MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

मोहनलाल सुखाडिया विश्वविद्यालय, उदयपुर

DEPARTMENT OF MATHEMATICS AND STATISTICS

SYLLABUS

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

FACULTY: SCIENCE

SUBJECT: MATHEMATICS

Programme Specific Objective:

The main objective of the M. Sc. program is to enable students:

- To understand the fundamental concepts of pure and applied Mathematics.
- To develop Mathematical aptitude and nurture students interest in problem solving aptitude.
- To impart qualitative education through effective teaching-learning processes by interactive teaching and latest software tools.
- To inspire youth for research in Mathematical sciences.
- To train Computational Scientists who can work on real life challenging problems.

Programme Specific Outcomes:

After completion of program, students will be able to:

- Model the real-world problems in to Mathematical equations and draw the inferences by finding appropriate solution.
- Apply the knowledge of Mathematical concepts in interdisciplinary fields.
- Pursue research in challenging areas of pure/applied Mathematics.
- Employ confidently the knowledge of Mathematical software and tools for treating the complex Mathematical problems and scientific investigations.
- Qualify national level tests like NET/GATE etc.
- Communicate effectively and explore ideas of Mathematics for propagation of knowledge and popularization of Mathematics in the society.

Revised & Reviewed

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.
			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, students 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, students 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 (Lebesgue), 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_δ sets. (18 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. (17 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. (18 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. (19 Lecture hours)

Books Recommended:

1. Pal R. Halmos : Measure Theory, D. Van Nostrand Company, INC, Univ. of Chicago.
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 of differential equation to solve problem.

Learning Outcomes:

After completion of this course, students will be able to

- Understand concept of partial differential equations and 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, students 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 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

Revised & Reviewed

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 obtained by the students of other Departments.												
GEC	MAT8100T	Dynamics of Rigid Bodies	L	T	-	90	5+1	6	20	80	100	---
	MAT8101T	Matrix Algebra	L	-	-	60	4	4	20	80	100	For students other than Mathematics & Statistics
	MAT8102T	Number Theory	L	T	-	90	5+1	6	20	80	100	---
	MAT8103T	Counting Techniques	L	-	-	60	4	4	20	80	100	For students other than Mathematics & Statistics

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, students 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. (17 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. (19 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, students 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 related simple properties. (20 Lecture hours)

UNIT II

Legendre's polynomial Functions: Legendre's and associated Legendre's differential equations, Generating function, Recurrence relations, Simple properties of Legendre's functions of first and second kind and the associated Legendre's function of integral order.

(18 Lecture hours)

UNIT III

Bessel functions: Solution of Bessel Differential Equation, Generating function, Integral representation of Bessel function, Recurrence relations, Addition formula, Orthogonality and other properties of Bessel functions. (16 Lecture hours)

UNIT IV

Classical Orthogonal Polynomials, Generating functions, Recurrence relations, Rodrigues formula and other properties associated with the Laguerre and Hermite Polynomials, Rodrigues formula and orthogonality of Legendre's 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, students 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 of inertia and Radius of gyration, Moments of inertia about the coordinate axes, Moments of inertia in simple cases, Moments of inertia about any line in space, Product of inertia, Product of inertia in simple cases, Theorem of Parallel axes, Momental ellipsoid at any point of the body, Momental ellipse, Equimomental system, Principal axes of a body at any point of a given line and related problems. (20 Lecture hours)

UNIT II

D'Alembert's principle, General equation of motion, Motion about fixed axes for Finite forces, Compound Pendulum, Reactions of the axis of rotation, Impulsive forces and Centre of Percussion. (18 Lecture hours)

UNIT III

Equation of Motion in two dimensions under finite forces, Kinetic energy of a rigid body in two-dimensional Motion, Moment of Momentum, Sliding and Rolling friction, Impulsive motion in two dimensions, Change in K.E. due to the action of impulse. (18 Lecture hours)

UNIT IV

Principles of conservation of momentum (Linear and Angular), Principles of Work and energy, Conservation of Forces, Conservation of Energy under the action of conservative of Forces, K.E. as the sum of kinetic energies due to Translation and Rotation.

