5. Gelfand, I.M. and Fomin, S.V. | : Calculus of variations. |

M.Sc. (Mathematics) I Semester (CBCS)**PAPER-IV****MECHANICS- I (MSCM-104)****UNIT – I**

Hydrodynamics: Lagrange's and Euler's, Methods; Acceleration, Equation of Continuity, Boundary surface, Stream lines, velocity potential.

UNIT – II

Euler's dynamical Equations, Bernoulli's Theorem, Lagrange's Equations under conservative forces, the motion once irrotational is always irrotational.

UNIT – III

Central Orbit, Kepler's Law of Planetary motion.

UNIT – IV

Galilean transformation, Michelson-Morley experiment, Lorentz-Fitzgerald contraction, postulates of special theory of Relativity, Lorentz transformations.

UNIT – V

Variation of mass with velocity, Mass-Energy formula, transformation formulas for momentum and energy. Minkowski's 4-dimensional continuum space, Space like and time like intervals, Relativistic Hamiltonian and Lagrangian.

Books Recommended:

1. A Text book of Hydrodynamics, Ramsay, A.S.
2. Hydrodynamics, Ray, M.
3. Hydrodynamics, Gaur, Mathur & Goyal
4. Theory of Relativity, Roy & Bali

M.Sc. (Mathematics) I Semester (CBCS)
PAPER-V
DIFFERENTIAL GEOMETRY – I (MSCM-105)

UNIT I

The Axes of Plane Sections: Circular sections, Axes of central sections of a central conicoid, Axes of non-central section of a central conicoid.

UNIT II

Axes of any section of a central conicoid, Circular sections. Generating Lines: Introduction, properties of generating line, intersection of generators of hyperboloid of one sheet, Locus of the points of intersection of perpendicular, The projection of generators, generators through any point of hyperboloid,

UNIT III

Direction cosines of generating line, the section of a surface by a tangent plane. Systems of generators of a central hyperboloid, Generators' of the hyperbolic paraboloid.

UNIT IV

Confocal Conicoids: The three confocals through a point, - Elliptic coordinates, confocal touching a given plane, confocal touching a given line, The parameter of the confocals through a point on a central conicoid, The normals. The self-polar tetrahedron, The axes of an enveloping cone.

UNIT V

Conoids; Equation to a conoid, surface in general, The degree of a surface, tangents and tangent planes, The inflexional tangents. The indicatrix and representation by parameters.

Books Recommended:

1. L.Robert&J.T.Bell : Coordinate Geometry of Three Dimensions.
2. Bansal& Sharma : Differential Geometry.
3. N.Saran&R.S.Gupta : Analytical Geometry of Three Dimensions

M.Sc. Mathematics II Semester (CBCS)

Session 2020-21

The examination shall consist of five theory papers and one practical paper.

S. No.	Paper Code	CC/S EC	Title	Hrs./ week	Internal Exam. Max.	External Exam. Max.	Total	Credit
1	MSCM-201	CC	Algebra –II	5	30	70	100	5
2	MSCM-202	CC	Complex Analysis	5	30	70	100	5
3	MSCM-203	CC	Special functions	5	30	70	100	5
4	MSCM-204	CC	Mechanics – II	5	30	70	100	5
5	MSCM-205	CC	Differential Geometry –II	5	30	70	100	5
6	MSCM-206	SEC – I	Basic Statistical Techniques	2	30	70	100	2
7	MSCM-207	SEC –II	Computer Programming in-c	2	30	70	100	2
Total							500	25

Note:

- CC - Core Course
- SEC - Skill Enhancement Course
- Student will opt any one of the Skill Enhancement Courses (SEC) out of given options.

M.Sc. (Mathematics) II Semester (CBCS)

PAPER-I

ALGEBRA-II (MSCM-201)

UNIT I

Prime fields of characteristic zero and of prime number, Polynomial rings, Factorization theory in Integral domain, Prime and irreducible elements, Greatest common divisor and least common multiple, Euclidean domain, Principle ideal domain and Unique Factorization domain and their related theorems, Product of ideals and nilpotent ideals.

UNIT II

Definition and examples of Modules, sub module, Sub module generated by a set, Sum and direct sum of two sub modules, Quotient Modules, R-Homomorphism, Kernel, Fundamental, Theorems of Homomorphism and isomorphism. Three isomorphism theorems in modules.

UNIT III

Simple, free, cyclic and Finitely generated modules, Fundamental theorem on finitely generated modules over Euclidean rings, Noetherian and Artinian modules, maximal element and theorems based on it.

UNIT IV

Field extension: finite and infinite, Examples, Algebraic and Transcendental extensions, Splitting field Separable and Inseparable extensions, Normal Extensions, Perfect fields, Finite fields, Primitive elements.

UNIT V

Automorphisms, Galois Theory of field extensions and its fundamental theorem, Solution of polynomial equations by radicals, Abel's theorem.

