MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

DEPARTMENT OF MATHEMATICS AND STATISTICS

Master of Science/ Arts (M.Sc./M.A.) 2025-26

Faculty : SCIENCE Subject : MATHEMATICS

Proposed Mathematics Courses for NEP in 2-year M.Sc. Program: Semester wise types, codes, titles, Delivery type, Workload, Credits of the courses, Marks of Examination and Remarks.

Level	Semester	Course Type	Course Code	Title	Delivery Type	Total Credit	Internal Assessment	EoS Exam	M.M.	Remarks
8	I	DCC	MAT8000T	Advanced Abstract Algebra-I	L	4	20	80	100	---
			MAT8001T	Measure Theory	L	4	20	80	100	---
			MAT8002T	Differential Equations & Calculus of Variations	L	4	20	80	100	---
			MAT8003T	Differential Geometry-I	L	4	20	80	100	---
			MAT8004T	Discrete Mathematics-I	L	4	20	80	100	---
			MAT8005T	Integral Equations	L	4	20	80	100	---
8	II	DCC	MAT8006T	Advanced Abstract Algebra-II	L	4	20	80	100	---
			MAT8007T	Complex Analysis	L	4	20	80	100	---
			MAT8008T	Partial Differential Equations	L	4	20	80	100	---
			MAT8009T	Discrete Mathematics-II	L	4	20	80	100	---
			MAT8010T	Tensor Analysis	L	4	20	80	100	---
		Select any one of the following Generic Elective Course (GEC) Courses in II semester or can select from the pools of GEC of other Departments (Details available at university website), can be opt by the students of other Departments.								
		GEC	MAT8100T	Dynamics of Rigid Bodies	L	4	20	80	100	---
			MAT8101T	Differential Geometry-II	L	4	20	80	100	---
			MAT8102T	Mathematical Modeling	L	4	20	80	100	---
			MAT8103P	Mathematica	P	4	20	80	100	---

Level	Semester	Course Type	Course Code	Title	Delivery Type	Total Credit	Internal Assessment	EoS Exam	M.M.	Remarks
9	III	DCC	MAT9011T	Topology	L	4	20	80	100	---
			MAT9012T	General Theory of Relativity	L	4	20	80	100	---
		Select any one (total three) Discipline specific Elective (DSE) Courses from each DSE group of the following in III semester.								
		DSE-I	MAT9104P	Computer Programming in-C	P	4	20	80	100	Students of B.Sc. (Comp. Sci.) can't opt.
			MAT9105T	Integral Transforms	L	4	20	80	100	---
		DSE-II	MAT9106T	Advanced Numerical Analysis-I	L	4	20	80	100	---
			MAT9107T	Graph Theory-I	L	4	20	80	100	---
		DSE-III	MAT9108T	Optimization Techniques-I	L	4	20	80	100	---
			MAT9109T	Mathematical Theory of Statistics-I	L	4	20	80	100	Students of B.Sc. (Statistics.) can't opt.
		Select any one of the following Generic Elective Course (GEC) Courses in III semester or can select from the pools of GEC of other Departments (Details available at university website), can be opt by the students of other Departments.								
		GEC	MAT9110T	Inventory Management	L	4	20	80	100	---
			MAT9111T	Time Series & Index Number	L	4	20	80	100	---
			MAT9112T	Fractional Calculus & Applications	L	4	20	80	100	---
			MAT9113P	MATLAB	P	4	20	80	100	---

Level	Semester	Course Type	Course Code	Title	Delivery Type	Total Credit	Internal Assessment	EoS Exam	M.M.	Remarks
9	IV	DCC	MAT9013T	Functional Analysis	L	4	20	80	100	---
		Select any one (total five) Discipline specific Elective (DSE) Course from each DSE group of the following in IV semester.								
		DSE-I	MAT9114P	Computer Programming of Numerical Methods	P	4	20	80	100	If opted C- Prog. as DSE in M.Sc. III Sem
			MAT9115T	Multivariable Calculus	L	4	20	80	100	---
		DSE-II	MAT9116T	Advanced Numerical Analysis-II	L	4	20	80	100	---
			MAT9117T	Graph Theory-II & Cryptology	L	4	20	80	100	If opted GT-I as DSE in M.Sc. III Sem
		DSE-III	MAT9118T	Optimization Techniques-II	L	4	20	80	100	If opted OT-I as DSE in M.Sc. III Sem
			MAT9119T	Mathematical Theory of Statistics-II	L	4	20	80	100	If opted MTS-I as DSE in M.Sc. III Sem
		DSE-IV	MAT9120T	Cosmology	L	4	20	80	100	---
			MAT9121T	Advanced Number Theory	L	4	20	80	100	---
		DSE-V	MAT9122T	Viscus Fluid Dynamics	L	4	20	80	100	---
			MAT9123T	Special Functions	L	4	20	80	100	

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

DCC- Discipline Centric Compulsory Course (MAT8000T to MAT8010T, MAT9011T to MAT9013T)

DSE- Discipline Specific Core Course (MAT9104P, MAT9105T to MAT9109T, MAT9114P, MAT9115T to MAT9123T)

GEC- Generic Elective Course (MAT8100T to MAT8102T, MAT8103P, MAT9110T to MAT9112T, MAT9113P)

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M.Sc./M.A. (Two Years Degree Program)

Subject: MATHEMATICS

End of Semester (EoS) Examination pattern of Theory Papers:

As proposed in the academic council held on 26-06-2023.

Internal Examination

Duration: 1 hour Max. Marks: 20 Min Marks: 08

Internal Examination:

1. The maximum marks of each paper shall be 20. The minimum passing marks shall be 8. In all papers except "Project" it will consist of two parts: a test (10 marks) and an internal assessment (10 marks).

2. The format or pattern of the test can be decided by the department.

3. The internal assessment shall be of maximum marks 10. This part shall be based on the performance of students in the assignments/seminars/quiz etc. In case of assignments, the teacher will give at least five assignments distributed over the entire course contents. These will be submitted by the students to the teacher for evaluation and submit awards. In Laboratory/Practical papers, internal assessment shall be done by checking the record of practical or organizing a quiz during classes or may academically rationale method decided by the department.

4. In the paper entitled "Project", student will submit a report on the progress of the work done during the semester to the Head. The report will be routed through the Mentor with his grading who will also award the internal marks of the "Project".

5. Students have to independently pass in the internal examination of each paper.

6. The marks awarded in the internal examination shall not be counted to calculate and award the final score, SGPA and the CGPA.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M.Sc./M.A. (Two Years Degree Program)

Subject: MATHEMATICS

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 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 Marks

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

मोहनलाल सुखाडिया विश्वविद्यालय, उदयपुर

DEPARTMENT OF MATHEMATICS AND STATISTICS

SYLLABUS

Master of Science/ Arts (M.Sc./M.A.) 2025-26

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.