(18 Lecture hours)

UNIT V

Lagrange's equations, Lagrange's function, Lagrange's equations for non-holonomic systems, Reduction of the principle of conservation of energy from the Lagrange's equations, Lagrange's equations under impulsive forces. (16 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

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, Students having Mathematics or Statistics as one the core subjects in graduation can't offer this paper.

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, students 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

Matrices: 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

Determinants: Evolutions by expanding of row or columns, Sarrus' diagram, Elementary properties of determinants, Cramer's rule, Determinant of special kinds. (11 Lecture hours)

UNIT III

Cofactor of an element of a determinant, 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.

(12 Lecture hours)

UNIT V

Characteristic polynomial, Characteristic equation, Characteristic roots, Characteristic Matrix, Eigen values and Eigen vector of matrix, Properties of Eigen values and Eigen Vectors, Cayley Hamilton Theorem. (12 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

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

Code of the Course : **MAT8102T**

Title of the Course : **NUMBER THEORY**

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 Abstract Algebra.

Objectives of the Course :

The course aims to introduce and illustrate different method of proof in the context of elementary number theory and will apply some basic techniques of number theory to cryptography.

Course Learning Outcomes:

After completion of this course, students will be able to

- Develop a deeper conceptual understanding of the theoretical basis of Number Theory.
- Communicate number theoretic techniques Mathematical audience.
- Familiarize with Algebraic number fields and roots of unity.
- Collect and use numerical data to form conjectures about the integers.

Syllabus:

UNIT I

Fraction and their properties, Finite continued fractions, Convergent to a continued fraction, Continued fractions with positive quotients, Simple continued fractions, The representation of an irreducible rational fraction by a simple continued fraction. (18 Lecture hours)

UNIT II

Uniqueness of a continued fraction Periodic continued fraction, Continued fraction algorithm and Euclid's algorithm, Difference between the fraction and its convergent, Infinite simple continued fractions, The representation of an irrational number by an infinite continued fraction, Pell's equation. (18 Lecture hours)

UNIT III

Algebraic numbers and integers, The rational integers, Gaussian integers and integers of k(p), Euclid's algorithm, Application of Euclid's algorithm to the fundamental theorem in k(1), Properties of the Gaussian integers. (18 Lecture hours)

UNIT IV

Algebraic number fields and their rings of integers, Calculations for quadratic and cubic cases, Localization, Galois extension, Dedekind rings, discrete valuation rings completion, Unramified and ramified extensions. (18 Lecture hours)

UNIT V

Real Euclidean fields, General remarks on the arithmetic of quadratic fields, Ideals in a quadratic field, Different discriminates, cyclotomies fields, Roots of unity. (18 Lecture hours)

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, Willey eastern India Ltd.
3. Lang, S. : Algebraic Number theory, GTM Vol. 110, Springer-Verlag 194.

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

Code of the Course : **MAT8103T**

Title of the Course : **COUNTING TECHNIQUES**

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, Students having Mathematics or Statistics as one the core subjects in graduation can't offer this paper.

Learning Objective :

The aim of the course is studying various techniques of counting and connect with the real word problems.

Learning Outcomes:

After completion of this course, students will be able to

- Understand basic concept of set theory in its application.
- Study and apply concept of permutation and combination.
- Understand concept of probability and related to problems.

Syllabus:

UNIT I

Sets: Definition, Formations, Various type of sets, Index set, power set, Operations on sets (Union, Intersection, Difference, Symmetric difference, Compliment) and partition.

(13 Lecture hours)

UNIT II

Basic principle of Counting, Factorial notation, Permutation of n different objects, Permutation of things not all different, Restricted permutations, Circular permutations, Pigeon hole principal. (11 Lecture hours)

UNIT III

Principle of inclusion and exclusion, combination, Restricted combination, combination of things not all different, Euler – $\emptyset$ function. (12 Lecture hours)

UNIT IV

Event, Sample of event, Mutually exclusive event, Random experiment, Classical definition of probability, Addition law of probability and related problem.

