MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

DEPARTMENT OF MATHEMATICS AND STATISTICS

Master of Science/ Arts (M.Sc./M.A.) 2023-24

Faculty : SCIENCE

Subject : MATHEMATICS

Semester : First

Course Type	Course Code	Title	Delivery Type			Total Hours	Credit	Total Credit	Internal Assessment	EoS Exam	M. M.	Remarks
			L	T	P							
DCC	MAT8000T	Advanced Abstract Algebra-I	L	T	-	90	5+1	6	20	80	100	---
	MAT8001T	Measure Theory	L	T	-	90	5+1	6	20	80	100	---
	MAT8002T	Differential Equations & Calculus of Variations	L	T	-	90	5+1	6	20	80	100	---
	MAT8003T	Differential Geometry	L	T	-	90	5+1	6	20	80	100	---

M. Sc./M.A. MATHEMATICS SEMESTER - I, 2023-24

Code of the Course : **MAT8000T**

Title of the Course : **ADVANCED ABSTRACT ALGEBRA-I**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Centric Compulsory (DCC)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

The aim of the course is to studying fundamental idea of Abstract Algebra, Apply the concept and principle to connect them with real world problem.

Learning Outcomes:

- After completion of this course, student will be able to
- Understand direct product of subgroups and Cauchy's theorem.
- Apply Sylow's and Jordan Holder theorem.
- Understand solvable group and their properties, fundamental theorem for finite abelian group.
- Apply Linear transformation and diagonalization.

Syllabus:

UNIT I

External and Internal direct product of two and finite number of subgroups, Commutator subgroup, Conjugate classes and class equation, Cauchy's theorem for finite abelian and non-abelian groups. (18 Lecture hours)

UNIT II

Double cosets and Sylow p-subgroups, Sylow's three theorem and their easy applications, Subnormal and Composition series, Jordan Holder theorem. (18 Lecture hours)

UNIT III

Solvable groups, Characteristic property of solvable group, Nilpotent groups, Fundamental theorem for finite abelian groups. (18 Lecture hours)

UNIT IV

Annihilators of subspace and its dimension in finite dimensional vector space, Invariant, Projection, Adjoint, Self-Adjoint operator. (18 Lecture hours)

UNIT V

Singular and nonsingular linear transformation, Similarity, Quadratic forms, Jordan Canonical Form and Diagonalization. (18 Lecture hours)

Books recommended:

1. Surjeet Singh and Quazi Zameeruddin : 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
6. Bhattacharya, P.B., Jain, S.K. : Basic Abstract Algebra

M. Sc./M.A. MATHEMATICS SEMESTER - I, 2023-24

Code of the Course : **MAT8001T**

Title of the Course : **MEASURE THEORY**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Centric Compulsory (DCC)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject and conceptual knowledge of Real Analysis at U.G. Level.

Learning Objective :

The objective of the course is to introduce Lebesgue's theory of Measure and develop fundamental tool of carrying out integration which behave well within limits.

Learning Outcomes:

After completion of this course, student will be able to

- Describe measure and its properties.
- Determine the measurable functions.
- Compute Lebesgue integrals.
- Understand convergence theorems for the integrals.

Syllabus:

UNIT I

Lebesgue outer measure: Length of an interval, Lebesgue outer measure of a subset of R, properties of outer measure, Countable sub-additivity, Outer measure of an interval.

Lebesgue Measure: σ- algebra, Signed measure, Measurable space, Measurable sets (Lebesgure), Algebra of measurable sets, Denumerable union and intersection of measurable sets, Countable additivity of measure, Counting measure, Haar measure, Borel measure, F_σ and G_σ sets. (16 Lecture hours)

UNIT II

Measurable functions: Different equivalent definition of a measurable function, Almost everywhere, Algebra of Measurable functions, Measurability of a continuous function, Supremum, Infimum, Limit superior, Limit inferior and limit of a sequence of measurable functions. (16 Lecture hours)

UNIT III

Convergence of sequence of Measurable function: Convergence Pointwise, Uniform Convergence, Convergence almost everywhere (a.e.), Convergence in measure, Characteristic function, Simple function, Step function, Theorems of Measurable functions.

(18 Lecture hours)

UNIT IV

Lebesgue Integral: Lebesgue Darboux sums, Lebesgue integral of a simple function and measurable function, Lebesgue integral and Riemann integral of a bounded function defined on a closed interval, First Mean value theorem, Properties of Lebesgue integral, The bounded convergence Theorem. (20 Lecture hours)

UNIT V

Summable function: Lebesgue integral of a non-negative function, Convergence Theorems and Lebesgue integral, Fatou's Lemma, Monotone convergence theorem, Lebesgue dominated convergence theorem, Convergence in mean. (20 Lecture hours)

Books Recommended:

1. Pal R. Halmos : Measure Theory, D.Van Nostrand Company, INC, Univ. of Chikago.
2. Murray R. Spiegel : Theory and Problems of Real Variables, Schaum's Outline series, McGraw-Hill Book.
3. G.D. Barra : Measure and Integration, New age International Publishers.
4. M.E. Munroe : Introduction to Measure and Integration, Department of Mathematics, Univ. of Illinoi's.
5. Gupta, Malik, Mittal : Measure Theory, A Pragati edition.
6. T.S. Nahar : Measure Theory, Navkar Publication.
7. H.K. Pathak : Real Analysis, Shree Krishnaa Sahitya Prakashan.

M. Sc./M.A. MATHEMATICS SEMESTER - I, 2023-24

Code of the Course : **MAT8002T**

Title of the Course : **DIFFERENTIONAL EQUATIONS & CALCULUS OF VARIATIONS**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Centric Compulsory (DCC)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject and knowledge of solving ordinary differential equations at U.G. Level.

Learning Objective :

The objective of the course is to apply the concepts and methods to solve problem using differential equation.

Learning Outcomes:

After completion of this course, student will be able to

- Understand concept of partial differential equations, solution of second order PDE using Monge's method.
- Classify partial differential equations and transform into canonical form.
- Use the information about the Eigen value and the corresponding Eigen functions for a Boundary value problem.
- Extract information from partial derivative models in order to interpret reality and understand the concept of BVP's.
- Develop the knowledge in the path of the rocket trajectory, optimal economic growth and apply calculus of variations in biological and medical field.

Syllabus:

UNIT I

Partial differential equation (PDE): Lipschitz condition, Existence and Uniqueness theorem, Existence and uniqueness solutions of Initial Value Problem (I.V.P.), Solution of second order partial differential equations through Monge's method. (19 Lecture hours)

UNIT II

Canonical forms and Classification: Reduction of second order Semi linear partial differential equations to canonical forms, Classification of second order partial differential equations having more than two independent variables, Cauchy's problem. (16 Lecture hours)

UNIT III

Second order ordinary differential equations: Boundary value problems (BVP), Orthogonality, Strum-Liouville B.V.P., Lagrange's Identity, Relevant theorems, Properties based on eigen values and eigen functions, Expansion of function in terms of eigen functions, Periodic Strum problem. (18 Lecture hours)

UNIT IV

Solution of second order P.D.E. by the method of separation of variables, Green's function and its construction, Solution of second order Homogonous B.V.P's through Green's function, Dirac delta function and its important properties. (18 Lecture hours)

UNIT V

Calculus of variations: Functionals, Euler- Lagrange's differential equation for externals and it's alternative forms, Variational problems involving several dependent variables, Several independent variables and higher order derivatives, Isoperimetric Problems, Solution of variational problems using Ritz method. (19 Lecture hours)

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 & Dhami : Differential Equations Vol. II.
5. Gelfand, I.M. and Fomin, S.V. : Calculus of Variations
6. M.D. Raisinghania : Ordinary and Partial Differential Equation

M. Sc./M.A. MATHEMATICS SEMESTER - I, 2023-24

Code of the Course : **MAT8003T**

Title of the Course : **DIFFERENTIAL GEOMETRY**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Centric Compulsory (DCC)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject and knowledge of Solid Geometry at U.G. Level.