Master of Science/ Arts (M.Sc./M.A.) MATHEMATICS,

Semester- First, 2025-26

Course Type	Course Code	Title	Delivery Type	Total Credit	Total Hours	Internal Assessment	EoS Exam	M.M.
DCC	MAT8000T	Advanced Abstract Algebra-I	L	4	60	20	80	100
	MAT8001T	Measure Theory	L	4	60	20	80	100
	MAT8002T	Differential Equations & Calculus of Variations	L	4	60	20	80	100
	MAT8003T	Differential Geometry	L	4	60	20	80	100
	MAT8004T	Discrete Mathematics-I	L	4	60	20	80	100
	MAT8005T	Integral Equations	L	4	60	20	80	100

M. Sc./M.A. MATHEMATICS, SEMESTER - I, 2025-26

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 : **4**

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

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

Prerequisites :

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

Learning Objective :

The 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; Cauchy's theorem for finite abelian and non- abelian groups with applications. (12 Lecture hours)

UNIT II

Sylow's three theorem and their easy applications; Subnormal and Composition series; Jordan Holder theorem. (12 Lecture hours)

UNIT III

Solvable groups, Nilpotent groups and their applications, Fundamental theorem for finite abelian groups. (12 Lecture hours)

UNIT IV

Annihilators of subspace and its dimension in finite dimensional vector space, Invariant, Projection, Adjoins with examples. (12 Lecture hours)

UNIT V

Singular and nonsingular linear transformation, quadratic forms and Diagonalization with their applications. (12 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, 2025-26

Code of the Course : **MAT8001T**

Title of the Course : **MEASURE THEORY**

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

Credit of the Course : **4**

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

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

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject 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: Lebesgue measure of a subset of R, Algebra of measurable sets, σ-algebra, Signed measure, Measurable space. (12 Lecture hours)

UNIT II

Lebesgue 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.

Measurable functions: Different equivalent definition of a measurable function, Almost everywhere, Characteristic function, Simple function, Step function. (12 Lecture hours)

UNIT III

Algebra of Measurable functions, Measurability of a continuous function, Supremum, Infimum, Limit superior, Limit inferior and limit of a sequence of measurable functions.

Convergence of sequence of Measurable function: Convergence Pointwise, Uniform Convergence, Convergence almost everywhere (a.e.), Convergence in measure, Relevant theorems. (12 Lecture hours)

UNIT IV

F. Riesz theorem, Lebesgue theorem, D. F. Egorov theorem, E. Borel theorem.

Lebesgue Integral: Lebesgue integral of a simple function and measurable function, Lebesgue integral and Riemann integral of a bounded function defined on a closed interval.

(12 Lecture hours)

UNIT V

First Mean value theorem, Properties of Lebesgue integral, Countable additivity of the integral, The bounded convergence Theorem.

Summable function: Lebesgue integral of a non-negative function, Convergence Theorems and Lebesgue integral, Fatou's Lemma, Lebesgue monotone convergence Theorem, Lebesgue dominated convergence Theorem, Convergence in mean. (12 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, 2025-26

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	**: 4**
Type of the Course	**: Discipline Centric Compulsory (DCC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject 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 Total Differential Equation and their geometrical interpretation.
- Use the information about the Eigen value and the corresponding Eigen functions for a Boundary value problem.
- Extract information from derivative models in order to interpret reality and understand the concept of BVP's and IVP'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

Total Differential Equations: Necessary and Sufficient Condition, Geometrical interpretation, Total Differential Equations containing more than three variables. (12 Lecture hours)

UNIT II

Second order ordinary differential equations: Boundary value problems (BVP), Orthogonality, Strum-Liouville B.V.P., Lagrange's Identity, Relevant theorems. (12 Lecture hours)

UNIT III

Properties based on eigen values and eigen functions, Expansion of function in terms of eigen functions, Periodic Strum problem.

Lipschitz condition, Existence and Uniqueness theorem, Existence and uniqueness solutions of Initial Value Problem (I.V.P.). (12 Lecture hours)

UNIT IV

Calculus of variations: Functionals, Euler- Lagrange's differential equation for externals and its alternative forms, Variational problems with fixed boundaries, Variational problems involving several dependent variables. (12 Lecture hours)

UNIT V

Functionals depends on several independent variables, Functionals depends on higher order derivatives, Isoperimetric Problems, Solution of variational problems using Ritz method.

(12 Lecture hours)

Books recommended:

1. Forsyth, A.R. : A Treatise of Differential Equations
2. Gupta, A.S. : Calculus of Variations with Applications
3. Bansal & Dhami : Differential Equations Vol. II.
4. Gelfand, I.M. and Fomin, S.V. : Calculus of Variations
5. M.D. Raisinghania : Ordinary and Partial Differential Equation

M. Sc./M.A. MATHEMATICS, SEMESTER - I, 2025-26

Code of the Course	**: MAT8003T**
Title of the Course	**: DIFFERENTIAL GEOMETRY**
Level of the Course	**: NHEQF Level 6.5**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Centric Compulsory (DCC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject 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: Parallel plane sections, Nature of plane sections of a central conicoid, Central sections, Non-central section, Any section of a central conicoid, Circular sections. (12 Lecture hours)

UNIT II

The axes of a plane section of the paraboloids and the hyperboloids.

Generating Lines: Introduction, Properties of generating lines, Direction cosines of generating lines, The section of a surface by a tangent plane, Systems of generators of a central hyperboloid. (12 Lecture hours)

UNIT III

Locus of the points of intersection of perpendicular generators, The projection of generators, Generators of the hyperbolic paraboloids, Confocal Conicoid: The three confocals through a point, Elliptic coordinates. (12 Lecture hours)

UNIT IV

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. (12 Lecture hours)

UNIT V

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. (12 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 : Advanced Differential Geometry

M. Sc./M.A. MATHEMATICS, SEMESTER - I, 2025-26

Code of the Course	**: MAT8004T**
Title of the Course	**: DISCRETE MATHEMATICS – I**
Level of the Course	**: NHEQF Level 6.5**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Centric Compulsory (DCC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

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

Learning Objective :

The objective of the course is to introduction to various aspects of Discrete Mathematics giving a broad exposure. Developing the skill to apply features of Discrete Mathematics to diverse areas for problem solving.

Learning Outcomes :

After completion of this course, students will be able to

- Developing critical thinking and the ability to reason properly.
- Broaden the scope of Mathematics through learning of different areas of Discrete Mathematics.
- Develop the ability to distinguish between the approach of Discrete Mathematics compared to other Mathematics disciplines studied so far.

Syllabus:

UNIT I

Formal Logic: Brief introduction to the concept of Logic in India: *Anvikshiki* (Science of Inquiry) and *Nyay* (Rules to Reason), Proposition, Inference, Logic Operators: AND, OR, XOR, NOT, implication), Symbolic Representation, Predicate, Tautologies, Quantifiers: free, bound variables and scope of the quantifier, Validity of arguments (without using truth-tables) - using Rules of Inference and Simplification, Predicate Calculus. (12 Lecture hours)

UNIT II

Types of Relations: Reflexive, Irreflexive, Symmetric, Asymmetric, Antisymmetric, Transitive and Equivalence Relations; Partial Order Relations; Basic representation of a Relation using matrix and digraph; Basics of Congruent modulo n, Congruence Classes modulo n, Addition of Residue Classes and Multiplication of Residue Classes; Functions – basic types.

(12 Lecture hours)

UNIT III

Network Flows – Definitions and problems: Transport Network, Source, Sink, Capacity, Flows, Saturated, Slack, Maximal Flow and Minimal Cuts, Max Flow-Min Cut Theorem, One basic way to increase the value of Flows.