Books recommended:

- | | | |
|---|---|---------------------------------------|
| 1. Surjeet Singh and QuaziZameeruddin | : | Modern Algebra |
| 2. I.N.Herstein | : | Topics in algebra |
| 3. R.S.Agrawal | : | Algebra |
| 4. N. Jacobson | : | Basic Algebra Vol. I, II |
| 5. S. Lang | : | Algebra IIIrd Edition |
| 6. P.B. Bhattacharya S.K. Jain and Etc. | : | Basic Abstract Algebra (IInd Edition) |

M.Sc. (Mathematics) II Semester (CBCS)
PAPER-II
COMPLEX ANALYSIS (MSCM-202)

UNIT I

Complex numbers, Algebra of complex functions, Differentiability of complex function, Analytic functions, Cauchy-Riemann equations, Harmonic functions, Power series, Radius of convergence, Circle of convergence.

UNIT II

Conformal transformation, Linear & Bilinear transformations, Fixed points, Cross ratio, Inverse points, Critical points, Exponential and Trigonometric transformations.

UNIT III

Complex integration : Riemann definition of integration, complex integral as the sum of line integrals, Cauchy's fundamental theorem, extension of Cauchy's theorem to multi-connected region, Cauchy's integral formula, Cauchy's integral formula for multi-connected region, Cauchy's integral formula for higher order derivatives.

UNIT IV

Morera's theorem, Liouville's theorem, Maximum Modulus theorem, Poisson's integral formula, Development of Analytic function as power series : Taylor's Series, Laurent's Series.

UNIT V

Singularities and Zeroes of an Analytic function, residues, Cauchy's theorem of residues and Evaluation of definite integrals.

Books Recommended:

1. E.G.Phillips : Functions of a complex variable.
2. E.T.Copson : An introduction to the Theory of functions of a Complex variable.
3. Zill Shanahan : A First Course in Complex Analysis with Application
4. T. Pati : Functions of a Complex Variable
5. S.Long : Complex Analysis.
6. T.W. Gamelin: Complex Analysis.

M.Sc. (Mathematics) II Semester (CBCS)
PAPER-III
SPECIAL FUNCTIONS (MSCM-203)

UNIT-I

Hypergeometric functions, hypergeometric series and function; Elementary properties of hypergeometric function; Integral formula for hypergeometric series. Generalized Hypergeometric Functions: Definition, Convergence of the series for ${}_pF_q$. Differential equation and its solution.

UNIT-II

Legendre's functions: Legendre's differential equation and associated Legendre's differential equations.

UNIT-III

Legendre's function of first kind and second kind and its properties, Associated Legendre's function of integral order. General solution of Legendre's equation. Orthogonality of Legendre polynomials.

UNIT-IV

Bessel Function: Generating function, Integral formulae, Recurrence relation; Addition formula and other, Properties of Bessel functions. Orthogonality of Bessel functions.

UNIT-V

Generating functions and other properties associated with the Laguerre, Legendre and Hermite Polynomials.

Books Recommended:

1. Rainville, E.D.: Special Functions.
2. Sneddon, I.N.: Special Transforms.
3. Goyal: Integral Transforms.
4. Dr Gokhroo and others: Special functions.

M.Sc. (Mathematics) II Semester (CBCS)
PAPER-IV
MECHANICS – II (MSCM-204)

UNIT -I

Rigid Dynamics: Moments and products of inertia, Principal axes theorem, Parallel axes, Momental ellipsoid.

UNIT -II

D'Alembert's principle and the equation of motion. Motion about fixed axes.

UNIT -III

Motion in two dimensions under finite forces including sliding and rolling friction, Impulsive motion in two dimensions.

UNIT -IV

Principles conservation of momentum and energy.

UNIT -V

Lagrange's equations in generalized coordinates under finite and impulsive forces.

Books Recommended:

1. S.L.Loney: Dynamics
2. A.S.Ramsay: Dynamics
3. Bansal, Sharma &Goyal: Dynamics of a Rigid Body
4. Ray &Sharma: A Text Book of dynamics of a Rigid Body

M.Sc. (Mathematics) II Semester (CBCS)
PAPER-V
DIFFERENTIAL GEOMETRY- II (MSCM-205)

UNIT I

Curves in space, Space curve, The tangent line and its direction cosines, Contact of a curve and surface , Normal line and Normal plane, The Osculating plane, Principal normal and binormal, direction cosines and equations of principal normal and binormal, Rectifying plane, Equation of fundamental planes , Curvature and Torsion and skew curvature, Serret – Frenet’s formulae and its applications.

UNIT II

Spherical Indicatrices, Osculating Circle and Osculating sphere.
 Envelopes: Envelopes of a system of surfaces with one parameter and its relation with characteristic, The edge of regression and its relation with characteristic, Envelope of a system of surfaces with two parameters and its relation with characteristic.

UNIT III

Ruled Surfaces : Skew and developable surfaces, Equation of the tangent plane to a ruled surface, Generators of developable surface, Envelope of a plane with one parameter to represent a developable surface and properties of a generator of a skew surface.

UNIT IV

Freedom equations ,Curves on a surface and curvilinear coordinates, Tangent plane and Normal line , some important surfaces in parametric form , Metric of a surface ,Fundamental forms and Fundamental Magnitudes , First fundamental form , Second fundamental form , Curvature of surfaces, Curvature of normal section, Meunier’s theorem , Principal directions and principal curvature ,Umbilic , Radius of curvature.