Learning Objective :

The objective of the course is to give an introduction about basic concept and terminology of Differential Geometry. Students will study plane section, confocal conicoid, conoids and curves in space.

Learning Outcomes:

After completion of this course, student will be able to

- Understand basic concept of plane section and circular section.
- Derive any section of a central conicoid, Generating lines and Tangent plane.
- Understand basic of confocal conicoids, elliptic coordinates, parameter of confocals.
- Study conoids, inflexional tangents and indicatrix.

Syllabus:

UNIT I

The Axes of Plane Sections: Central sections, Non central section, Circular sections, Any section of a central conicoid, The hyperboloids and the paraboloids. (18 Lecture hours)

UNIT II

Generating Lines: Introduction, Properties of generating line, Direction cosines of generating lines, The section of a surface by a tangent plane, Systems of generators of a central hyperboloid, Locus of the points of intersection of perpendicular generators, The projection of generators, Generators of the hyperbolic paraboloids. (18 Lecture hours)

UNIT III

Confocal Conicoids: The three confocals through a point, Elliptic coordinates, Confocal touching a given plane and 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 and the conicoid. (18 Lecture hours)

UNIT IV

Conoids: Equation to a conoid, Surface in general, The degree of a surface, tangents and tangent planes, The inflexional tangents, Singular points, The indicatrix and parametric equations. (18 Lecture hours)

UNIT V

Curves in space: Equation to a curve, The tangent and its direction cosines, The normal plane, contact of a curve and surface, Osculating plane and sphere, Principal normal and binormal, Direction Cosines of the principal normal and binormal, curvature, torsion, Spherical indicatrices, Frenet's formulae. (18 Lecture hours)

Books recommended:

1. Robert, L., Bell, J.T. : Coordinate Geometry of the three dimensions
2. Bansal & Sharma : Differential Geometry
3. N. Saran & R. S. Gupta : Analytical Geometry of Three Dimension
4. Raj Bali : Advance Differential Geometry

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

DEPARTMENT OF MATHEMATICS AND STATISTICS

Master of Science/ Arts (M.Sc./M.A.) 2023-24

Faculty : SCIENCE

Subject : MATHEMATICS

Semester : Second

Course Type	Course Code	Title	Delivery Type			Total Hours	Credit	Total Credit	Internal Assessment	EoS Exam	M.M.	Remarks
			L	T	P							
DCC	MAT8004T	Advanced Abstract Algebra-II	L	T	-	90	5+1	6	20	80	100	---
	MAT8005T	Complex Analysis	L	T	-	90	5+1	6	20	80	100	---
	MAT8006T	Special Functions	L	T	-	90	5+1	6	20	80	100	---
Select any one of the following Generic Elective Course (GEC) Courses in II semester, may be opted from other Departments.												
GEC	MAT8100T	Dynamics of Rigid Bodies	L	T	-	90	5+1	6	20	80	100	Only for the students of M.Sc. Mathematics
	MAT8101T	Matrix Algebra	L	T	-	60	4	4	20	80	100	---
	MAT8102T	Number Theory	L	T	-	90	5+1	6	20	80	100	Only for the students of M.Sc. Mathematics
	MAT8103T	Counting Techniques	L	T	-	60	4	4	20	80	100	---

M. Sc./M.A. MATHEMATICS SEMESTER - II, 2023-24

Code of the Course : **MAT8004T**

Title of the Course : **ADVANCED ABSTRACT ALGEBRA-II**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Centric Compulsory (DCC)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

The objective of the course enables the students to acquire knowledge about various topics under ring theory and its applications.

Learning Outcomes:

After completion of this course, student will be able to

- Identify various types of fields, rings, integral domain.
- Understand concept of modules and its types, fundamental theorem of homomorphism.
- Reproduce and exemplify field extension and its types.
- Explain and apply Automorphism, Galois theory of field extension and its theorem.

Syllabus:

UNIT I

Prime fields of characteristic zero or 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, Division Algorithm, Remainder Theorem, Factor Theorem.

(18 Lecture hours)

UNIT II

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

(18 Lecture hours)

UNIT III

Basis of Module, Simple module, Uniform module, 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.

(18 Lecture hours)

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. (18 Lecture hours)

UNIT V

Automorphisms, Galois Theory of field extensions and its fundamental theorem, Solution of polynomial equations by radicals, Roots of unity, Abel's theorem. (18 Lecture hours)

Books recommended:

1. Surjeet Singh and Quazi Zameeruddin : 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
6. P.B. Bhattacharya S.K. Jain and Etc. : Basic Abstract Algebra

M. Sc./M.A. MATHEMATICS SEMESTER - II, 2023-24

Code of the Course : **MAT8005T**

Title of the Course : **COMPLEX ANALYSIS**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Centric Compulsory (DCC)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

This course is aimed to provide an introduction to the theories for functions of a complex variable. Students will be equipped with the understanding of the fundamental concepts of complex variable theory.

Learning Outcomes:

After completion of this course, students will be able to

- Evaluate integrals along a path.
- Find various transformations.
- Compute the Taylor and Laurent expansions of simple functions.
- Determining the nature of the singularities and calculating residues.
- Apply Cauchy Residue Theorem in evaluating integrals.

Syllabus:

UNIT I

Complex numbers: Principle argument, Positional equality, Conjugate or inverse along a curve, Functions of complex variable: Type of functions, Branch point and branch cut, Algebra of complex functions, Concept of limit, Continuity and differentiability of complex function, Analytic functions, Cauchy-Riemann equations (Cartesian and polar form), Harmonic functions, Power series as an analytic function, Radius of convergence, Circle of convergence. (20 Lecture hours)

UNIT II

Elementary functions, Mapping by some elementary functions, Linear & Bilinear transformations, Fixed points, Cross ratio, Inverse points, Critical points, Elliptic hyperbolic and parabolic transformations, Isogonal and conformal transformations, Exponential, Logarithmic and Trigonometric transformations. (16 Lecture hours)

UNIT III

Complex integration: Curves in complex plane, Properties of complex line integrals, Cauchy's fundamental theorem, Cauchy-Goursat 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. (18 Lecture hours)

UNIT IV

Morera's theorem, Primitives, Fundamental theorem of integral calculus, Cauchy's inequality, Liouville's theorem, Maximum Modulus principle, Minimum Modulus principle, Poisson's integral formula, Development of Analytic function as power series: Taylor's Series, Laurent's Series. (16 Lecture hours)

UNIT V

Singularities and Zeroes of an Analytic function, Weierstrass theorem, Rouche's theorem, Schwarz's Lemma, Fundamental theorem of Algebra, Meromorphic & rational functions, Argument theorem, residues, Cauchy's theorem of residues and Evaluation of definite integrals. (20 Lecture hours)

Books Recommended:

1. S. Ponnusamy : Foundations of Complex Analysis
2. J.W Brown & R.V. Churchill : Complex Variables and Applications
3. L.V. Ahlfors : Complex Analysis
4. J.N. Sharma : Functions of a Complex Variable

5. Zill & Shanahan : Complex Analysis with Applications

M. Sc./M.A. MATHEMATICS SEMESTER - II, 2023-24

Code of the Course **: MAT8006T**

Title of the Course **: SPECIAL FUNCTIONS**

Level of the Course **: NHEQF Level 6.5**

Credit of the Course **: 6**

Type of the Course **: Discipline Centric Compulsory (DCC)**

Delivery type of the Course **: Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites **:**

B.Sc./B.A. with Mathematics as a core subject and the knowledge of Integrations.