(12 Lecture hours)

UNIT V

Multiplication law of probability, Conditional probability, Independent events, Probability of atleast one event, Bayes' theorem and its application. (12 Lecture hours)

Books Recommended:

1. Anjana Gupta : Discrete Mathematics, S. K. Kataria & Sons, New Delhi.
2. Mradula Garg & R. Panday : Discrete Mathematics, JPH
3. J. N. Kapur& H.C. Saxena : Mathematical Statistics, S. Chand & Co., New Delhi
4. Gokhroo & others : Mathematical Statistics

Revised & Reviewed

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			Credit	Total Credit	Internal Assessment	EoS Exam	M.M.	Remarks
			L	T	P						
DCC	MAT9007T	Topology	L	T	-	6	6	20	80	100	---
	MAT9008T	Relativity and Tensor Analysis	L	T	-	6	6	20	80	100	---
Select any one (total two) Discipline specific Elective (DSE) Courses from each DSE group of the following in III semester.											
DSE-I	MAT9104P	Computer Programming in-C	L	-	P	2+4	6	20	80	100	Students of B.Sc. (Comp. Sci.) can't opt.
	MAT9105T	Numerical Analysis	L	T	-	5+1	6	20	80	100	If N.A. not opted at UG level
	MAT9106T	Integral Transform	L	T	-	5+1	6	20	80	100	---
DSE-II	MAT9107T	Optimization Techniques-I	L	T	-	5+1	6	20	80	100	---
	MAT9108T	Discrete Mathematics-I	L	T	-	5+1	6	20	80	100	---
	MAT9109T	Mathematical Theory of Statistics-I	L	T	-	5+1	6	20	80	100	Students of B.Sc. (Statistics) can't opt
Select any one of the following Generic Elective Course (GEC) Courses (Optional) in III semester, may be obtained by the students of other Departments.											
GEC	MAT9110T	Applied Mathematics	L	-	-	4	4	20	80	100	For students of other than Mathematics & Statistics
	MAT9111T	Inventory Management	L	-	-	4	4	20	80	100	---
	MAT9112P	Mathematica	-	-	P	4	4	20	80	100	---

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

Code of the Course : **MAT9007T**

Title of the Course : **TOPOLOGY**

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 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 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, students 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. (20 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. (18 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. (20 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. (16 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.

(16 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 : **MAT9008T**

Title of the Course : **RELATIVITY AND TENSOR 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 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 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 cosmology and astrophysics.

Learning Outcomes:

After completion of this course, students will be able to

- Understand concept of special theory of relativity, Michelson-Morley experiment and Lorentz transformation.
- Study of various type of tensors with operations.
- Study and apply Geodesics, null geodesics, Ricci tensor, Bianchi identities.
- Derive Maxwell'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.

(19 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.

(18 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. (18 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. (19 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. (16 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 : **MAT9104P**

Title of the Course : **Computer Programming in C**

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 : **Demonstration & 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, Candidate who have offered computer science as an optional subject in graduation will not be permitted to offer this course.

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, students 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 model.

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. (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. (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. (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. (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.

(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.

End of Semester (EoS) Examination pattern of Practical Exam.:

Duration: 5 hours Max. Marks: 80 Min Marks: 32

The examination shall be of five hours wherein the students have to perform any two practical's based on making algorithm, flowchart, coding of program and execution on computer with result verification.

The marks distribution shall be the following:

1- Two Practical's (Formation, coding and execution): 50 Marks (25 + 25)
2- Viva Voce: 20 Marks
3- Evaluation of the record book of practical's performed in the semester: 10 Marks

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	**: 6**
Type of the Course	**: Discipline Specific Elective (DSE)**
Delivery type of the Course	**: Lecture** (60 Hours for content delivery) and 30 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject, Candidate having numerical analysis as a core paper in graduation will not be permitted to offer this course.

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, students 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. (18 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.

(18 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. (16 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. (19 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. (19 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)

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

Code of the Course : **MAT9106T**

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 : **MAT9107T**

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, students 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 : **MAT9108T**

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, students 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

Linear Programing Problem, Kinds of solution, 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 : **MAT9109T**

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, 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.

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, students 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

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

Code of the Course : **MAT9110T**

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, Students having Mathematics or Statistics as one the core subjects in graduation can't offer this paper.

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, students will be able to

- Understand the concept of 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

Functions: Definition, Types of function, Graph of standard functions.

Limit: Definition, Various methods to evaluate limits. (12 Lecture hours)

UNIT - II

Continuity: Definition, Continuous function and its properties, Related problems.