UNIT V

Lines of Curvature,Differential equations of lines of curvature of surfaces $r = r(u, v)$.Principal radii and lines of curvature through a point of the surface $z = f(x, y)$,Lines of curvature of an ellipsoid, developable surface and revolution, Theorems on line of curvature, Third fundamental Form, Relation between the three fundamental forms.

Books recommended:

1. L.Robert, J.T.Bell: Coordinate Geometry of the Three Dimensions
2. Bansal& Sharma : Differential Geometry.
3. Raj Bali : Advanced Tensor Analysis.
4. N.Saran& R.S. Gupta : Analytical Geometry of the Three Dimensions.
5. Raj Bali : Advanced Differential Geometry.

M.Sc. (Mathematics) II Semester (CBCS)
PAPER-VI
BASIC STATISTICAL TECHNIQUES (MSCM-206)

The following topics are prescribed for practical work :

1. Presentation of raw data.
 2. Graphical representation of data, Diagrammatic representation,
 3. Measures of central tendency, Dispersion, Moments, Skewness, and kurtosis.
 4. Fitting of curves: Straightline, Parabola, Exponential and Power curves.
 5. Calculation of correlation coefficient by Karl Pearson's and Spearman's rank method.
 6. Construction of regression line.
 7. Calculation of Multiple and Partial correlation coefficient.
 8. Exercises on finite difference table: (i) Construction of finite difference table, (ii) Newton's Gregory forward and backward interpolation formula. (iii) Estimation of missing values in case of equal intervals.
 9. Lagrange's and Newton's divided difference formula.
 10. Lagrange's inverse interpolation formula.
- Student will be asked about the basic concepts of the above topics in the viva voce.

M.Sc. (Mathematics) II Semester (CBCS)
PAPER-VII
COMPUTER PROGRAMMING IN-C (MSCM-207)

The following topics are prescribed for practical work :

Write a C Program with its executed output for the following problems:-

1. To Print & Find the sum of Natural Numbers up to n.
2. To Print & Find the sum of Odd Numbers up to n.
3. Find Factorial of a number.
4. To Print & Find the sum of Fibonacci Series up to n terms.
5. To Print table of a number.
6. To Find the sum of individual digits of a number and Reverse a number.
7. To check whether a given number is Prime or not.
8. To check whether a given number is Armstrong or not.
9. To check whether a given number is Palindrome or not.
10. To print table chart up to n.
11. To generate Prime numbers up to n.
12. To generate Armstrong numbers up to n.
13. To find sum and average of n numbers stored in Array.
14. To find Largest of n numbers stored in Array.
15. To find Smallest of n numbers stored in Array.
16. To search an element from an Array and print its location.
17. To sort n numbers stored in Array in Ascending order.
18. To Add/Sub two matrices.
19. To find Transpose of a matrix.
20. To Multiply two matrices.
21. To find the sum of diagonal elements of a matrix.
22. To find Factorial of a number using function.
23. To swap two numbers using call by value and call by reference.

M.Sc. (Mathematics) III Semester (CBCS)

Session 2021-22

The examination shall consist of five theory papers.

S. No.	Paper Code	CC/DS E	Title	Hrs./ week	Internal Exam. Max.	External Exam. Max.	Total	Credit
1	MSCM-301	CC	Topology	5	30	70	100	5
2	MSCM-302	CC	Tensor Analysis	5	30	70	100	5
3	MSCM-303	DSE - I	Numerical Analysis-I	5	30	70	100	5
4	MSCM-304	DSE - II	Discrete Mathematics- I	5	30	70	100	5
5	MSCM-305	DSE - III	Optimization Techniques –I	5	30	70	100	5
6	MSCM-306	DSE - IV	Mathematical Theory of Statistics-I	5	30	70	100	5
7	MSCM-307	DSE - V	Integral Equations	5	30	70	100	5
8	MSCM-308	DSE - VI	Astronomy – I	5	30	70	100	5
9	MSCM-309	DSE – VII	Number Theory – I	5	30	70	100	5
	Total						500	25

Note:

- CC - Core Course
- DSE - Discipline Specific Elective Courses
- Student will opt any three of the Discipline Specific Elective Course (DSE) out of given options.

M.Sc. (Mathematics) III Semester (CBCS)**PAPER-I****TOPOLOGY (MSCM-301)****UNIT-I**

Topological Spaces: Definition of Topology, T-open sets, weaker and stronger topology, open sets and closed sets, closure of a set, limit point of a set, derived set, Interior of a set, Boundary of set, Intersection of topological spaces, Kuratowski-space, Kuratowski theorem.

UNIT-II

Base, sub base, open bases, open sub bases, first countable space, second countable space, separable space, continuous functions in topological spaces, sequentially topological spaces.

UNIT-III

Separation Axioms: T_0 , T_1 , T_2 - space, separation axioms, normal spaces, Regular spaces, Completely regular space, Tychonoff space, Hausdorff space.

Compactness: Cover, open cover, finite sub cover, compact sets, Lindelof space, Locally compact, sequentially compact, Bolzano Weirstrass property and sequentially compactness, compactness for metric spaces, Lindelof theorem, Product spaces.

UNIT-IV

Connectedness: Connectedness and continuity, components of a space, product of connected topological spaces, Locally connected Spaces.