Learning Objective **:**

The objective of the course is to analyze properties of special functions by their integral representation and symmetry.

Learning Outcomes:

After completion of this course, student will be able to

- Find solutions of various differential equations using series solution.
- Classify and explain the function of different type of differential equations.
- Analyse properties of various special functions by their integral representations.
- Apply special functions in various problems.

Syllaus:

UNIT I

Series solutions: Singularities in second order ordinary differential equations with constant coefficients and variable coefficients, Radius of convergence, Series solutions of second order homogeneous ordinary differential equations, Forbenius method.

Hypergeometric equations: Hypergeometric series, Hypergeometric functions, Confluent Hypergeometric function and solution of confluent Hypergeometric equation.

(20 Lecture hours)

UNIT II

Legendre's polynomial Functions: Legendre's and associated Legendre's differential equations, Simple properties of Legendre's functions of first and second kind and the associated Legendre's function of integral order. (16 Lecture hours)

UNIT III

Bessel functions: Generating function, Integral formula, Recurrence relations, Addition formula and other properties of Bessel functions. (18 Lecture hours)

UNIT IV

Classical Orthogonal Polynomials, Generating functions and other properties, Associated with the Laguerre, Legendre and Hermite Polynomials. (16 Lecture hours)

UNIT V

Jacobi Polynomials, Chebyshev polynomials: Generating function, Recurrence relations, Orthogonal and other properties.

Diffusion, Vibration Equation and Application of Special Functions. (20 Lecture hours)

Books recommended:

1. Rainville, E.D. : Special Functions, Macmillan, New York.
2. Sneddon, I.N. : Special Functions Oliver & Boyd.
3. S.P. Goyal : Special Functions
4. Saran, Sharma & Trivedi : Special Functions, A pragati edition.
5. Saxena & Gokharoo : Special Functions, JPH.
6. G.S. Rao : Special Functions, Shree Krishnaa Sahitya Prakashan.

M. Sc./M.A. MATHEMATICS SEMESTER - II, 2023-24

Code of the Course : **MAT8100T**

Title of the Course : **DYNAMICS OF RIGID BODIES**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Generic Elective Course (GEC)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject and basic knowledge of Mechanics at U.G. level.

Learning Objective :

The objective of the course is to demonstrate knowledge and understanding of the fundamental concepts in motion of rigid body with D'Alembert's principle and Lagrange's formulation of mechanics.

Learning Outcomes:

After completion of this course, student will be able to

- Understand concept of Rigid dynamics, moment of inertia, product of inertia, Momental Ellipsoid and principal axes.
- Understand D' Alembert's principle and derive equations of motion.
- Study the motion in two dimensions under finite forces and impulsive forces.
- Apply principles of the conservation of momentum and energy.
- Derive Lagrange's equations in generalized coordinates under finite and impulsive forces.

Syllabus:

UNIT I

Moments and products of inertia, Parallel axes theorem, Momental ellipsoid, Equimomental system, Principal axes. (20 Lecture hours)

UNIT II

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

(18 Lecture hours)

UNIT III

Motion in two dimensions under finite forces including sliding and rolling friction, Impulsive motion in two dimensions. (18 Lecture hours)

UNIT IV

Principles of conservation of momentum and energy. (16 Lecture hours)

UNIT V

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

(18 Lecture hours)

Books Recommended:

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

Note: Only candidate of M.Sc. (Mathematics) are eligible to opt this paper.

M. Sc./M.A. MATHEMATICS SEMESTER - II, 2023-24

Code of the Course : **MAT8101T**

Title of the Course : **MATRIX ALGEBRA**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **4**

Type of the Course : **Generic Elective Course (GEC)**

Delivery type of the Course : **Lecture** (40 Hours for content delivery) and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

Graduate in any discipline.

Learning Objective :

The objective of the course is to acquire knowledge about matrices, determinant, their properties and applications.

Learning Outcomes:

After completion of this course, student will be able to

- Study various types of matrices and its properties.
- Understand properties of Determinant and its evaluation.
- Study the elementary transformation and inverse of matrix.
- Explain the methods of solving linear equations.
- Determine Eigen values and Eigen vectors.

Syllabus:

UNIT I

Definition of various types of matrices, Addition of matrices, Scalar Multiplication, Multiplication of matrices, Transpose of a matrix, Symmetric and Skew symmetric matrices, Hermitian and Skew Hermitian matrices. (13 Lecture hours)

UNIT II

Elementary properties of determinants, Cramer's rule, Determinant of special kinds.

(11 Lecture hours)

UNIT III

Adjoint of a square matrix and its properties, Inverse of a matrix, Elementary transformations, Sub matrices and minor of matrix, Rank of a matrix, Equivalent matrices. (12 Lecture hours)

UNIT IV

Linear equations, Methods of solving simultaneous linear equations, Condition of Consistency and Inconsistency of linear equations, Homogenous equations.

(10 Lecture hours)

UNIT V

Eigen values and Eigen vector of matrix, Properties of Eigen values and Eigen Vectors, Cayley Hamilton Theorem. (14 Lecture hours)

Books Recommended:

1. Sharma,Gokhroo, saini : Elements of Matrices Determinants
2. Mandot, Gandhi, Khurdiya : Advanced Matrices
3. Pundir & Pundir : Mathematical Methods
4. Suddhendu Biswas : Matrix Algebra

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

DEPARTMENT OF MATHEMATICS AND STATISTICS

Master of Science/ Arts (M.Sc./M.A.) 2024-25

Faculty : SCIENCE

Subject : MATHEMATICS

Semester : Third

Course Type	Course Code	Title	Delivery Type			Total Hours	Credit	Total Credit	Internal Assessment	EoS Exam	M.M.	Remarks
			L	T	P							
DCC	MAT9000T	Topology	L	-	-	60	4	4	20	80	100	---
	MAT9001T	Relativity and Tensor Analysis	L	-	-	60	4	4	20	80	100	---
Select any two of the following Discipline specific Elective (DSE) Courses in III semester.												
DSE	MAT9100P	Computer Programming in-C	L	-	P	30+ 120	2+4	6	20	80	100	Students of B.Sc. (Comp. Sci.) can't opt.
	MAT9101T	Optimization Techniques-I	L	T	-	90	5+1	6	20	80	100	---
	MAT9102T	Mathematical Theory of Statistics-I	L	T	-	90	5+1	6	20	80	100	Students of B.Sc. (Statistics) can't opt
	MAT9103T	Discrete Mathematics-I	L	T	-	90	5+1	6	20	80	100	---
	MAT9104T	Integral Transform	L	T	-	90	5+1	6	20	80	100	---
Select any one of the following Generic Elective Course (GEC) Courses in III semester, may be opted from other Departments.												
GEC	MAT9105T	Numerical Analysis	L	T	-	60	4	4	20	80	100	---
	MAT9106T	Applied Mathematics	L	T	-	60	4	4	20	80	100	---
	MAT9107T	Inventory Management	L	T	-	60	4	4	20	80	100	---
	MAT9108P	Mathematica	-	-	P	120	4	4	20	80	100	---

M. Sc./M.A. MATHEMATICS SEMESTER - III, 2024-25

Code of the Course : **MAT9000T**

Title of the Course : **TOPOLOGY**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **4**

Type of the Course : **Discipline Centric Compulsory (DCC)**

Delivery type of the Course : **Lecture** (40 Hours for content delivery) and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

The objective of the course is to enriched the knowledge of the students with concept of metric space, elementary properties of topological spaces and function algebra.