(12 Lecture hours)

UNIT IV

Difference Equation: Finite Differences, Backward, Forward and Central Differences, Difference Equation – order and degree, Linear Difference Equations, Formulation of Difference Equations by eliminating arbitrary constants, Solving the Equation $y_{x+1} = A\,y_x + B$ – problems only.

(12 Lecture hours)

UNIT V

Semigroups and Monoids, Homomorphism of Semigroups and Monoids, Quotient Semigroups, Free Semigroup, Sub-Semigroups, Sub-Monoids, Direct Product, Fundamental Homomorphism Theorem.

(12 Lecture hours)

Books recommended:

1. J.P. Tremblay & R. Manohar : Discrete Mathematical structure with applications to computer science.
2. J.L.Mott, A. Kandel & T.P. Baker : Discrete Mathematics for Computer Scientists & Mathematicians, Prentice Hall of India, Delhi, India.
3. Pundir & Pundir : Difference Equations, Pragati Prakashan, Meerut, India.
4. Kolman, Busby & Ross : Discrete Mathematical Structures, Pearson Education Asia, Delhi, India.
5. Dileep S. Chauhan & Rakesh Pandey : Elements of Discrete Mathematics, Jaipur Publishing house, Jaipur, India.
6. Iyengar, Chandrasekaran, Venkatesh & Arunachalam : Discrete Mathematics, Vikas Publishing House, Noida, India.
7. N. Chandrasekaran & M. Umaparvathi : Discrete Mathematics, Prentice Hall of India, Delhi, India.

M. Sc./M.A. MATHEMATICS, SEMESTER - I, 2025-26

Code of the Course	**: MAT8005T**
Title of the Course	**: INTEGRAL EQUATIONS**
Level of the Course	**: NHEQF Level 6.5**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Centric Compulsory (DCC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

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

Learning Objective :

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 completion of this course, students will be able to

- Classify the types 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. (12 Lecture hours)

UNIT II

Solution of Fredholm integral equations of second kind with separable kernels, Reduction to a system of Algebraic equations. (12 Lecture hours)

UNIT III

Solution of Fredholm and Volterra integral equations of second kind by method of successive substitution, successive approximations, iterative method, Neumann series, Resolvent Kernel and its applications. (12 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. (12 Lecture hours)

UNIT V

Hilbert-Schmidt theorem, Solution of Fredholm integral equations of second kind with symmetric Kernels, Classical–Fredholm Theory: Fredholm First Theorem and calculating Resolvent kernel of Fredholm integral equation of second kind by using it. (12 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.

Master of Science/ Arts (M.Sc./M.A.) MATHEMATICS,

Semester- Second, 2025-26

Course Type	Course Code	Title	Delivery Type	Total Credit	Total Hours	Internal Assessment	EoS Exam	M.M.
DCC	MAT8006T	Advanced Abstract Algebra-II	L	4	60	20	80	100
	MAT8007T	Complex Analysis	L	4	60	20	80	100
	MAT8008T	Partial Differential Equations	L	4	60	20	80	100
	MAT8009T	Discrete Mathematics-II	L	4	60	20	80	100
	MAT8010T	Tensor Analysis	L	4	60	20	80	100
Select any one of the following Generic Elective Course (GEC) Courses in II semester or can select from the pools of GEC of other Departments (Details available at university website), can be opt by the students of other Departments.								
GEC	MAT8100T	Dynamics of Rigid Bodies	L	4	60	20	80	100
	MAT8101T	Advanced Differential Geometry	L	4	60	20	80	100
	MAT8102T	Mathematical Modelling	L	4	60	20	80	100
	MAT8103P	MATHEMATICA	P	4	120	20	80	100

M. Sc./M.A. MATHEMATICS, SEMESTER - II, 2025-26

Code of the Course	**: MAT8006T**
Title of the Course	**: ADVANCED ABSTRACT ALGEBRA-II**
Level of the Course	**: NHEQF Level 6.5**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Centric Compulsory (DCC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

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

Learning Objective :

The objective of the course 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 and of prime number, Polynomial rings, Factorization theory in Integral domain, Prime and irreducible elements, Greatest common divisor and least common multiple, Euclidean domain, Principle ideal domain and Unique Factorization domain and their related theorems. (12 Lecture hours)

UNIT II

Definition and examples of Modules, sub module, Sum and direct sum of two sub modules, Quotient Modules, R-Homomorphism, Kernel, Fundamental Theorems of Homomorphism, Three isomorphism theorems in modules. (12 Lecture hours)

UNIT III

Free, Cyclic and Finitely generated modules, Fundamental theorem on finitely generated modules over Euclidean rings, Noetherian and Artinian modules. (12 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. (12 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. (12 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, 2025-26

Code of the Course	**: MAT8007T**
Title of the Course	**: COMPLEX ANALYSIS**
Level of the Course	**: NHEQF Level 6.5**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Centric Compulsory (DCC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

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

Learning Objective :

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. (12 Lecture hours)

UNIT II

Power series as an analytic function, Radius of convergence, Circle of convergence, Conformal mappings, Mappings by elementary functions, Bilinear transformation, Fixed points, Cross-ratio, Complex integration: Curve, Jordan arc, Jordan curve, Closed curve, Opposite curve, Smooth curve, Rectifiable curve, Properties of complex line integrals.

(12 Lecture hours)

UNIT III

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, Morera's theorem, Primitives. (12 Lecture hours)

UNIT IV

Fundamental theorem of integral calculus, Cauchy's inequality, Liouville's theorem, Maximum Modulus principle, Minimum Modulus principle, Poisson's integral formula, Taylor's Series, Laurent's Series, Singularities and Zeroes of an Analytic function.

(12 Lecture hours)

UNIT V

Rouche's theorem, Schwarz's Lemma, Fundamental theorem of Algebra, Meromorphic & rational functions, Argument principle, residues, Cauchy's theorem of residues and Evaluation of definite integrals. (12 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, 2025-26

Code of the Course	**: MAT8008T**
Title of the Course	**: PARTIAL DIFFERENTIAL EQUATIONS**
Level of the Course	**: NHEQF Level 6.5**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Centric Compulsory (DCC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

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

Learning Objective :

The objective of the course is to apply the concepts and methods of Partial 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.
- Use separation of variables and Green's functions to solve BVP.
- Classify partial differential equations and transform into canonical form.

Syllabus:

UNIT I

Linear partial differential equation (LPDE): Solution of Linear partial differential equations with constant coefficients, Equations reducible to Linear equations with constant coefficients.

(12 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. (12 Lecture hours)

UNIT III

Partial differential equation (PDE): Solution of second order partial differential equations through Monge's method, Cauchy's problem. (12 Lecture hours)

UNIT IV

Solution of second order P.D.E. by the method of separation of variables, Green's function and its construction. (12 Lecture hours)

UNIT V

Solution of second order Homogenous B.V.P's through Green's function, Properties of Green's function, Dirac delta function and its important properties. (12 Lecture hours)

Books recommended:

1. Sneddon, I.N. : Element of Partial Differential Equation
2. Bansal & Dhami : Differential Equations Vol. II., JPH, Jaipur.
3. M.D. Raisinghania : Ordinary and Partial Differential Equation, S. Chand, New Delhi.
4. H. K. Pathak, J. P. Chauhan : Partial Differential Equation, Shree Krishna Sahitya Prakashan, Meerut, UP.
5. Pundir & Pundir : Advanced Partial Differential Equation, Pragati, Prakashan, Meerut.