UNIT-V

Approximation: The Weirstrass approximation theorem, function algebra, $C(X, \mathbb{R})$ and $C(X, \mathbb{C})$, the real Stone-Weirstrass theorem, The Complex Stone-Weirstrass theorem.

Books Recommended:

1. George F. Simmons: Introduction to Topology and modern analysis, McGraw Hill Book Co.
2. W.J. Thron: Topological structure.
3. J. Kelley: General Topology.

M.Sc. (Mathematics) III Semester (CBCS)

PAPER-II

TENSOR ANALYSIS (MSCM-302)

UNIT I

Tensors; Transformation of coordinates, Contravariant and covariant vectors, Second order tensors, Higher order tensors. Addition, subtraction and multiplication of tensors, Contraction, Quotient Law, Symmetric and skew symmetric tensors: Conjugate symmetric tensors of the second order, Fundamental tensor, Associated tensors.

UNIT II

Christoffel symbols, Transformation law of Christoffel symbols, Covariant differentiation of vectors and tensors.

UNIT III

Geodesics, Null Geodesics, Tensor form of gradient, Divergence, Laplacian and curl, Intrinsic derivative, Riemannian and Normal Coordinates, Gaussian Coordinates, Parallel transport, Geodesics are auto parallel curves, Parallel propagation.

UNIT IV

Riemannian curvature tensor, Symmetric properties of R_{ljk}^i , Covariant curvature tensor R_{hijk} , Number of independent components of R_{hijk} in a V_n , Ricci tensor, Bianchi identities, Conformal Curvature tensor, Condition for flat space.

UNIT V

Maxwell's equations in empty space, Transformation of vector and scalar potentials, Transformations of electric and magnetic intensities, Lorentz invariance of Maxwell's equations. Maxwell's equations in Tensor form, Energy momentum tensor for electromagnetic field, Einstein-Maxwell equation in General Relativity.

Books Recommended:

1. P.G.Bergman: Introduction to Theory of Relativity.
2. J.L. Bansal: Tensor Analysis.
3. Roy & Bali : Theory of Relativity.

M.Sc. (Mathematics) III Semester (CBCS)
PAPER-III
NUMERICAL ANALYSIS-I (MSCM-303)

UNIT I

Theory of Iteration: Simple iteration, Rate of Convergence, Acceleration a convergence, Method for multiple and complex roots, Convergence of iteration process in the case of several unknowns.

UNIT II

Real and complex roots, Solution of transcendental and polynomial equations by using bisection method, Secant method, Regula-Falsi method, Newton Raphson method, Chebyshev method.

UNIT III

Concept of synthetic division , The Birge – vita, Bairstow and Graeffe’s root squaring method. System of Simultaneous equations (Linear): Direct method of determinant, Gauss– Elimination.

UNIT IV

Gauss-Jordan Cholesky, Partition method of Successive approximation, Conjugate Gradient, Gauss or Jacobi iteration, Gauss-Seidel and Relaxation methods.

UNIT V

Eigen value problems: Basic properties of Eigen values and Eigen vector power methods, Method for finding all Eigen pairs of a matrix, Complex Eigen values.

Books Recommended:

1. Jain, Iyenger and Jain: Numerical Analysis.
2. Jain, M. K.: Numerical solutions of differential equation.

M.Sc. (Mathematics) III Semester (CBCS)
PAPER-IV
DISCRETE MATHEMATICS-I (MSCM-304)

UNIT I

Formal logic– Statement, Symbolic Representation and Tautologies, Quantifiers, Predicate validity, Propositional logic. Semi groups and monoids, Relations and ordering. Functions definitions and examples of semi groups and monoids (including those pertaining to concatenation operation).

UNIT II

Homomorphism of semi groups and monoids. Quotient subgroups, sub semigroups and sub monoids. Direct products. Basic Homomorphism theorem.

UNIT III

Lattices: - Lattices as partially ordered sets. Their properties. Lattices as Algebraic systems. Sub lattices, direct products and Homomorphism complete, Complemented and distributive lattices.

UNIT IV

Boolean Algebras:- Boolean Algebras as lattices. Various Boolean identities. The switching Algebras examples. Sub Algebras. Direct products and Homeomorphisms, Join- irreducible elements, Atoms and minterms.

UNIT V

Boolean forms and their equivalence. Minterms, Boolean forms. Minimization of Boolean functions. Application of Boolean Algebras to switching theory (OR and not gates).The Karnaugh map method.

Books recommended:

1. Discrete Mathematical structure with applications to computer science, J.P. Tremblay & R. Manohar
2. Graph theory with applications to Engineering and Computer Science, N. Arsing Deo
3. Advanced Discrete Mathematics(Navkar Publications), Gokhroo & Gokhroo

M.Sc. (Mathematics) III Semester (CBCS)
OPTIMIZATION TECHNIQUES-I (MSCM-305)

UNIT I

Dual simplex method, Bounded value algorithm, Parametric linear Programming.

UNIT II

Sensitivity Analysis: (i) Changes in the coefficients of the objective function, (ii) Changes in the components of vector b , (iii) Changes on the component (a_{ij}) of the matrix A .