Learning Outcomes:

After completion of this course, student will be able to

- Demonstrate knowledge of metric space with properties and examples.
- Understand concepts of topology, bases, countable space and related theorems.
- Create new topological spaces.
- Study compactness, connectedness and continuity related theorems.

Syllabus:

UNIT I

Metric Space: Definition, Examples and properties of a metric space, Open and closed sphere, open sets, closed sets and the related results, limit point, Adherent and Isolated points, continuous mappings, Convergence of a sequence, Cauchy Sequence, Uniform and Pointwise convergence, Nested sequence, Complete metric space, compact spaces and compact sets, Baire's category theorem. (12 Lecture hours)

UNIT II

Topological Spaces: Definition of Topology, T-open sets, weaker and stronger topology, Types of Topologies, comparison of Topologies, 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. Base, sub base, open bases, open sub bases, first countable space, second countable space, separable space, continuous functions in topological spaces, sequentially topological spaces. (12 Lecture hours)

UNIT III

Separation Axioms: T_o , T_1 , T_2- space, separation axioms, normal spaces, Regular spaces, completely regular space, Tychonoff space, Housdorff space, Completely Normal spaces, Problems related to separation of Axioms.

Compactness: Cover, open cover, finite sub cover, compact sets, Lindelof space, Locally compact, sequentially compact, Bolzano Weierstrass property and sequentially compactness, compactness for metric spaces, Lindelof theorem, Product spaces. (12 Lecture hours)

UNIT IV

Connectedness: Separated sets, Disconnectedness, Connectedness and continuity, components of a space, product of connected topologic al spaces, Locally connected Spaces, totally disconnected space. (12 Lecture hours)

UNIT V

Approximation: The Weierstrass approximation theorem, function algebra, C(X, R) and C (X, C), the real Stone-Weierstrass theorem, The Complex Stone-Weierstrass theorem.

(12 Lecture hours)

Books recommended:

1. George F. Simmons : Introduction to Topology and modern analysis
2. S.I. Hu : Elements of Real Analysis
3. H.L. Royden : Real analysis
4. W.J. Thron : Topological structure
5. J. Kelley : General Topology
6. Malik, Arora, Savita : Mathematical Analysis

M. Sc./M.A. MATHEMATICS SEMESTER - III, 2024-25

Code of the Course : **MAT9001T**

Title of the Course : **RELATIVITY AND TENSOR ANALYSIS**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **4**

Type of the Course : **Discipline Centric Compulsory (DCC)**

Delivery type of the Course : **Lecture** (40 Hours for content delivery) and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

The objective of the course is to study tensor algebra as a tool which is essential to understand the various concepts of relativity and cosmology. Relativity is an essential part to study cosmos and astrophysics.

Learning Outcomes:

After completion of this course, student will be able to

- Understand concept of special theory of relativity, Michelson-Marley experiment and Lorentz transformation.
- Study of various type of tensors with operations.
- Study and apply Geodesics, null geodesics, Ricci tensor, Bianchi identities
- Derive Max well's equations, transformation of electric and magnetic intensities.

Syllabus:

UNIT I

Michelson-Morley experiment, postulates of special theory of Relativity, Lorentz transformations. Mass-Energy formula, transformation formulas for momentum and energy, Minkowski's 4-dimensional continuum space, Space like and time like intervals.

(12 Lecture hours)

UNIT II

Tensors: Transformation of coordinates, Contravariant and covariant vectors, Higher order tensors, Contraction, Quotient Law, symmetric and skew symmetric tensors, conjugate symmetric tensors of the second order, Fundamental tensor, Associated tensors.

(12 Lecture hours)

UNIT III

Christoffel symbols, Transformation law of Christoffel symbols, Covariant differentiation of vectors and tensors, Tensor form of gradient, divergence, Laplacian and curl, Intrinsic derivative. (12 Lecture hours)

UNIT IV

Geodesics, Null Geodesics, Geodesics and Riemannian Coordinates, Parallelism of vectors, Riemannian curvature tensor, Symmetric properties of R^i_{ljk}, Covariant curvature tensor R_{hljk}, Number of independent components of R_{hljk} in a V_n, Ricci tensor, Bianchi identities, Conformal Curvature tensor, Condition for flat space. (10 Lecture hours)

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. (14 Lecture hours)

Books Recommended:

1. P.G.Bergman : Introduction to Theory of Relativity
2. J.L.Synge : Relativity, The special Theory
3. B. Spain : Tensor Calculus
4. J.L. Bansal : Tensor Analysis
5. Roy & Bali : Theory of Relativity
6. Raj Bali : Advanced Tensor Analysis

M. Sc./M.A. MATHEMATICS SEMESTER - III, 2024-25

Code of the Course : **MAT9100P**

Title of the Course : **Computer Programming in C (Practical Oriented)**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Specific Elective (DSE)**

Delivery type of the Course : **Lecture** (20 Hours for content delivery and 10 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment) and **Practical** (80 Hours for hands on algorithm, flowcharts and coding of program, execution, result, 40 Hours for lab practices)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

The course introduces the learners to C programming language, which is a starting level for getting into programming, The course also provides hands-on training to help you write and test your coding skill, and prepare you for real-life application.

Learning Outcomes:

After completion of this course, student will be able to

- Develop a C program
- Control the sequence of the program and give logical outputs Implement strings in your C program.
- Store different data types in the same memory, Manage I/O operations in your C program.
- Repeat the sequence of instructions and points for a memory location.
- Apply code reusability with functions, Explain the uses of pre-processors and various memory models

Syllabus:

UNIT I

Definition and properties of algorithm, flow chart, conversion of flow chart to language, examples of algorithms and flow charts, introduction to program design, errors, syntax error, logical error, runtime error. (6 Lecture + 24 practical hours)

UNIT II

Character set of C, constants and variables in C, arithmetic expressions in C, assignment and multiple assignment and mode of statements in C, built in functions and libraries in C, input and output statements in C, data types, structure of C program, elementary programs in C.

(6 Lecture + 24 practical hours)

UNIT III

Logical if statements in C: if- else, nested if, switch, break, continue, GOTO statements in C

For, while and do-while loops in C, nested loops. (6 Lecture + 24 practical hours)

UNIT IV

Functions: Defining and accessing a function, passing arguments to a function, specifying arguments data types, function prototypes, Scope rules of functions, call by value, call by reference. (6 Lecture + 24 practical hours)

UNIT V

Array: introduction of array, Classification of arrays, functions with arrays, Pointers in C, pointers and arrays, File input/output: create, open, write, delete, close.