M. Sc./M.A. MATHEMATICS, SEMESTER - II, 2025-26

Code of the Course	**: MAT8009T**
Title of the Course	**: DISCRETE MATHEMATICS – II**
Level of the Course	**: NHEQF Level 6.5**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Centric Compulsory (DCC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

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

Learning Objective :

The objective of the course is a higher course in Discrete Mathematics pertaining to concepts specific to Discrete Mathematics.

Learning Outcomes :

After completion of this course, students will be able to

- Acquiring knowledge of mathematical structures of Discrete Mathematics which can be used in various disciplines.
- Learning about concepts of Discrete Mathematics used majorly in Computer Science.
- Enhance the scope of application of mathematical ideas by learning various mathematical structures and techniques.

Syllabus:

UNIT I

Lattices : Lattices as Partially Ordered Sets and as Algebraic Systems, Sub-Lattices, Complete, Complemented, Distributive, Bounded Lattices, Direct Product and Homomorphism of Lattices. (12 Lecture hours)

UNIT II

Boolean algebras: Boolean algebras as Lattices, Various Boolean identities, Switching Network and relationship with Boolean algebra, Sub-Algebra, Atoms, Minterms, Maxterms, Join-irreducible elements, Isomorphism of Boolean algebra B_n with Power Set algebra.

(12 Lecture hours)

UNIT III

Boolean expressions, Canonical Forms – Conjunctive Normal Form (CNF) and Disjunctive Normal Form (DNF), Application of Boolean algebra to Switching theory and Logic Gates (AND, OR, NOT), Karnaugh-Map method for simplification. (12 Lecture hours)

UNIT IV

Introductory Computability Theory – Finite State Machines and Transition Tables and Transition Diagrams, Equivalent Machines (finding Partitions), Simplifying machines, Finite State Automation – Deterministic and Non-Deterministic, Acceptor. (12 Lecture hours)

UNIT V

Phrase Structure Grammar, Derivations, Language generated by a grammar, Types of Grammars – Regular, Context- Free and Context-Sensitive Grammar, Languages recognized by Finite State Automatons, Regular Sets, Regular Expressions, Pumping Lemma, Kleene's Theorem (statement only). (12 Lecture hours)

Books recommended:

1. J.P. Tremblay & R. Manohar : Discrete Mathematical structure with applications to computer science.
2. Chandrasekaran & Umaparvathi : Discrete Mathematics, Prentice Hall of India, Delhi, India.
3. Anjana Gupta : Discrete Mathematics, S. K. Kataria & Sons, Delhi, India.
4. Kenneth Rosen : Discrete Mathematics and Its Applications, Tata McGraw Hill Publishing, Delhi, India.
5. Dileep S. Chauhan & Rakesh Pandey : Elements of Discrete Mathematics, Jaipur Publishing house, Jaipur, India.
6. Hari Kishan & Shiv Raj Pundir : Discrete Mathematics, Pragati Prakashan, Meerut, India.
7. Gokhroo & Gokhroo : Advanced Discrete Mathematics, Navkar Publications, Ajmer, Raj.

M. Sc./M.A. MATHEMATICS, SEMESTER - II, 2025-26

Code of the Course	**: MAT8010T**
Title of the Course	**: TENSOR ANALYSIS**
Level of the Course	**: NHEQF Level 6.5**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Centric Compulsory (DCC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

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

Learning Objective :

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

Learning Outcomes :

After completion of this course, students will be able to

- 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

Tensors; Transformation of coordinates, Contravariant and covariant vectors, second order tensors, Higher order tensors. Addition, subtraction and multiplication of tensors, Contraction, Quotient Law, symmetric and skew symmetric tensors: Conjugate symmetric tensors of the second order, Fundamental tensor, Associated tensors. (12 Lecture hours)

UNIT II

Christoffel symbols, Transformation law of Christoffel symbols, Covariant differentiation of vectors and tensors. (12 Lecture hours)

UNIT III

Geodesics, Null Geodesics, Tensor form of gradient, divergence, Laplacian and curl, Intrinsic derivative, Riemannian and Normal Coordinates, Gaussian Coordinates, Parallel transport, Geodesics are auto parallel curves, Parallel propagation. (12 Lecture hours)

UNIT IV

Riemannian curvature tensor, Symmetric properties of R^{l}_{ijk}, Covariant curvature tensor R_{hijk}, Number of independent components of R_{hijk} in a V_n, Ricci tensor, Bianchi identities, Conformal Curvature tensor, Condition for flat space. (12 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. (12 Lecture hours)

Books Recommended:

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

Generic Elective Courses (GEC)

Select any one of the following GEC in II semester or can select from the pools of GEC of other Departments (Details available at university website), can be opt by the students of other Departments.

Course Type	Course Code	Title	Delivery Type	Total Credit	Total Hours	Internal Assessment	EoS Exam	M.M.
GEC	MAT8100T	Dynamics of Rigid Bodies	L	4	60	20	80	100
	MAT8101T	Advanced Differential Geometry	L	4	60	20	80	100
	MAT8102T	Mathematical Modelling	L	4	60	20	80	100
	MAT8103P	MATHEMATICA	P	4	120	20	80	100

M. Sc./M.A. MATHEMATICS, SEMESTER - II, 2025-26

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	**: 4**
Type of the Course	**: Generic Elective Course (GEC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with 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.

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. (12 Lecture hours)

UNIT II

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. (12 Lecture hours)

UNIT III

D'Alembert's principle, General equation of motion, Motion about fixed axes for Finite forces, Compound Pendulum, Reactions of the axis of rotation. (12 Lecture hours)

UNIT IV

Impulsive Forces and Centre of Percussion, 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. (12 Lecture hours)

UNIT V

Impulsive motion in two dimensions, Change in K.E. due to the action of impulse, 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. (12 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, 2025-26

Code of the Course	**: MAT8101T**
Title of the Course	**: ADVANCED DIFFERENTIAL GEOMETRY**
Level of the Course	**: NHEQF Level 6.5**
Credit of the Course	**: 4**
Type of the Course	**: Generic Elective Course (GEC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with 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

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. (12 Lecture hours)

UNIT II

Curvature, Torsion, Spherical indicatrices, Frenet's formulaes. 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. (12 Lecture hours)

UNIT III

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 forms. (12 Lecture hours)

UNIT IV

Curvature of normal sections through elliptic, hyperbolic and parabolic points, Umbilics. Principal radii at a point of an ellipsoid. Curvature of an oblique section, Radius of curvature of a given section through any point of a surfaces=f(x, y), Lines of Curvature: Definition, Lines of curvature of an ellipsoid. (12 Lecture hours)

UNIT V

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. Euler's theorem on lines of Curvature, Dupin's Theorem, Rodrigue's formula, Third fundamental form, Relation between three fundamental forms. (12 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

M. Sc./M.A. MATHEMATICS, SEMESTER - II, 2025-26

Code of the Course	**: MAT8102T**
Title of the Course	**: Mathematical Modelling**
Level of the Course	**: NHEQF Level 6.5**
Credit of the Course	**: 4**
Type of the Course	**: Generic Elective Course (GEC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with knowledge of Mathematics.