UNIT III

Addition of the new variable, Addition of a new constraint. Deletion of a variable, Deletion of constraint.

UNIT IV

Integer programming: Importance of integer programming problems, Gomory's cutting plane methods, δ Fractional cut and λ -cut, Branch and bound method.

UNIT V

Project Management by PERT and CPM, cost time, trade off, Resource leveling.

Books Recommended:

1. Kantiswaroop, Mak-Mohan, P.K. Gupta. : Operation Research
2. Hamdy A. Taha : Operation Research
3. S.D. Sharma : Operation Research
4. S.I. Gass : Linear-Programming
5. K.V. Mittal : Optimization Methods in Operations
Research and systems analysis

M.Sc. (Mathematics) III Semester (CBCS)**PAPER-VI****MATHEMATICAL THEORY OF STATISTICS-I (MSCM-306)****UNIT I**

Elements of theory of probability; sample space, various definitions of probability, addition and multiplication laws of probability, conditional probability and statistical independence of events. Baye's theorem and its applications.

UNIT II

Mathematical expectations, conditional expectations, Moments and cumulates. Moments generating and characteristic functions. Inversion theorem, Chebyshev's inequality, Central limit theorem for i.i.d. random variables.

UNIT III

Binomial, Negative -binomial, Poisson and Hyper geometric distributions.

UNIT IV

Rectangular, Normal, Cauchy, Gamma and Beta distributions Elementary idea of Exponential and Laplace distributions.

UNIT V

Curve fitting and principle of least squares, Scatter diagram, linear regression and correlation.

Note: Candidates who have offered Mathematical Statistics / Statistics / Applied Statistics as an optional subject in their B.Sc. examination will not be permitted to offer this course.

Books Recommended:

1. Gupta and Kapoor: Fundamentals of Mathematical Statistics,
2. Kapur and Sexena: Mathematical Statistics

M.Sc. (Mathematics) III Semester (CBCS)
PAPER-VII
INTEGRAL EQUATIONS (MSCM – 307)

UNIT I

Linear Integral Equations: Definition and Classification, Conversion of initial and boundary value problem to an integral equation, Eigen values and Eigen functions.

UNIT II

Solution of Fredholm integral equations of second kind with separable kernels. Reduction to a system of Algebraic equations.

UNIT III

Solution of Fredholm and Volterra integral equations of second kind by method successive substitution and successive approximations. Resolvent Kernel and its applications.

UNIT IV

Condition of uniform convergence and uniqueness of series solutions. Integral Equation with symmetric kernels: Complex Hilbert space, Orthogonal system of functions. Fundamental Properties of Eigen values and Eigen functions for symmetric Kernels, Expansion in Eigen-functions and bilinear form.

UNIT V

Hilbert–Schmidt theorem, Solution of Fredholm integral equations of second kind with Symmetric Kernels. Classical–Fredholm theory, Fredholm theorems, Solution of Volterra integral equations with convolution type Kernels and Librated Kernels.

Books Recommended:

1. Ranville, E.D. : Laplace and Fourier Transforms.
2. Sneddon, I.N. : The use of Integral Transforms.
3. Zemanian, A.H. : Generalized Integral transforms.
4. Lowit : Linear Integral equations.

M.Sc. (Mathematics) III Semester (CBCS)
PAPER-VIII
ASTRONOMY-I (MSCM – 308)

UNIT I

Spherical Trigonometry- Great and small circular spherical triangles and their properties, various spherical trigonometrically formula-Cosine, sine, supplemental cosine, sine cosine, contingent, half of an angle and side Napier's analogies.

UNIT II

Delambe's analogies, their identities formulae for, right angled triangles and their solutions.

UNIT III

Celestial sphere, diurnal motion, Hour angle rising and setting of stars motion of sun, Zenith distance and Azimuth, Twilight.

UNIT IV

Refraction: Laws, effect of refraction on sun rise and sun set, Simpson's Hypothesis, effect of refraction in right ascension and declination etc. Time: Equation of time, seasons and their lengths, precession and Nutation and their effects on right ascension and declination, planetary precession double stars.

UNIT V

Aberration and its effect of longitude, latitude, right ascension and declination, position of apex, diurnal aberration and its effect in declination, right ascension and hour angle.

Books Recommended:

1. Astronomy by Gorakh Prasad.
2. Astronomy by Smart.

M.Sc. (Mathematics) III Semester (CBCS)
PAPER-IX
NUMBER THEORY-I (MSCM – 309)

UNIT - I

Divisibility: GCD and LCM of two or more integers, Euclidean, algorithm, the linear Diophantine equation $ax + by = c$. Prime Numbers, composite numbers, infinitude of primes, fundamental theorem of arithmetic.

UNIT II

Congruences: Basic properties, divisibility tests, linear Congruences. Application of congruences: Fermat's little theorem, Euler's generalization, Wilson's theorem Chinese remainder theorem.

UNIT III

Number Theoretic functions: T.J, and, Multiplicative functions, Mobius inversion formula, the greatest integer function. Primitive Roots and Indices, Primitive roots, characterization of natural numbers having primitive roots, theory of indices, solution of certain congruence, through indices.

UNIT IV

Quadratic Residues: Quadratic residues and quadratic non residues of an integer in general and of a prime in particular, Gauss Lemma and its applications, the quadratic reciprocity law.