(6 Lecture + 24 practical hours)

Books Recommended:

1. Introduction Information Technology: Satish Jain, BPB Publication, New Delhi.
2. Fundamentals of computers: P. K. Sinha
3. The C-Programming Language: B.W. Kernyharn & D.M. Ritche - PHI Ltd.
4. Computer Programming in C: Y Kanetkar-B.P.B. Publication, New Delhi.
5. Programming In ANSI C: E Balagurusamy**.**
6. Compute Based Numerical Statistical Technique: Sanjeev Kumar & V. S. Verma, Ram Prasad Publications.

Note: Candidate who have offered computer science as an optional in graduation subject will not be permitted to offer above paper.

EoS: At the end of semester evaluation of the student for this paper based on making algorithm, flowchart, coding of program and execution on computer with result verification.

M. Sc./M.A. MATHEMATICS SEMESTER - III, 2024-25

Code of the Course : **MAT9101T**

Title of the Course : **OPTIMIZATION TECHNIQUES-I**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Specific Elective (DSE)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

The objective of this course is to enhanced the knowledge of students with advanced concepts and techniques of linear programming problem along with real life applications.

Learning Outcomes:

After completion of this course, student will be able to

- Explain linear programming problem (L.P.P.) and method used to solve it.
- Explain the relationship between a LPP and its dual, understand the economic interpretation of duality.
- Analyse the discrete changes in the parameters of the problem and its effect on optimal solution.
- Enumerate fundamentals of integer programming techniques and apply different techniques to solve various optimization problems arising from different areas.
- Understand how optimization can be used to solve industrial problems.

Syllabus:

UNIT I

Theory of Simplex method, Optimality and unboundness, Simplex algorithm, Big-M method. (18 Lecture hours)

UNIT II

Duality, Primal dual relationship, Duality and simplex method, Dual simplex method, Bounded value algorithm. (20 Lecture hours)

UNIT III

Sensitivity Analysis: Variation in

(i) The coefficient (c_j) of the objective function.

(ii) The component (b_i) of required vector b.

(iii) The component (a_{ij}) of the matrix A. (16 Lecture hours)

UNIT IV

Sensitivity Analysis (Cont.):

(i) Addition of new variable.

(ii) Addition of a new constraint.

(iii) Deletion of a variable.

(iv) Deletion of constraint. (16 Lecture hours)

UNIT V

Integer programming: Importance of integer programming problems, Gomory's cutting plane methods, δ Fractional cut and λ-cut, Branch and bound method. (20 Lecture hours)

Books Recommended:

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

M. Sc./M.A. MATHEMATICS SEMESTER - III, 2024-25

Code of the Course : **MAT9102T**

Title of the Course : **MATHEMATICAL THEORY OF STATISTICS-I**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Specific Elective (DSE)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

The objective of the course is to studding probability theory, discrete and continuous distribution with applications which will be foundation for further study in statistics.

Learning Outcomes:

After completion of this course, student will be able to

- Understand concepts of probability, Baye's theorem and its applications.
- Finding mathematical expectations, moments generating function.
- Apply Binomial, Poisson distribution.
- Study Normal, Gamma and Beta distributions and apply real life problem.

Syllabus:

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. (16 Lecture hours)

UNIT II

Mathematical expectations, conditional expectations, Moments and cumulates, Moments generating and characteristic functions, Inversion theorem, Chebychev's inequality, Central limit theorem for i.i.d. random variables. (20 Lecture hours)

UNIT III

Binomial, Negative-binomial, Geometric distribution, Poisson and Hyper Geometric distributions. (18 Lecture hours)

UNIT IV

Rectangular, Normal, Cauchy, Gamma and Beta Distributions, Elementary idea of Exponential and Laplace distributions. (18 Lecture hours)

UNIT V

Curve fitting and principle of least squares, Scatter diagram, linear regression and correlation. (18 Lecture hours)

Books recommended:

1. Gupta and Kapoor : Fundamentals of Mathematical Statistics
2. Kapur and Sexena : Mathematical Statistics
3. Goon and Others : Outline of Statistical Theory

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

M. Sc./M.A. MATHEMATICS SEMESTER - III, 2024-25

Code of the Course : **MAT9103T**

Title of the Course : **DISCRETE MATHEMATICS-I**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Specific Elective (DSE)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

The objective of the course is to introduce basic Discrete Mathematics as well as serve the purpose of building foundation for other courses of Modern Mathematics which rely heavily on Discrete Mathematics.

Learning Outcomes:

After completion of this course, student will be able to

- Understand fundamental concepts of mathematical logic and certain Algebra concepts from the view point of Discrete Mathematics.
- Expansion of the Algebra concepts from the view point of Discrete Mathematics.
- Introduce the Mathematical structure of Lattices, Partially ordered sets and their various kinds of Lattices.
- Study Boolean Algebra its relation with Lattices and relevant concepts.
- Minimize Boolean function, Various canonical forms and Karnaugh-Map.

Syllabus: UNIT I

Formal logic: Statement, Symbolic Representation and Tautologies, Quantifiers, Predicate validity, Propositional logic.

Relations: Reflexive, Symmetric, Antisymmetric, Transitive, Equivalence, Congruence, Partial Order Relations, Functions.

Proof Techniques of implication (three proving methods only): Direct Proof, Indirect Proof (Direct Proof of Contrapositive). Proof by Contradictions and Disproving by Counter example- all with elementary examples only. (18 Lecture hours)

UNIT II

Semi Group and Moniods: Definitions and examples, Homomorphism of semi groups and monoids, Quotient Semigroup, sub semigroups and sub monoids, Direct products, Basic Homomorphism theorem.

Introductory concepts and definitions only: Equivalence class, Quotient set.

(18 Lecture hours)

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. (18 Lecture hours)

UNIT IV

Boolean Algebras: Boolean Algebras as lattices, Various Boolean identities, the switching Algebras examples, Sub Algebras, Join- irreducible elements, Atoms and minterms.

(18 Lecture hours)

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. (18 Lecture hours)

Books recommended:

1. J.P. Tremblay & R. Manohar : Discrete Mathematical structure with applications to computer science.
2. J.L. Gerstling : Mathematical Structures for Computer Science.
3. N. Arsing Deo : Graph theory with applications to Engineering and Computer Science.
4. K.D. Joshi : Foundation of Discrete Mathematics.
5. S. Wiitala : Discrete mathematics – A Unified Approach.
6. C. L. Liu : Elements of Discrete Mathematics.
7. N. Chandrasekaran & M. Umaparvathi : Discrete Mathematics, PHI

M. Sc./M.A. MATHEMATICS SEMESTER - III, 2024-25

Code of the Course : **MAT9104T**

Title of the Course : **INTEGRAL TRANSFORMS**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Specific Elective (DSE)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

This course is aimed to provide an introduction about various integral transforms and their fundamental properties. Students will be equipped to apply these concepts in solving a variety of initial and boundary value problems.

Learning Outcomes:

After completion of this course, students will be able to

- Understand concept of various integral transforms.
- Derive their fundamental properties.
- Apply transforms in finding solution of initial and boundary value problems.