Differentiability: Differentiability at a point, Relation between continuity and differentiability.

(12 Lecture hours)

UNIT - III

Derivatives: 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, and its applications.

(12 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, and applications of integration. (11 Lecture hours)

References:

1. Serge Lang : Basic Mathematics, Springer, Addison -Wesley Publishing.
2. Alan Graham : Basic Mathematics: An Introduction: Teach Yourself, United Kingdom
3. Arihant : Handbook of Mathematics, Arihant Publications
4. Naresh Chandani : Basic Mathematics, CBH, Jaipur

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

Code of the Course : **MAT9111T**

Title of the Course : **INVENTORY MANAGEMENT**

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 **Tutorial** (20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

Graduate in any discipline.

Objectives of the Course :

The course aims to acquaint students with the general concept of inventory management, and its applications in different fields.

Course Learning Outcomes:

After completion of this course, students will be able to

- Understand key concepts of inventory management and its role in various fields.
- Determine optimal order quantity for various deterministic and probabilistic Inventory models.
- Apply and extend inventory models to analyse real world.

Syllabus:

UNIT I

Introduction to Inventory Management, Different types of costs in inventory system, Classification inventory models, The EOQ Model with and without shortage.

(12 Lecture hours)

UNIT II

Multi item EOQ models with constraints: Limitation on investment, Limitation on inventories, Limitation on floor space or storage space and examples based on them, Dynamic or Fluctuating Demand models. (11 Lecture hours)

UNIT III

Deterministic Models with Price- Breaks: Price breaks, Purchase inventory models with one, two and any number of price breaks, Dynamic order quantity system. (11 Lecture hours)

UNIT IV,

Finite replenishment rate Inventory models with and without planned shortages: Replacement policy for item whose maintenance cost increases with time and many value is constant, Replacement policy for item whose maintenance cost increases with time and many value changes, Reliability Models**.** (13 Lecture hours)

UNIT V

Probabilistic inventory models: Single period probabilistic inventory models with discrete and continuous demand, Probabilistic order level system with constant lead time, Multi-period Probabilistic order level system with constant lead time. (13 Lecture hours)

Books Recommended:

1. Hadley, G., & Whitin, T. M. : Analysis of inventory systems, Prentice-Hall, New Delhi.
2. Waters, D. : Inventory control and management, JohnWiley & Sons Ltd, West Sussex.
3. Silver, E. A., Pyke, D. F., & Peterson, R. : Inventory management and production planning and scheduling, John Wiley & Sons, New Jersey.
4. Kanti Swaroop, Man Mohan, P.K. Gupta. : Operations Research, S. Chand & Sons., New Delhi.
5. S.D. Sharma : Operations Research, Kedar Nath Ram Nath, Meerut.

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

Code of the Course : **MAT9112P**

Title of the Course : **MATHEMATICA**

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 : **Demonstration & Practical** (80 Hours for hands on algorithm, flowcharts and coding of program, execution, result, 40 Hours for lab practices)

Prerequisites :

Graduate in any discipline.

Objectives of the Course :

The objective of this course is to introduce the fundamentals of Mathematica software. Mathematica helps students by providing accurate calculations using incredible technical computing software in many areas including ODEs, Matrices, Basic Algebra, etc.

Course Learning Outcomes:

After completion of this course, students will be able to

- Understand basic principles of programming language.
- How to solve complex mathematical problems using Mathematica.

Syllabus:

PART – A:

User interface, Mathematica language and syntax, Functions manipulation, Plotting mathematical functions and data. Plotting 2D, 3D functions and manipulation, Solving algebraic equation: Root finding, Transcendental equation,

PART – B:

Solving ordinary differential equation (ODE), Solving Partial differential equation (PDE), Vectors and matrices, Limits, Integration and Differentiation, Numerical computation, Symbolic manipulation.

Books Recommended:

1.	Stephen Wolfram	:	The Mathematica Book, 5th Edition, Wolfram Media Inc.
2.	José Guillermo Sánchez León	:	Mathematica Beyond Mathematics: The Wolfram Languagein the Real World, 1st Ed., Chapman and Hall/CRC.
3.	Web links	:	NPTEL/SWAYAM/MOOCS

End of Semester (EoS) Examination pattern of Practical Exam.:

Duration: 5 hours Max. Marks: 80 Min Marks: 32

The examination shall be of five hours wherein the students have to perform any two practicals based on making coding of program, execution and solving Mathematical problems on computer with software MATHEMATICA selecting one from each part.