UNIT V

Special Numbers: Fibonacci numbers, Fermat's numbers, Perfect numbers. Diophantine Equations: Representation of integers as sums of 2, 3 and 4 squares.

Books Recommended:

1. Donald M. Burton : Elementary Number Theory, Allyn and Bacon Inc.
2. Niven & H.S. Zuckerman : An Introduction to the Theory of Numbers,
Wiley eastern India Ltd.
3. Lang, S. : Algebraic Number theory, GTM Vol. 110,
Springer-Verlag 194.

M.Sc. (Mathematics) IV Semester (CBCS)

Session 2021-22

The examination shall consist of five theory papers and one practical paper.

S. No.	Paper Code	CC/ DSE/ SEC	Title	Hrs. /week	Internal Exam.	External Exam.	Total	Credit
					Max.	Max.		
1	MSCM-401	CC	Functional Analysis	5	30	70	100	5
2	MSCM-402	CC	Relativity and Cosmology	5	30	70	100	5
3	MSCM-403	DSE - IX	Numerical Analysis-II	5	30	70	100	5
4	MSCM-404	DSE - X	Discrete Mathematics- II	5	30	70	100	5
5	MSCM-405	DSE - XI	Optimization Techniques – II	5	30	70	100	5
6	MSCM-406	DSE - XII	Mathematical Theory of Statistics-II	5	30	70	100	5
7	MSCM-407	DSE -XIII	Integral Transforms	5	30	70	100	5
8	MSCM-408	DSE - III	Astronomy -II	5	30	70	100	5
9	MSCM-409	DSE -IV	Number Theory-II	5	30	70	100	5
10	MSCM-410	SEC-I	Computer programming of numerical methods	2	30	70	100	2
11.	MSCM-411	SEC-II	Statistical Inference	2	30	70	100	2
	Total						500	25

Note:

- CC - Core Course
- DSE - Discipline Specific Elective Courses
- SEC - Skill Enhancement Course
- Student will opt any three of the Discipline Specific Elective Course (DSE) and any one of the Skill Enhancement Courses (SC) out of given options.

M.Sc. (Mathematics) IV Semester (CBCS)
PAPER-I
FUNCTIONAL ANALYSIS (MSCM-401)

UNIT I

Normed linear spaces; Banach spaces, Riesz Lemma, Quotient space of normed linear space and its completeness and examples Continuous linear transformations

UNIT II

Hahn-Banach theorem; the natural embedding of a normed linear space into its second conjugate, the open mapping theorem; the closed graph theorem, the uniform boundedness theorem.

UNIT III

Inner product spaces, Hilbert spaces; Schwartz's inequality: Bessel's inequality, orthogonality, Parallelogram law, Polarization identity with examples, Pythagoras theorem, orthonormal sets.

UNIT IV

Orthonormal basis and Parseval's identity, Complete Orthonormal sets, Gram Schmidt Orthogonalization process with examples, conjugate space.

UNIT V

Riesz representation theorem, Adjoint of an operator, Self adjoint operator, Normal operator, Unitary operator, Matrix representation of a linear operator.

Books Recommended:

1. Introduction to Topology and modern analysis, McGraw Hill Book Co., George F. Simmons
2. Elements of Real Analysis, S.I.Hu
3. Topological structure, W.J. Thron

M.Sc. (Mathematics) IV Semester (CBCS)
PAPER-II
RELATIVITY AND COSMOLOGY (MSCM-402)

UNIT I

Principle of covariance, principle of equivalence, Mach- Principle, geodesic postulates, Newton's Potential, Newtonian approximation of relativistic equation of motion. Einstein field equations with derivation and its Newtonian approximation.

UNIT II

Clock paradox, Schwarzschild exterior solution for empty space, singularities and related problems, isotopic form of Schwarzschild line element, energy momentum tensor and its expression for perfect fluid.

UNIT III

Planetary orbit, Three crucial tests, Advance of Perihelion of planets, Gravitational Deflection of light ray, Shift in the spectral lines. Radar echo delay. Analogous to Kepler's law, Schwarzschild interior solution.

UNIT IV

Principals of Cosmology, Static cosmological models. Einstein and De-Sitter Universes, their derivations, properties and comparison with the actual universe and some related problems.

UNIT V

Non static cosmological models. Hubble's law, Weyl's postulate. Derivation of Robertson-Walker Metric, Geometrical features of R-W metric. Surface brightness, source counts, Red shift. Particle and event Horizons, Expressions for FRW model upto non zero pressure.

Books recommended:

1. Introduction to Theory of Relativity, P.G. Bergman
2. Lecture on general Relativity, J.V. Narlikar
3. A first course in General Relativity, B.F. Schutz

M.Sc. (Mathematics) IV Semester (CBCS)
PAPER-III
NUMERICAL ANALYSIS-II (MSCM-403)

UNIT I

Curve fitting and Function Approximations: Least square principle, fitting a straight line, exponential functions, parabola and polynomial of nth degree, Approximation of functions by Chebyshev Polynomials.

UNIT II

Numerical Solutions of ordinary differential equations using Taylor series method, Picard's method, Euler's method, Modified Euler's method.