Syllabus:

UNIT I

Laplace transform: Definition and its fundamental properties, Rules of manipulations, Laplace theorems of derivatives and integrals, periodic function, Properties of inverse Laplace transforms, Convolution theorem, Complex inversion formula. (20 Lecture hours)

UNIT II

Applications of Laplace transform to the solutions of ordinary linear differential equations with constant and variable coefficients, simultaneous ordinary linear differential equations, partial differential equations and simple boundary value problems. (20 Lecture hours)

UNIT III

Fourier Transform: Definition and properties of Fourier sine and cosine and complex Fourier transforms, Convolution theorem, Inversion theorems, Parseval's identify for Fourier transform and Fourier transform of derivatives. (18 Lecture hours)

UNIT IV

Applications of Fourier transforms to the solutions of partial differential equations. Mellin Transform: Definition and elementary properties, Mellin transforms of derivatives and integrals, Inversion theorem and convolution theorem. (16 Lecture hours)

UNIT V

Infinite Hankel transform: Definition and Elementary Properties, Hankel transform of derivations, Inversion theorem and Parseval's theorem, Application to the Solution of simple boundary value problems. (16 Lecture hours)

Books Recommended:

1. Ranville, E.D. : Laplace and Fourier Transforms
2. Sneddon, I.N. : The use of Integral Transforms
3. Debnath L. and Bhatta D. : Integral Transforms and their applications
4. Zemanian, A.H. : Generalized Integral transforms
5. Goyal, S.P. & Goyal, A. K. : Integral Transforms

M. Sc./M.A. MATHEMATICS SEMESTER - III, 2024-25

Code of the Course : **MAT9105T**

Title of the Course : **NUMERICAL ANALYSIS**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **4**

Type of the Course : **Generic Elective Course (GEC)**

Delivery type of the Course : **Lecture** (40 Hours for content delivery) and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with knowledge of simple differentiation and integration.

Learning Objective :

The course aims to strengthen the theoretical, conceptual and analytical aspects of the use of numerical methods.

Learning Outcomes:

After completion of this course, student will be able to

- Find required missing terms from the given data's.
- Find numerical values of differential and integration using various formulas.
- Implement numerical methods for a variety of multidisciplinary applications.
- Solve algebraic equation using direct and iterative methods.

Syllabus:

UNIT - I

Differences, Operators and factorial notation, Relation between differences and derivatives, differences of Polynomial, Newton's interpolation formula, Newton-Gregory formula for forward and backward interpolation, Divided differences, Relation between divided differences and simple differences. (13 Lecture hours)

UNIT - II

Newton's divided difference interpolation formula, Lagrange's interpolation formula.

Central difference: Gauss's formula, Stirling's and Bessel's interpolation formula, Inverse interpolation.

Numerical differentiation: Derivatives from Interpolation formulae, Method of operators.

(13 Lecture hours)

UNIT-III

Numerical Integration: Newton-cotes Quadrature formula, Trapezoidal, Simpson's one third, Simpson's three-eight rules, Weddle's rule, Gauss Quadrature formulae, Estimation of errors in quadrature formula. (10 Lecture hours)

UNIT-IV

Numerical solution of Algebraic and Transcendental equations, Bisection method, Regula-Falsi method, Method of iteration, Newton Raphson's method, Newtons theorem on multiple roots. (12 Lecture hours)

UNIT-V

Solution of ordinary differential equation of first order with initial and boundary conditions using Picard's Euler's, Modified Euler's, Runge Kutta method, Milne's Predictor-Corrector method. (12 Lecture hours)

References:

1. C. E. Froberg : Introduction to Numerical Analysis
2. M. K. Jain, S. R. K. Iyenger and R.K. Jain : Numerical methods: Problems & solutions
3. H.C. Saxena : Numerical Analysis (S. Chand)
4. Goyal, Mittal : Numerical Analysis
5. Rao V. Dukkipati : Numerical Methods (New Age)

Note: Only for the candidate who has not studied at U.G. level.

M. Sc./M.A. MATHEMATICS SEMESTER - III, 2024-25

Code of the Course : **MAT9106T**

Title of the Course : **APPLIED MATHEMATICS**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **4**

Type of the Course : **Generic Elective Course (GEC)**

Delivery type of the Course : **Lecture** (40 Hours for content delivery) and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

Graduate in any discipline.

Learning Objective :

The objective of the course is to provide way of viewing and analyzing the real world.

Learning Outcomes:

After completion of this course, student will be able to

- Understand the concept of set, function, limit and continuity with properties.
- Study and understand the derivative of function by various methods.
- Evaluate integral by various methods.
- Discuss the properties and evaluation of definite integrals.

Syllabus:

UNIT - I

Set theory: Definition and types, operations of sets, Venn Diagrams, De-Morgan's Law.

(10 Lecture hours)

UNIT - II

Functions, limit and continuity: Definition of function, graph of function, limit, theorem on limit, methods to evaluate limits, continuity, continuous function and its properties.

(12 Lecture hours)

UNIT - III

Differentiability and Derivatives: Differentiability at a point, differentiation by first principle, derivative of function of function, derivative of trigonometric and logarithmic functions, differentiation by method of substitution, derivatives as a rate measure. (14 Lecture hours)

UNIT-IV

Indefinite Integration: Integration of function, some standard results, integration by substitution and by parts. Integration of algebraic and trigonometric function. Integration by partial fractions. (13 Lecture hours)

UNIT-V

Definite integration: Definition and properties of definite integrals, evaluation of definite integrals. (11 Lecture hours)

References:

1. Naresh Chandani : Basic Mathematics
2. D.C. Sancheti and V.K. Kapoor : Business Mathematics

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

DEPARTMENT OF MATHEMATICS AND STATISTICS

Master of Science/ Arts (M.Sc./M.A.) 2024-25

Faculty : SCIENCE

Subject : MATHEMATICS

Semester : Fourth

Course Type	Course Code	Title	Delivery Type			Total Hours	Credit	Total Credit	Internal Assessment	EoS Exam	M.M.	Remarks
			L	T	P							
DCC	MAT9002T	Functional Analysis	L	T	-	90	5+1	6	20	80	100	---
Select any three of the following Discipline specific Elective (DSE) Courses in IV semester.												
DSE	MAT9109P	Computer Programming of Numerical Methods	L	-	P	30+120	2+4	6	20	80	100	If opted C-Prog. as DSE in M.Sc. III Sem
	MAT9110T	Optimization Techniques-II	L	T	-	90	5+1	6	20	80	100	If opted OT-I as DSE in M.Sc. III Sem
	MAT9111T	Mathematical Theory of Statistics-II	L	T	-	90	5+1	6	20	80	100	If opted MTS-I as DSE in M.Sc. III Sem
	MAT9112T	Discrete Mathematics-II	L	T	-	90	5+1	6	20	80	100	If opted DM-I as DSE in M.Sc. III Sem
	MAT9113T	General Relativity and Cosmology	L	T	-	90	5+1	6	20	80	100	---
	MAT9114T	Advanced Numerical Analysis	L	T	-	90	5+1	6	20	80	100	---
	MAT9115T	Integral Equations	L	T	-	90	5+1	6	20	80	100	If opted IT as DSE in M.Sc. III Sem

OT-I: Optimization Techniques-I MTS-I: Mathematical Theory of Statistics-I

DM-I: Discrete Mathematics-I IT: Integral Transform

M. Sc./M.A. MATHEMATICS SEMESTER - IV, 2024-25

Code of the Course : **MAT9002T**

Title of the Course : **FUNCTIONAL ANALYSIS**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Centric Compulsory (DCC)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject and the knowledge of vector space.

Learning Objective :

The objective of the course is to strong foundation in functional analysis, focusing on spaces (Banach space, Hilbert space), operators, fundamental theorem and applications.

Learning Outcomes:

After completion of this course, student will be able to

- Study of Normed linear space, Banach space and their applications.
- Understand the various important theorems.
- Understand inner product space and Hilbert space with various important law.
- Study orthonormal basis and sets.
- Study of various operators and spectral theorem.