Learning Objective :

The objective of the course is to developing students' ability to create mathematical representations of real-world phenomena can help them tackle complex problems in various fields. Mathematical modeling is a powerful tool for problem-solving, and it's awesome that the course aims to make it a transferable skill for students to apply in future endeavors.

Learning Outcomes :

After completion of this course, students will be able to

- Use various mathematical techniques and tools to solve problems, including graphs, tables, and equations and define the mathematical characterization of the problem.
- Develop skills in using computer programming and statistical analysis to model systems.

Syllaus:

UNIT I

Mathematical modeling: need, techniques, classification and illustrative examples, limitations of mathematical models, Methodology of model building.

Systems analysis: Making assumptions, Flow diagrams. (12 Lecture hours)

UNIT II

Mathematical equations for modeling: Equations from the literature, Modeling through ordinary differential equations, Analogies from physics, Data exploration.

Solving equations: Analytically, Numerically.

Testing models: Asymptotic behaviour, Estimating model parameters. (12 Lecture hours)

UNIT III

Linear growth and decay models, non-linear growth and decay models, Compartment models, Checking model validity, verification of models, Stability analysis. (12 Lecture hours)

UNIT IV

Epidemics modeling Discrete time non-linear models: Ecology, Environment Biology through ordinary differential equation, Partial differential equation. (12 Lecture hours)

UNIT IV

Mathematical modeling through difference equations in population dynamics, genetics, Markov chains model, Stochastic models, Monte Carlo methods. (12 Lecture hours)

Books recommended:

1. Frank. R. Giordano, Maurice. D. Weir, William P. Fox : A first course in Mathematical Modelling, Vikash Publishing House, UK.
2. Kapur J. N. : Mathematical Modelling, Wiley Eastern Limited, New Delhi.
3. Murthy D. N. P., Page N. W. and Rodin E. Y. : Mathematical Modelling: A Tool for Problem Solving in Engineering, Physics, Biological and Social Sciences, Pergamon Press.
4. M. M. Meerscheart : Mathematical Modeling, Academic Press.
5. Law A. M. and Kelton W. D. : Simulation Modeling and Analysis, McGraw-Hill.
6. R. P. Maurya : Mathematical Modelling, Navkar, Ajmer

M. Sc./M.A. MATHEMATICS, SEMESTER - II, 2025-26

Code of the Course	**: MAT8103P**
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 and Basic computer skills to download the required files and programmes needed for the course.

Learning Objective :

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.

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

Master of Science/ Arts (M.Sc./M.A.) MATHEMATICS,

Semester-Third, 2026-27

Course Type	Course Code	Title	Delivery Type	Total Credit	Total Hours	Internal Assessment	EoS Exam	M.M.	Remarks
DCC	MAT9011T	Topology	L	4	60	20	80	100	---
	MAT9012T	General theory of Relativity	L	4	60	20	80	100	---
Select any one (total three) Discipline specific Elective (DSE) Courses from each DSE group of the following in III semester.									
DSE-I	MAT9104P	Computer Programming in C	P	4	120	20	80	100	Students of B.Sc. (Comp. Sci.) can't opt.
	MAT9105T	Integral Transforms	L	4	60	20	80	100	---
DSE-II	MAT9106T	Advanced Numerical Analysis -I	L	4	60	20	80	100	---
	MAT9107T	Graph Theory - 1	L	4	60	20	80	100	---
DSE-III	MAT9108T	Optimization Techniques-I	L	4	60	20	80	100	---
	MAT9109T	Mathematical Theory of Statistics-I	L	4	60	20	80	100	Students of B.Sc. (Statistics) can't opt
Select any one of the following Generic Elective Course (GEC) Courses in III semester or can select from the pools of GEC of other Departments (Details available at university website), can be opt by the students of other Departments.									
GEC	MAT9110T	Inventory Management	L	4	60	20	80	100	---
	MAT9111T	Time Series & Index Number	L	4	60	20	80	100	---
	MAT9112T	Fractional Calculus & Applications	L	4	60	20	80	100	---
	MAT9113P	MATLAB	P	4	120	20	80	100	---

M. Sc./M.A. MATHEMATICS, SEMESTER - III, 2026-27

Code of the Course	**: MAT9011T**
Title of the Course	**: TOPOLOGY**
Level of the Course	**: NHEQF Level 7**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Centric Compulsory (DCC)**
Delivery type of the Course	**: Lecture (40 Hours for content delivery and** 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)
Prerequisites	:

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

Learning Objective :

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

Learning Outcomes :

After completion of this course, 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, limit point, continuous mappings, Convergence of a sequence, Cauchy Sequence, Uniform and Pointwise convergence, Complete metric space, compact spaces and compact sets, Baire's category theorem. (12 Lecture hours)

UNIT II

Topological Spaces: Definition of Topology, T-open sets, weaker and stronger topology, 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. (12 Lecture hours)

UNIT III

Separation Axioms: T_0, T_1, T_2- space, separation axioms, normal spaces, Regular spaces, completely regular space, tychonoff space, Housdorff space.

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

UNIT IV

Connectedness: Separated Sets, Connectedness and continuity, components of a space, product of connected topological spaces, Locally connected Spaces. (12 Lecture hours)

UNIT V

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

(12 Lecture hours)

Books recommended:

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

M. Sc./M.A. MATHEMATICS, SEMESTER - III, 2026-27

Code of the Course	**: MAT9012T**
Title of the Course	**: GENERAL THEORY OF RELATIVITY**
Level of the Course	**: NHEQF Level 7**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Centric Compulsory (DCC)**
Delivery type of the Course	**: Lecture (40 Hours for content delivery and** 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

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

Learning Objective :

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

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.
- Understand the Principle of covariance and equivalence, Mach's principle and Einstein field equations.
- Discuss Schwarzschild exterior solution with related problems, three crucial tests of general relativity and Schwarzschild interior solution.

Syllabus:

UNIT I

Michelson-Morley experiment, Postulates of special theory of Relativity, Lorentz transformations, Consequence of Lorentz transformations (Lorentz-Fitzgerald contraction Formula, Time Dilation), Relativistic Transformation Formula for velocities, Transformation for the Lorentz Contraction Factor. (12 Lecture hours)

UNIT II

Variation of mass with velocity, Mass-Energy formula, Transformation formulas for Mass, Transformation formulas for momentum and energy, Minkowski's 4-dimensional continuum space, Space like and time like intervals, Principle of covariance, Principle of equivalence, Mach- Principle, Geodesic postulates. (12 Lecture hours)

UNIT III

Newton's Potential, Newtonian approximation of relativistic equation of motion, Einstein field equations with derivation and its Newtonian approximation, Clock paradox, Schwarzschild exterior solution for empty space, Singularities and related problems, Isotropic form of Schwarzschild line element. (12 Lecture hours)

UNIT IV

Planetary orbit, Three crucial tests, Advance of Perihelion of planets, Gravitational Deflection of light ray, Red Shift in the spectral lines, Radar echo delay. (12 Lecture hours)

UNIT V

Analogous to Kepler's law, Schwarzschild interior solution, Boundary Conditions, Energy momentum tensor and its expression for perfect fluid. (12 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

Discipline specific Elective (DSE) Courses

Select any one (total three) paper of DSE Course from each DSE group of the following in III semester.