UNIT III

Solutions by Runge-Kutta method up to fourth order, Solutions by multi step method, Milne's method, Adams Moulton's method, Stability analysis of single and multi-step methods.

UNIT IV

Difference method for solving linear boundary value problem of ODE's, finite difference method and shooting method, Numerical integration by trapezoidal, Simpson's and gauss quadrature rule.

UNIT V

Finite Difference scheme for non-linear boundary value problems of the type y' and others.

Books Recommended:

1. Jain, Iyenger and Jain : Numerical Analysis.
2. Jain, M. K. : Numerical solutions of differential equation.

M.Sc. (Mathematics) IV Semester (CBCS)
PAPER-IV
DISCRETE MATHEMATICS-II (MSCM-404)

UNIT I

Graph theory: Definition of (Undirected) graphs, Paths, Circuits, Cycles and Sub graphs. Induced Subgrapha..., Degree of vertex. Connectivity. Planer graphs and their properties.

UNIT II

Trees. Euler's formula for connected planar graphs Complete and Complete Bipartite graphs. Non Planar graph, Kuratowsk's theorem (Statement only). Spanning trees. Cut sets, Fundamental cut-sets, and Cycles. Minimal spanning trees and Kruskal's Algorithm.

UNIT III

Euler's theorem on the existence of eulerian paths and circuits. Directed graphs. In degree and out degree of a vertex. Weighted undirected graphs, Dijkstra's Algorithm. Strong connectivity . Directed trees. Search trees. Tree traversals.

UNIT IV

Introductory computability Theory – Finite state machines and their Transition Table Diagrams. Equivalence of finite state machines. Reduced machines. Homomorphism. Finite Automata. Acceptors. Non- deterministic Finite Automata.

UNIT V

Phrase structure Grammar. Rewriting Rules. Derivations, Sentential forms. Language generated by a Grammar. Regular context – free, and context sensitive Grammars and Languages. Regular sets, Regular expressions and pumping Lemna, Kleene's Theorem stamens.

Books recommended:

1. Discrete Mathematical structure with applications to computer science, J.P. Tremblay & R. Manohar
2. Graph theory with applications to Engineering and Computer Science, N. Arsing Deo
3. Advanced Discrete Mathematics(Navkar Publications), Gokhroo & Gokhroo

M.Sc. (Mathematics) IV Semester (CBCS)
PAPER-V
OPTIMIZATION TECHNIQUES-II (MSCM-405)

UNIT I

Classical Optimization Techniques: Unconstrained problems of Maxima-Minima global maximum, Local maxima method of Lagrange's Multipliers for constrained with equality constraints.

UNIT II

Constraints in the form of inequalities: Kuhn Tucker Theorem Kuhn-Tucker necessary and sufficient conditions, saddle point.

UNIT III

Quadratic programming problem: Wolfe's algorithms and Beale's algorithm, Fractional Programming problem.

UNIT IV

Dynamic Programming Problem: Bellman's principle of optimality, multiple stage decision problems, characteristics of DPP. Solution of finite number of stages problems by DPP.

UNIT V

Network flow problems: Maximal flow, minimal flow, shortest route problem.

Books recommended:

1. Operation Research, Kantiswaroop, Mak-Mohan, P.K. Gupta.

M.Sc. (Mathematics) IV Semester (CBCS)
PAPER-VI
MATHEMATICAL THEORY OF STATISTICS-II (MSCM-406)

UNIT I

Chi-square and t sampling distribution with derivations, properties and applications.

UNIT II

F sampling distribution with derivations, properties and applications. Large sample theory and applications.

Determination of sample size.

UNIT III

Elements of theory of estimation: Point estimation, criterion of good estimators for one parameter; Consistency, Efficiency, sufficiency and unbiasedness.

UNIT IV

Method of maximum likelihood estimation properties of maximum likelihood estimators (without proof). M.L.E. for Binomial, Poisson and Normal populations. Interval estimation for mean and variance in case of Normal population.

UNIT V

Elements of testing of hypothesis: Two kinds of error in testing of hypothesis. Critical region, Neyman-Pearson Lemma and determination of BCR in Neyman sense for testing simple v/s simple hypothesis in uniform and normal populations.

Note: Candidates who have offered Mathematical Statistics / Statistics / Applied Statistics as an optional subject in their B.Sc. examination will not be permitted to offer this course.

Books recommended:

1. Gupta and Kapoor: Fundamentals of Mathematical Statistics,.
2. Kapur and Saxena: Mathematical Statistics.

M.Sc. (Mathematics) IV Semester (CBCS)
PAPER-VII
INTEGRAL TRANSFORM (MSCM-407)

UNIT I

Laplace transform: Definition and its properties. Rules of manipulations, Laplace theorems of derivatives and integrals, Properties of inverse Laplacetransforms, Convolution theorem, Complex inversion formulas.

UNIT II

Applications of Laplace transform to the solutions of ordinary differential equations with constant and variable coefficients and simple boundary value problems.

UNIT III

Fourier Transform: Definition and properties of Fourier sine and cosine and complex transforms, Convolution theorem, Inversion theorems and Fourier transform of derivations.