Syllabus:

UNIT I

Normed linear spaces, Banach spaces, Riesz Lemma, Quotient space of normed liner space and its completeness with examples, Continuous linear transformations. (20 Lecture hours)

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. (16 Lecture hours)

UNIT III

Inner product spaces, Hilbert spaces, Schwartz's inequality, Bessel's inequality, orthogonality, Parallelogram law, Polarization identity with examples, Pythagoras theorem, orthonormal sets. (20 Lecture hours)

UNIT IV

Orthonormal basis and Parseval's identity, Complete Orthonormal sets, Gram Schmidt Orthogonalization process with examples, conjugate space H*, Perpendicular projection, invariance and reducibility. (18 Lecture hours)

UNIT V

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

Finite dimensional spectral theory, spectral theorem. (16 Lecture hours)

Books recommended:

1. Joseph Muscat : Functional Analysis
2. Pundir & Pundir : Integration Theory & functional Analysis
3. H.K. Pathak : Functional Analysis with Application
4. Jain & Sharma : Functional Analysis
5. Charles Swartz : An Introduction to Functional Analysis

M. Sc./M.A. MATHEMATICS SEMESTER - IV, 2024-25

Code of the Course : **MAT9109P**

Title of the Course : **COMPUTER PROGRAMMING OF NUMERICAL METHODS (Practical Oriented)**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Specific Elective (DSE)**

Delivery type of the Course : **Lecture** (20 Hours for content delivery and 10 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment) and **Practical** (80 Hours for hands on algorithm, flowcharts and coding of program, execution, result, 40 Hours for lab practices)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

C programming language is a numerical computing language that is used to develop and create programs to handle mathematical calculations in science, engineering and other fields.

Learning Outcomes:

After completion of this course, student will be able to

- Normalized floating numbers, perform operations of normalized floating number and to write & run C program on Normalized floating Number.
- Write and run programs to find roots of Algebraic and Transcendental equations.
- Write and run programs to solve numerical solutions of simultaneous linear equations.
- Write and run programs of Differentiation and integration.
- Write and run Programs of numerical solutions of Differential equation.

Syllabus:

UNIT I

Algorithm, Flowchart and Computer Programming in C on: Arithmetic operations with normalized floating-point numbers, Number system conversions.

(6 Lecture + 24 practical hours)

UNIT II

Algorithm, Flowchart and Computer Programming in C for numerical solution of algebraic and transcendental equations: Bisection, False position, Newton-Raphson, secant method.

(6 Lecture + 24 practical hours)

UNIT III

Algorithm, Flowchart and Computer Programming in C for numerical solution of simultaneous linear equation: Gauss Elimination method, Gauss-Seidel method.

(6 Lecture + 24 practical hours)

UNIT IV

Algorithm, Flowchart and Computer Programming in C for Differentiation & Integration: Simpson's rule, Trapezoidal rule, Gaussian Quadrature formula.

(6 Lecture + 24 practical hours)

UNIT V

Algorithm, Flowchart and Computer Programming in C for Numerical Solutions of differential equations: Eulers method, Taylor's series 4^{th} order method, Runge Kutta 4^{th} order method, Predictor-corrector method. (6 Lecture + 24 practical hours)

Books Recommended:

1. The C-Programming Language: B.W. Kernyharn & D.M. Ritche - PHI Ltd.
2. Computer Programming in C : Y Kanetkar-B.P.B. Publication, New Delhi.
3. Programming in ANSI C: E Balagurusamy.
4. Computer oriented Numerical Methods: V. Rajaraman PHI Ltd.
5. Compute Based Numerical Statistical Technique: Sanjeev Kumar & V. S. Verma, Ram Prasad Publications.

Note: Only those candidates are eligible who have opted C-programming as DSE in M.Sc. III semester

EoS: At the end of semester evaluation of the student for this paper based on making algorithm, flowchart, coding of program and execution on computer with result verification.

M. Sc./M.A. MATHEMATICS SEMESTER - IV, 2024-25

Code of the Course : **MAT9110T**

Title of the Course : **OPTIMIZATION TECHNIQUES-II**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Specific Elective (DSE)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject and knowledge of simplex method.

Learning Objective :

The objective of this course is to enhanced the knowledge of students with advanced concepts and techniques of Non-linear programming problem and dynamic programming problem along with real life applications.

Learning Outcomes:

After completion of this course, student will be able to

- Explain the fundamental knowledge of non-linear and dynamic programming problems.
- Use of classical optimization techniques.
- Describes the basics of different evolutionary algorithms.
- Formulate specialized programming problems, namely PERT and CPM problems and describe theoretical workings of the solution.
- Understand the different methods of optimization and suggest a technique for a specific problem.

Syllabus:

UNIT I

Classical Optimization Techniques: Unconstrained problems of Maxima-Minima, global maxima and minima, Local maxima and minima, method of Lagrange's Multipliers (equality constraints). (16 Lecture hours)

UNIT II

Constraints in the form of inequalities: Kuhn Tucker Theorem, Kuhn-Tucker necessary and sufficient conditions, saddle point. (16 Lecture hours)

UNIT III

Quadratic programming problem: Wolfe's algorithms and Beale's algorithm, Fractional Programming problem. (18 Lecture hours)

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.

(21 Lecture hours)

UNIT V

Project Management by PERT and CPM, Time-Cost Trade-Off, Resource leveling.

(19 Lecture hours)

Books Recommended:

1. Kanti Swaroop, Man 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
6. J.K. Sharma : Operation Research

Note: Only those candidates are eligible who have opted Optimization Techniques-I as DSE in M.Sc. III semester

M. Sc./M.A. MATHEMATICS SEMESTER - IV, 2024-25

Code of the Course : **MAT9111T**

Title of the Course : **MATHEMATICAL THEORY OF STATISTICS-II**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Specific Elective (DSE)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

The objective of this course is to enhanced the knowledge of students with basic concepts of estimation theory and testing hypothesis with real life applications.

Learning Outcomes:

After completion of this course, student will be able to

- Understand basic concepts of estimation, criterion of good estimators, consistency, efficiency, sufficiency and unbiasedness.
- Discuss testing of hypothesis, error Neyman Pearson Lemma and its applications.
- Describe Chi square with properties and applications.
- t & F distribution with properties and applications.
- Discuss the method of maximum Likelihood estimator and its properties and find M.L.E. for binomial, Poisson and Normal populations.

Syllabus:

UNIT I

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

Interval Estimation: Confidence limit, Confidence interval. (20 Lecture hours)

UNIT II

Elements of testing of hypothesis: Two kinds of error in testing of hypothesis. Critical region, level of significance, power of test, most powerful test, uniformly most powerful test. Nayman-Pearson Lemma. (19 Lecture hours)

UNIT III

Chi-square distribution with derivations, properties and applications. (18 Lecture hours)

UNIT IV

t and F sampling distribution with derivations, properties and applications. Large sample theory and applications. Determination of sample size. (18 Lecture hours)

UNIT V

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. (15 Lecture hours)

Books recommended:

1. Gupta and Kapoor : Fundamentals of Mathematical Statistics.
2. Kapur and Saxena : Mathematical Statistics.
3. Goon and Others : Outline of Statistical Theory, Vol. I, II.