Course Type	Course Code	Title	Delivery Type	Total Credit	Total Hours	Internal Assessment	EoS Exam	M.M.	Remarks
DSE-I	MAT9104P	Computer Programming in C	P	4	120	20	80	100	Students of B.Sc. (Comp. Sci.) can't opt.
	MAT9105T	Integral Transforms	L	4	60	20	80	100	---
DSE-II	MAT9106T	Advanced Numerical Analysis -I	L	4	60	20	80	100	---
	MAT9107T	Graph Theory-I	L	4	60	20	80	100	---
DSE-III	MAT9108T	Optimization Techniques-I	L	4	60	20	80	100	---
	MAT9109T	Mathematical Theory of Statistics-I	L	4	60	20	80	100	Students of B.Sc. (Statistics) can't opt

M. Sc./M.A. MATHEMATICS, SEMESTER - III, 2026-27

Code of the Course : **MAT9104P**

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

Level of the Course : **NHEQF Level 7**

Credit of the Course : **4**

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:

PART – A:

Concept of Programming algorithm: Flow chart, Conversion of flow chart to language, examples of algorithms and flow charts.

Errors: Syntax error, Logical error, Runtime error.

Introduction of C Language: Input and output statements in C, Data types, Structure of C program, Built in functions and libraries in C, Elementary programs in C, Logical if statements in C: If- else, Nested if, Switch, Break, Continue, GOTO statements in C.

PART – B:

For, While and do-while loops in C, Nested loops.

Functions: Defining and accessing a function, Passing arguments to a function.

Array: introduction of array, Classification of arrays, functions with arrays.

File input/output: Create, Open, Write, Delete, Close.

Books Recommended:

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

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, 2026-27

Code of the Course	**: MAT9105T**
Title of the Course	**: INTEGRAL TRANSFORMS**
Level of the Course	**: NHEQF Level 7**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Specific Elective (DSE)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject and basic concepts of Differential Calculus and Integral Calculus.

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 these transform techniques to solve the physical problem governed by ODE and PDE.

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. (12 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. (12 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. (12 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. (12 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. (12 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, 2026-27

Code of the Course : **MAT9106T**

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

Level of the Course : **NHEQF Level 7**

Credit of the Course : **4**

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

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

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject, 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 numerical solutions of algebraic and transcendental equations.
- Solve algebraic equation numerically using direct and iterative methods.
- Understand the concept of real and complex roots of polynomials.
- Find Eigenvalues and Eigenvectors using different methods.

Syllabus:

UNIT - I

Numerical solution of Algebraic and Transcendental equations: Newton-Raphson method, Chebyshev method, Muller's method, Methods for multiple and complex roots, Acceleration of the convergence. (12 Lecture hours)

UNIT - II

Solution of Polynomial equations: Descartes Rule of Signs, Concept of Synthetic Division, Birge Vieta method, Bairstow method, Graeffe's root squaring method. (12 Lecture hours)

UNIT-III

Solution of System of Linear Algebraic equations: Direct method of determinants, LU-Decomposition method, Cholesky method, Error analysis for direct method.

(12 Lecture hours)

UNIT-IV

Partition method of successive approximation, Iteration methods: Gauss- Seidel method, Successive Over Relaxation (SOR) method, Conjugate gradient method. (12 Lecture hours)

UNIT-V

Eigenvalues and Eigenvectors: Jacobi method and Householder's method for Symmetric matrices, Rutishauser method for arbitrary matrices, Power method. (12 Lecture hours)

Books Recommended:

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. D. S. Chauhan, Paresh Vyas : Studies in Numerical Analysis, JPH, Jaipur

M. Sc./M.A. MATHEMATICS, SEMESTER - III, 2026-27

Code of the Course	**: MAT9107T**
Title of the Course	**: GRAPH THEORY-I**
Level of the Course	**: NHEQF Level 7**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Specific Elective (DSE)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

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

Learning Objective :

The objective of the course is to learning about the major field known as Graph Theory which has emerged as a subject with wide ranging applications.

Learning Outcomes :

After completion of this course, students will be able to

- Building the basics of Graph Theory.
- Learning about the major kinds of graphs such as Trees and Planar graphs and proof techniques of theorems in Graph Theory.
- Acquiring the skills to represent mathematical ideas in the pictorial form of graphs and solve problems accordingly.

Syllabus: **UNIT I**

Definitions and examples of Simple graphs and Multigraphs; Adjacency Matrix, Incidence Matrix, Distance, Eccentricity, Length of Path, Isomorphism, Operations on Graphs - Cartesian Product, Union, Intersection, Join, Ring Sum, Complement; Handshaking Lemma, Paths and Cycles in a graph; Subgraphs, Induced Subgraphs; Certain types of graphs – Complete and Complete Bipartite Graphs, Paths, Cycles, Wheels, Regular graphs with their examples; Degree of a vertex, Connected graphs, Vertex Connectivity and Edge Connectivity.

(12 Lecture hours)

UNIT II

Planar graphs, Maximal Planar graphs; Non-Planar Graphs, Kuratowski's theorem (statement only), Homeomorphism, Operations of series reduction and elementary subdivision, Euler's Theorem for Connected Planar Graphs. (12 Lecture hours)

UNIT III

Trees: Binary Trees, Binary Search Trees, Balanced and Complete n-ary Trees, Tree Traversal Algorithms (Preorder, Inorder and Postorder), Spanning Trees, Cut- Sets, Fundamental Cut-Sets and Fundamental Cycles, Minimal Spanning Trees and Kruskal's algorithm. (12 Lecture hours)

UNIT IV

Introducing Euler and Hamiltonian graphs, Euler's theorem for existence of Eulerian paths and circuits, Directed Graphs (Digraphs) – indegree and outdegree of a vertex, Handshaking dilemma, Weighted undirected graphs and Dijkstra's algorithm. (12 Lecture hours)

UNIT V

Graph Colouring: Vertex colouring, Edge colouring, Proper Colouring of Graphs.

Colouring Planar Graphs: Five Colour Theorem with proof and Four Colour Theorem for Planar Graphs (statement only), Greedy algorithms for Vertex and Edge Colouring, Chromatic Number and Chromatic Index. (12 Lecture hours)

Books recommended:

1. G. Suresh Singh : Graph Theory, PHI Learning, Eastern Economy Edition, Delhi, India.
2. C. Vasudev : Graph Theory with Applications, New Age International Publishers, India.
3. Prabhakar Gupta & Vineet Agrawal : Graph Theory, Pragati Prakashan, Meerut, India.
4. M.K. Gupta : Discrete Mathematics, Krishna's Publications, Meerut, India.
5. Dileep S. Chauhan & Rakesh Pandey : Elements of Discrete Mathematics, Jaipur Publishing house, Jaipur, India.
6. Hari Kishan & Shiv Raj Pundir : Discrete Mathematics, Pragati Prakashan, Meerut, India.
7. Gokhroo & Gokhroo : Advanced Discrete Mathematics, Navkar Publications, Ajmer, Raj.