UNIT IV

Applications of Fourier transforms to the solutions of partial differential equations. Mellin Transform: Definition and elementary properties, Mellin transforms of derivations and integrals Inversion theorem and convolution theorem.

UNIT V

Infinite Hankel transform: Definition and Elementary Properties, Hankel transform of derivations, Inversion theorem and parseval theorem. Application to the Solution of simple boundary value problems

Books Recommended:

1. Renville, E.D: Laplace and Fourier Transforms,
2. Sneddon, I.N:The use of Integral Transforms,.
3. Zemanian, A.H :Generalized Integral transforms,.

M.Sc. (Mathematics) IV Semester (CBCS)

PAPER-VIII

ASTRONOMY –II (MSCM-408)

UNIT I

Parallax: shape of each, geocentric parallax, distance of Moon, Parallax in declination and Hour angle and geocentric parallax in zenith dist. azimuth, right ascension and declination annual parallax in longitude, and latitude, Parallax angle and stellar parallax in right ascension and declination.

UNIT II

The meridian circle: the three errors, Besell's formula, correction for level and collimation error, total correction to the observed time of transit.

UNIT III

Kepler's Laws and planetary motion: Various definitions and laws, relation in elliptic motion, anomaly V in terms of eccentric anomaly, true anomaly V in terms of mean anomaly M , Euler's theorem.

UNIT IV

Planetary phenomena: Sidereal period and synodic period and their relation, elongation phases of moon, brightness, maximum brightness. Eclipses: Eclipses of moon angular radius of earth's shadow, duration of eclipses, the ecliptic limits, eclipses of sun and their Limits, frequency of eclipse, the Metonic cycle.

UNIT V

Proper motions of stars and their relation, tangential velocity and parallax, radial velocity at different epochs, the solar motion and parallactic motion, determination of solar apex from proper motions.

Books recommended:

1. Gorakh Prasad: Astronomy.

M.Sc. (Mathematics) IV Semester (CBCS)
PAPER-IX
NUMBER THEORY-II (MSCM-409)

UNIT I

Continued Fractions: Finite and infinite continued fraction convergent of a given continued fraction and their properties.

UNIT II

Uniqueness of a continued fraction Periodic continued fraction, Pell's equation in general, characterization of solutions of $x^2 - dy^2 = 1$ in terms of its smallest positive solution.

UNIT III

Algebraic number fields and their rings of integers, Calculations for quadratic and cubic cases. Localization, Galois extension.

UNIT IV

Dedekind rings, discrete valuation rings completion, unramified and ramified extensions.

UNIT V

Different discriminates, cyclotomic fields, roots of unity.

Books recommended:

1. Elementary Number Theory, Allyn and Bacon Inc., Donald M. Burton
2. An Introduction to the Theory of Numbers, Willey eastern India Ltd., Niven & H.S. Zuckerman

M.Sc. (Mathematics) IV Semester (CBCS)

PAPER-VIII

COMPUTER PROGRAMMING OF NUMERICAL METHODS (MSCM-410)

The following topics are prescribed for practical work :

1. To convert a given Real number in Normalized Floating Point Mode.
2. To Add two numbers represented in Normalized Floating Point Mode.
3. To Subtract two numbers represented in Normalized Floating Point Mode.
4. To Multiply two numbers represented in Normalized Floating Point Mode.
5. To Divide two numbers represented in Normalized Floating Point Mode.
6. To find the root of a given Non-Linear equation using Bisection Method.
7. To find the root of a given Non-Linear equation using False Position Method.
8. To find the root of a given Non-Linear equation using Newton Raphson Method.
9. To find the numeric solution of given Differential Equation using Euler's Method.
10. To find the numeric solution of given Differential Equation using RungeKutta 2nd order Method.
11. To find the numeric solution of given Differential Equation using RungeKutta 4th order Method.
12. To solve the given set of simultaneous algebraic equations using Gauss-Seidel method.
13. To solve the given set of simultaneous algebraic equations using Gauss-Elimination method.
14. To estimate the coefficients of Linear Regression (Fit a straight Line) for the set of given data.
15. To Integrate the function using Simpson's 1/3 Rule.
16. To Integrate the function using Simpson's 3/8 Rule.
17. To Integrate the function using Trapezoidal Rule.

M.Sc. (Mathematics) IV Semester (CBCS)
PAPER-IX
STATISTICAL INFERENCE (MSCM-411)

The following topics are prescribed for practical work :

1. Large sample test of significance for mean, standard deviation and proportion for one and two sample problems.
2. T-test for the significance of single mean and difference of mean.
3. Test for the significance of correlation coefficient and regression coefficients.
4. F-test for equality of two population variance.
5. Chi square test for (i) Goodness of fit , (ii) Independent of attributes, (iii) Significance of single variance,(iv) Homogeneity of second correlation coefficient.
6. Confidence interval for (i) mean in case of large and small samples and (ii) Proportion.
7. Sign test, Run test and Median test.
8. Analysis of variance for (i) One-way classification (ii) Two-way classification with an observation per cell.
9. Analysis of (i) CRD (ii) RBD (iii) LSD.
10. Sample surveys (i) SRS (ii) Stratified sampling including allocation problem.

Student will be asked about the basic concepts of the above topics in the viva voce.