The marks distribution shall be the following:

1- Two Practical's (Formation, coding and execution): 50 Marks (25 + 25)
2- Viva Voce: 20 Marks
3- Evaluation of the record book of practical's performed in the semester: 10 Mark

Revised & Reviewed

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			Credit	Total Credit	Internal Assessment	EoS Exam	M.M.	Remarks
			L	T	P						
DCC	MAT9009T	Functional Analysis	L	T	-	5+1	6	20	80	100	---
Select any one (total three) Discipline specific Elective (DSE) Courses from each DSE group of the following in IV semester.											
DSE-I	MAT9113P	Computer Programming of Numerical Methods	L	-	P	2+4	6	20	80	100	If opted C- Prog. as DSE in M.Sc. III Sem
	MAT9114T	Advanced Numerical Analysis	L	T	-	5+1	6	20	80	100	---
	MAT9115T	Integral Equations	L	T	-	5+1	6	20	80	100	If opted IT as DSE in M.Sc. III Sem
DSE-II	MAT9116T	Discrete Mathematics-II	L	T	-	5+1	6	20	80	100	If opted DM-I as DSE in M.Sc. III Sem
	MAT9117T	Optimization Techniques-II	L	T	-	5+1	6	20	80	100	If opted OT-I as DSE in M.Sc. III Sem
	MAT9118T	Mathematical Theory of Statistics-II	L	T	-	5+1	6	20	80	100	If opted MTS-I as DSE in M.Sc. III Sem
DSE-III	MAT9119T	General Relativity and Cosmology	L	T	-	5+1	6	20	80	100	---
	MAT9120T	Viscus Fluid Dynamics	L	T	-	5+1	6	20	80	100	---
	MAT9121T	Advanced Differential Geometry	L	T	-	5+1	6	20	80	100	---

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 : **MAT9009T**

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, students 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 : **MAT9113P**

Title of the Course : **COMPUTER PROGRAMMING OF NUMERICAL METHODS**

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 : **Demonstration & 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 and opted C-programming as DSE in M.Sc. III semester.

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, students 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. (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.

(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.

(24 practical hours)

UNIT IV

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

(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. (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.

End of Semester (EoS) Examination pattern of Practical Exam.:

Duration: 5 hours Max. Marks: 80 Min Marks: 32

The examination shall be of five hours wherein the students have to perform any two practicals based on making algorithm, flowchart, coding of program and execution on computer with result verification.

The marks distribution shall be the following:

1- Two Practical's (Formation, coding and execution): 50 Marks (25 + 25)
2- Viva Voce: 20 Marks
3- Evaluation of the record book of practical's performed in the semester: 10 Marks

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, students 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 and opted Integral Transforms as DSE in M.Sc. III semester.

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, students 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. (17 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. (19 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.

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

Code of the Course : **MAT9116T**

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 and opted Discrete Mathematical Structure-I as DSE in M.Sc. III semester.

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, students 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)

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

Code of the Course : **MAT9117T**

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 opted Optimization Techniques-I as DSE in M.Sc. III semester.

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, students 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. (17 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.

(20 Lecture hours)

UNIT V

Project Scheduling, Network, Fulkerson's rule, Project Evaluation and Review Technique, Critical Path Method, 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

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

Code of the Course : **MAT9118T**

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 and opted Mathematical Theory of Statistics-I as DSE in M.Sc. III semester.

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, students 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. (18 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, Mean, Variance and Moment generating function.

Applications of Chi-square distribution: Test of goodness of Fit, Test of independence of Attribute, 2*2 contingency table. (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. (17 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.

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

Code of the Course : **MAT9119T**

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, students will be able to

- Understand the principle of covariance and equivalence, Mach's principle and Einstein field equations.
- Discuses Schwarzschild exterior solution with related problems, Three crucial tests of general relativity and Schwarzschild interior solution.
- Understand principle of cosmology, Einstein and de-Sitter universes.
- Understand the concept of non-static cosmological models, Hubble's law and 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 : **MAT9120T**

Title of the Course : **VISCOUS FLUID DYNAMICS**

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 fundamentals of fluid mechanics from an advanced point of view, with emphasis on the Mathematical treatment of viscosity.