M. Sc./M.A. MATHEMATICS, SEMESTER - III, 2026-27

Code of the Course	**: MAT9108T**
Title of the Course	**: OPTIMIZATION TECHNIQUES-I**
Level of the Course	**: NHEQF Level 7**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Specific Elective (DSE)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

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

Learning Objective :

The objective of 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, Big-M method. (12 Lecture hours)

UNIT II

Duality, Primal dual relationship, Duality and simplex method, Dual simplex method.

(12 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. (12 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. (12 Lecture hours)

UNIT V

Integer programming: Importance of integer programming problems, Gomory's cutting plane methods, Branch and bound method. (12 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, 2026-27

Code of the Course : **MAT9109T**

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

Level of the Course : **NHEQF Level 7**

Credit of the Course : **4**

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

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

Prerequisites :

- B.Sc./B.A. with Mathematics as a core subject.
- ***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. (12 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. (12 Lecture hours)

UNIT III

Binomial, Negative binomial, Poisson and Hyper Geometric distributions. (12 Lecture hours)

UNIT IV

Rectangular, Normal, Cauchy, Gamma and Beta Distributions, Elementary idea of Exponential and Laplace distributions. (12 Lecture hours)

UNIT V

Curve fitting and Principle of least squares, Scatter diagram, Linear regression and Correlation. (12 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

Generic Elective Courses (GEC)

Select any one of the following GEC in III semester or can select from the pools of GEC of other Departments (Details available at university website), can be opt by the students of other Departments.

Course Type	Course Code	Title	Delivery Type	Total Credit	Total Hours	Internal Assessment	EoS Exam	M.M.
GEC	MAT9110T	Inventory Management	L	4	60	20	80	100
	MAT9111T	Time Series & Index Number	L	4	60	20	80	100
	MAT9112T	Fractional Calculus & Applications	L	4	60	20	80	100
	MAT9113P	MATLAB	P	4	120	20	80	100

M. Sc./M.A. MATHEMATICS, SEMESTER - III, 2026-27

Code of the Course	**: MAT9110T**
Title of the Course	**: INVENTORY MANAGEMENT**
Level of the Course	**: NHEQF Level 7**
Credit of the Course	**: 4**
Type of the Course	**: Generic Elective Course (GEC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

Graduate in any discipline.

Learning Objective :

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

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.

(12 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. (12 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. (12 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. (12 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, 2026-27

Code of the Course	**: MAT9111T**
Title of the Course	**: TIME SERIES & INDEX NUMBER**
Level of the Course	**: NHEQF Level 7**
Credit of the Course	**: 4**
Type of the Course	**: Generic Elective Course (GEC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

Graduate in any discipline.

Learning Objective :

The course aims to introduce Time series and Index Number for prediction of future events.

Learning Outcomes :

After completion of this course, students will be able to

- Different components of time series and different method to obtain it.
- Construction of Index numbers types of it and requisites of an ideal index number.
- Solution of problems based on the Time series and Index number.

Syllabus:

UNIT I

Time Series: Introduction to times series data, application of time series from various fields, Components of a times series, Analysis of time series. Trend: Estimation of trend by Graphical method, method of semi averages, method of curve fitting and method of Moving Averages. (12 Lecture hours)

UNIT II

Estimation of seasonal component by method of simple averages, Ratio to Trend method, Ratio to Moving Averages and Link Relative method. Nonlinear Measurement of Seasonal Variations: Freehand method, Moving average and Parabolic trend methods.

(12 Lecture hours)

UNIT III

Index Numbers: Classification of index number, Problems involved in the construction of Index numbers, methods of constructing index numbers: Unweighted index number, Simple Aggregate method and simple Average of Relatives method. Weighted Index number: weighted Aggregative index numbers. (12 Lecture hours)

UNIT IV,

Weighted Average of Relative Index number, Quality and volume index no. Test for Perfection; Time Reversal test, Factor Reversal test and Circular test. Construction of chain index no, Conversion of chain index to fixed Base Index. Merit and Demerit of chain base method. (12 Lecture hours)

UNIT V

Requisites of an ideal index number, Uses and limitation of the index numbers, Errors in index numbers, Base shifting, splicing and deflating concepts, Consumer price index number; utility and construction of Consumer price index. Method of constructing the index. (12 Lecture hours)

Books Recommended:

1. Gupta S.C. and Kapoor, V.K. : Fundamentals of Applied Statistics, Sultan Chand & Sons, New Delhi.
2. Kapur, J.N. and Saxena, H.C. : Mathematical Statistics, S. Chand & Company Ltd., New Delhi.
3. Kendall, M.G. : Time Series, Charles Griffin.
4. Chatfield, C. : The Analysis of Time Series –An Introduction, Chapman & Hall.
5. Das, M.K. and Gupta B. : Fundamental of Statistics Vol. I & II World Press, Calcutta.
6. Mukhopadhyay, P. : Applied Statistics, 2nd ed. Revised reprint, Books and Allied.
7. Gupta S.P. and Gupta M.P. : Business Statistics, Sultan Chand & Sons, New Delhi.

M. Sc./M.A. MATHEMATICS, SEMESTER - III, 2026-27

Code of the Course	**: MAT9112T**
Title of the Course	**: FRACTIONAL CALCULUS & APPLICATIONS**
Level of the Course	**: NHEQF Level 7**
Credit of the Course	**: 4**
Type of the Course	**: Generic Elective Course (GEC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject and conceptual knowledge of undergraduate-level ordinary and partial differential equations, Differential and Integral calculus.

Learning Objective :

The objective of this course is to introduce the fundamental concepts and mathematical formulations of fractional calculus including various definitions of fractional derivatives and integrals, and applications.

Learning Outcomes :

After completion of this course, students will be able to

- Gain insights into the historical development and mathematical significance of fractional calculus.
- Understand the fundamental concepts and definitions of fractional derivatives and integrals (Riemann–Liouville, Caputo, Weyl etc.).
- Distinguish between classical and fractional-order operators.
- Apply integral transforms to fractional differential and integral operators.

Syllabus:

UNIT I

Brief review of Special Functions of the Fractional Calculus, Definition of Mittag-Leffler Functions of one and two parameters, Relations of Mittag-Leffler Function to some other functions, The Laplace transform of Mittag-Leffler Function in two parameters. Wright Function, Definition of Wright function, Integral relation and relation to other functions, Miller Ross function. (12 Lecture hours)

UNIT II

The Riemann Liouville Fractional Integral, Fractional Integrals of some functions namely binomial function, exponential, the hyperbolic and trigonometric functions, Bessel's functions, Hyper-geometric function, Dirichlet's Formula, Laplace Transform of the Fractional integral, Leibnitz's Formula for Fractional Integrals, Derivatives of the Fractional Integral and the Fractional Integral of Derivatives. (12 Lecture hours)

UNIT III

Derivatives, Properties of Fractional derivatives, Riemann-Liouville fractional derivatives, Riemann Liouville left-sided derivative, Riemann-Liouville right-sided derivative, Leibnitz's Formula of Fractional Derivatives. Laplace transform of fractional derivatives, Fractional derivatives of standard functions Left and right fractional derivatives. (12 Lecture hours)

UNIT IV

Definition of Weyl Fractional Integral, Weyl Fractional Derivatives, A Leibniz Formula for Weyl Fractional Integral and simple applications. (12 Lecture hours)

UNIT V

Definition Caputo Fractional Derivative, Leibnitz's formula for Caputo fractional derivative, Laplace transform of Caputo fractional derivative, Difference between Caputo fractional derivative and R-L fractional derivative, Caputo left-sided derivative, Caputo right sided derivative, Caputo-Fabrizio fractional derivative. (12 Lecture hours)

Books Recommended:

1. Miller K.S. and Ross B. : An Introduction to the Fractional Differential Equations, John Wiley and Sons.
2. Samko S.G., Kilbas A.A., Marichev O.I. : Fractional Integrals and Derivatives, Gordon and Breach Science Publishers.
3. Kilbas A.A., Srivastava H.M., Trujillo J.J. : Theory and Applications of Fractional Differential Equations, Elsevier.
4. Oldham K.B., Spanier J. : The Fractional Calculus, Academic Press Inc.
5. Ricardo A., Dina T., Delfim F.M. Torres : The Variable-Order Fractional Calculus of Variations, Springer.
6. Podlubny I. : Fractional Differential Equation, Academic Press Inc.
7. Das S. : Functional Fractional Calculus, Springer.