Note: Only those candidates are eligible who have opted Mathematical Theory of Statistics-I as DSE in M.Sc. III semester

M. Sc./M.A. MATHEMATICS SEMESTER - IV, 2024-25

Code of the Course : **MAT9112T**

Title of the Course : **DISCRETE MATHEMATICS-II**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Specific Elective (DSE)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

The objective of this course is to introduce basic as well as advanced concepts of Graph Theory (a widely used subject of Discrete Mathematics with broad ranging applications in many fields including the Internet) and also introduce other subjects of Discrete Mathematics such as Finite State Machines, Grammars and Languages.

Learning Outcomes:

After completion of this course, student will be able to

- Understand basic concept of Graph Theory, introducing planar graphs.
- Understand trees (an important class of graphs, planar graphs, Bipartite graphs, Spanning trees and their properties.
- Discuss of Euler's Theorem related to Euler graphs, Directed graphs and certain other advanced concepts of trees.
- Understand Finite state machines and related concepts and their various kinds.
- Learn Grammar, Languages and their construction derivations etc. with their various type and certain advanced concepts.

Syllabus:

UNIT I

Graph theory: Definition of (Undirected) graphs, Paths, Circuits, Cycles and Sub graphs, Induced Sub graphs, Degree of vertex, Connectivity, Planer graphs and their properties. Introduction to graph labeling: Definition of Harmonious, felicitous, sequential graceful Magic and Antimagic labeling with simple example. (18 Lecture hours)

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.

(18 Lecture hours)

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. (18 Lecture hours)

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. (18 Lecture hours)

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. (18 Lecture hours)

Books recommended:

1. J.P. Tremblay & R. Manohar : Discrete Mathematical structure with applications to computer science.
2. J.L. Gerstling : Mathematical Structures for Computer Science, (3rd edition).
3. N. Arsing Deo : Graph theory with applications to Engineering and Computer Science.
4. K.D. Joshi : Foundation of Discrete Mathematics
5. S. Wiitala : Discrete mathematics – A Unified Approach
6. C. L. Liu : Elements of Discrete Mathematics.
7. Gokhroo & Gokhroo : Advanced Discrete Mathematics (Navkar Publications)

Note: Only those candidates are eligible who have opted Discrete Mathematical Structure-I as DSE in M.Sc. III semester.

M. Sc./M.A. MATHEMATICS SEMESTER - IV, 2024-25

Code of the Course : **MAT9113T**

Title of the Course : **GENERAL RELATIVITY AND COSMOLOGY**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Specific Elective (DSE)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

The objective of this course is to enhanced the knowledge of students with basic concepts of general relativity which is essential foundation for standard models of cosmology.

Learning Outcomes:

After completion of this course, student will be able to

- Understand the principle of covariance equivalence, Mach's principle and Newton's potential derive Einstein field equations.
- Disuses Schwarzschild extensor solution singularise and related problems. Derive energy momentum tensor for perfect fluid.
- Discuss planetary orbit, Three crucial tests of general relativity, Radar echo delay and study Schwarzschild interior solution.
- Understand principle of cosmology, Einstein and De-Sitter Universes and their derivations with properties and their comparison.
- Understand the concept of non-static cosmological models, Hubble's law derivation of Robertson-walker metric, its geometric feature and expressions for FRW model.

Syllabus:

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. (16 Lecture hours)

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. (19 Lecture hours)

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. (19 Lecture hours)

UNIT IV

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

(16 Lecture hours)

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 up to non-zero pressure. (20 Lecture hours)

Books Recommended:

1. P.G. Bergman : Introduction to Theory of Relativity
2. J.L. Synge : Relativity, the General Theory
3. J.V. Narlikar : Lecture on general Relativity
4. Roy & Bali : Theory of Relativity
5. B.F. Shutz : A first course in General Relativity

M. Sc./M.A. MATHEMATICS SEMESTER - IV, 2024-25

Code of the Course : **MAT9114T**

Title of the Course : **ADVANCED NUMERICAL ANALYSIS**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Specific Elective (DSE)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

Enhance the fundamental concept of advanced numerical methods and its applications.

Learning Outcomes:

After completion of this course, student will be able to Understand

- Solution of linear boundary value problems of ordinary differential equations by finite difference methods.
- Solution of Non-linear boundary value problems by finite difference scheme.
  Rate of Convergence of iterative methods.
- Methods to solve system of Simultaneous equations (Linear).

Syllabus:

UNIT I

Difference method for solving linear boundary value problem of ODE's: Finite difference method and shooting method.

Finite Difference scheme for non-linear boundary value problems of the type $y' = f(x, y)$, $y'' = (x, y, y')$ and $y^{iii} = f(x, y, y', y'')$, $y^{iv} = f(x, y, y', y'' y''')$ (18 Lecture hours)

UNIT II

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. (18 Lecture hours)

UNIT III

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, solution of transcendental and polynomial equations by using, Newton Raphson method, Chebyshev method and Muller method. (18 Lecture hours)

UNIT IV

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. (18 Lecture hours)

UNIT V

Gauss-Jordan Cholesky, Partition method of Successive approximation, Conjugate Gradient, Iterative methods (Jacobi's and Gauss-Seidel), Relaxation methods. (18 Lecture hours)

References:

1. C. E. Froberg : Introduction to Numerical Analysis
2. M. K. Jain, S. R. K. Iyenger and R.K. Jain : Numerical methods: Problems & solutions
3. H.C. Saxena : Numerical Analysis (S. Chand)
4. Goyal, Mittal : Numerical Analysis
5. Rao V. Dukkipati : Numerical Methods (New Age)
6. Jain, M. K : Numerical solutions of differential equation

M. Sc./M.A. MATHEMATICS SEMESTER - IV, 2024-25

Code of the Course : **MAT9115T**

Title of the Course : **INTEGRAL EQUATIONS**

Level of the Course : **NHEQF Level 6.5**

Credit of the Course : **6**

Type of the Course : **Discipline Specific Elective (DSE)**

Delivery type of the Course : **Lecture** (60 Hours for content delivery) and **Tutorial** (30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject.

Learning Objective :

This course is aimed to provide introduction about various type of linear integral equations. Students will be equipped with the understanding the concept of solution of these integral equations by various techniques.

Learning Outcomes:

After complication of this course, student will be able to

- Identify the type of linear integral equations.
- Find their solutions by various techniques.

Syllabus:

UNIT I

Linear Integral equations: Definition and classification, Conversion of initial and boundary value problem to an integral equation, Eigen values and Eigen functions. (18 Lecture hours)

UNIT II

Solution of Fredholm integral equations of second kind with separable kernels, Reduction to a system of Algebraic equations. (15 Lecture hours)

UNIT III

Solution of Fredholm and Volterra integral equations of second kind by method successive substitution, successive approximations, iterative method, Neumann series, Resolvent Kernel and its applications. (21 Lecture hours)

UNIT IV

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. (16 Lecture hours)

UNIT V

Hilbert-Schmidt theorem, Solution of Fredholm integral equations of second kind with symmetric Kernels, Classical–Fredholm theory, Fredholm theorems, Resolvent kernel and solution of Volterra integral equations with convolution type kernels by using Laplace transform. (20 Lecture hours)

Books Recommended:

1. Ranville, E.D. : Laplace and Fourier Transforms.
2. Sneddon, I.N. : The use of Integral Transforms.
3. Swarup S. & Singh S.R. : Integral Equations.
4. Lowit : Linear Integral Equations.
5. Goyal S.P. & Goyal A.K. : Linear Integral Equations.