Learning Outcomes:

After completion of this course, students will be able to

- Analyse stress.
- Understand the various properties of fluids and their influence on fluid motion.
- Identify and analyse various types of fluid flows.

Syllabus:

UNIT I

Viscosity, Analysis of stress, Relation between stress and rate of strain, Navier-stokes equations and equation of energy in cartesian system of coordinates. (18 Lecture hours)

UNIT II

vorticity and circulation. Reynolds law of similarity, Physical importance of non-dimensional parameters, Reynolds number Froude numbers, Mach number, Prandtl number, Eckert number. (18 Lecture hours)

UNIT III

Some exact solutions of Navier-stokes equations-steady, Motion between parallel plates, Hagen poiseuille flow a circular pipe, Flow between coaxial circular pipes, Flow between two concentric rotating cylinders. (18 Lecture hours)

UNIT IV

Pulsatile flow between parallel surfaces, Flow in convergent and divergent channels (Jaffery-Hamel flow), Flow in the vicinity of stagnation point. (18 Lecture hours)

UNIT V

Unsteady motion of a plate, Theory of very slow motion of a sphere in viscous fluid Osceen's improvement of stoke's theory. (18 Lecture hours)

Book& Recommended:

1. G. Schfichting : Boundary Layer Theory.
2. S.I. Pai : Viscous Flow Theory, Vol.I, Laminar flow.
3. J.L. Bansal : Viscous Fluid Dynamics.
4. M. D. Raisinghania : Fluid Dynamics.
5. Shanti Swarup : Fluid Dynamics.

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

Code of the Course : **MAT9121T**

Title of the Course : **ADVANCED DIFFERENTIAL GEOMETRY**

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 basic knowledge of Differential Geometry.

Learning Objective :

The objective of the course is to give an introduction about advanced concept and terminology of Differential Geometry.

Learning Outcomes:

After completion of this course, students will be able to

- Analyze and describe geodesic structures.
- Solve the problems of digital signal processing.
- Study of electromagnetic field in relativity and cosmology.

Syllabus:

UNIT I

Radius of torsion the relation $\sigma=\pm\eta\tan\alpha$ Circle of Curvature, The osculating sphere and coordinates in terms of arc. Envelopes: Envelopes of a system of surfaces with one parameter and its relation with characteristic, The age of regression and its relation with characteristic, Envelope of a system of surfaces with two parameters and its relation with characteristic.

(20 Lecture hours)

UNIT II

Ruled Surface, Skew and Developable Surface, Tangent plane to a ruled surface, Generators of developable surface, Envelope of a plane with one parameter, Criterion for $\zeta=f(\xi,\eta)$ to represent a developable surface and properties of a generator of a skew surface, Curvature of surfaces, First and Second Fundamental form, Curvature of normal sections through elliptic, hyperbolic and parabolic points, Umbilics. Principal radii at a point of an ellipsoid.

(18 Lecture hours)

UNIT III

Curvature of an oblique section, Radius of curvature of a given section through any point of a surfacez=f(x,y), Lines of Curvature: Definition, Lines of curvature of an ellipsoid, Lines of curvature on a developable surface, Normals to a surface at points of a line of a curvature, Lines of curvature on a surface of revolution. (18 Lecture hours)

UNIT IV

Euler's theorem on lines of Curvature, Dupin's Theorem, Rodrigue's formula, Third fundamental form, Relation between three fundamental forms, Asymptotic lines, Theorems on Asymptotic lines, Curvature and Torsion of an Asymptotic line, Fundamental equations of surface theory, Parallel surfaces.

(16 Lecture hours)

UNIT V

Geodesics, General differential equation of a geodesic, Canonical equations of geodesic, Necessary and Sufficient condition for a curve u=u(t),v=v(t) to be geodesic, Geodesic on a surface of revolution, Geodesics on a conoidal surface and developable surface, Jochimsthal theorem. Geodesic curvature and Torsion of a Geodesic. (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