M. Sc./M.A. MATHEMATICS, SEMESTER - III, 2026-27

Code of the Course	**: MAT9113P**
Title of the Course	**: MATLAB**
Level of the Course	**: NHEQF Level 7**
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 :

Basic computer skills to download the required files and programmes needed for the course.

Learning Objective :

- To teach the basis of computational techniques for solving ordinary differential equations.
- To introduce the use of MATLAB for numerical integration and interpolations.
- To discuss different types of plotting (2D, 3D, contour etc.) using MATLAB.

Learning Outcomes :

After completion of this course, students will be able to

- Learn different environment of MATLAB.
- Do symbolic computations using MATLAB.
- Solve a system of differential equations via MATLAB.
- Learn different types of plotting namely, 2D, 3D, contour etc.
- Do numerical integration and interpolation with unequal intervals

Syllabus:

PART – A:

The MATLAB Environment, MATLAB Basics: Variables, Numbers, Operators, Expressions, Input and output, Vectors, Arrays: Matrices. Built-in Functions and User defined Functions. Files and File Management: Import/Export, Basic 2D, 3D plots, Graphic handling, Use of MATLAB in Matrix Addition, multiplication, subtraction. Symbolic Calculation-symbols,

differentiation, integration, etc. Conditional Statements, Loops. MATLAB Programs: Programming and Debugging. Mathematical Computing with MATLAB-Algebraic equations.

PART- B:

Basic Symbolic Calculus and Differential equations, Ordinary Differential Equations: A first order and first-degree ODE. Interpolation with equal Interval: Newton –Gregory forward and backward interpolation formula. Numerical Integration: Trapezoidal method, Numerical Integration: Simpson method (1/3 and 3/8).

Books Recommended:

1. Pratap R. : Getting started with MATLAB, Oxford University Press. 2.
2. Lynch, S. : Dynamical Systems with Applications using MATLAB, Birkhäuser.
3. Fousett, L.V. : Applied Numerical Analysis using MATLAB, Pearson Education.
4. Chapara S.C., Canale, R.P. : Numerical Methods for Engineers, McGraw Hill
5. Gilat A. : MATLAB: An Introduction with Applications, Wiley.

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

Master of Science/ Arts (M.Sc./M.A.) MATHEMATICS,

Semester- Fourth, 2026-27

Course Type	Course Code	Title	Delivery Type	Total Credit	Total Hours	Internal Assessment	EoS Exam	M.M.	Remarks
DCC	MAT9013T	Functional Analysis	L	4	60	20	80	100	---
Select any one (total five) Discipline specific Elective (DSE) Course from each DSE group of the following in IV semester.									
DSE-I	MAT9114P	Computer Programming of Numerical Methods	P	4	120	20	80	100	If opted C-Prog. as DSE in M.Sc. III Sem
	MAT9115T	Multivariable Calculus	L	4	60	20	80	100	---
DSE-II	MAT9116T	Advanced Numerical Analysis -II	L	4	60	20	80	100	---
	MAT9117T	Graph Theory-II & Cryptology	L	4	60	20	80	100	If opted GT-I as DSE in M.Sc. III Sem
DSE-III	MAT9118T	Optimization Techniques-II	L	4	60	20	80	100	If opted OT-I as DSE in M.Sc. III Sem
	MAT9119T	Mathematical Theory of Statistics-II	L	4	60	20	80	100	If opted MTS-I as DSE in M.Sc. III Sem
DSE-IV	MAT9120T	Cosmology	L	4	60	20	80	100	---
	MAT9121T	Advanced Number Theory	L	4	60	20	80	100	---
DSE-V	MAT9122T	Viscus Fluid Dynamics	L	4	60	20	80	100	---
	MAT9123T	Special Functions	L	4	60	20	80	100	---

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

M. Sc./M.A. MATHEMATICS, SEMESTER - IV, 2026-27

Code of the Course	**: MAT9013T**
Title of the Course	**: FUNCTIONAL ANALYSIS**
Level of the Course	**: NHEQF Level 7**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Centric Compulsory (DCC)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)
Prerequisites	:

B.Sc./B.A. with Mathematics as a core subject 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. (12 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. (12 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. (12 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. (12 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. (12 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

Discipline specific Elective (DSE) Courses

Select any one (total five) DSE Course from each DSE group of the following in IV semester.

Course Type	Course Code	Title	Delivery Type	Total Credit	Total Hours	Internal Assessment	EoS Exam	M.M.	Remarks
DSE-I	MAT9114P	Computer Programming of Numerical Methods	P	4	120	20	80	100	If opted C-Prog. as DSE in M.Sc. III Sem
	MAT9115T	Multivariable Calculus	L	4	60	20	80	100	---
DSE-II	MAT9116T	Advanced Numerical Analysis -II	L	4	60	20	80	100	---
	MAT9117T	Graph Theory-II & Cryptology	L	4	60	20	80	100	If opted GT-I as DSE in M.Sc. III Sem
DSE-III	MAT9118T	Optimization Techniques-II	L	4	60	20	80	100	If opted OT-I as DSE in M.Sc. III Sem
	MAT9119T	Mathematical Theory of Statistics-II	L	4	60	20	80	100	If opted MTS-I as DSE in M.Sc. III Sem
DSE-IV	MAT9120T	Cosmology	L	4	60	20	80	100	---
	MAT9121T	Advanced Number Theory	L	4	60	20	80	100	---
DSE-V	MAT9122T	Viscus Fluid Dynamics	L	4	60	20	80	100	---
	MAT9123T	Special Functions	L	4	60	20	80	100	---

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

M. Sc./M.A. MATHEMATICS, SEMESTER - IV, 2026-27

Code of the Course	**: MAT9114P**
Title of the Course	**: COMPUTER PROGRAMMING OF NUMERICAL METHODS**
Level of the Course	**: NHEQF Level 7**
Credit of the Course	**: 4**
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:

PART – A:

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

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

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

PART – B:

Algorithm and Computer Programming in C for Numerical Differentiation & Integration: Simpson's rule (1/3 & 3/8), Trapezoidal rule, Gaussian Quadrature formula.

Algorithm and Computer Programming in C for Numerical Solutions of differential equations: Eulers method, Taylor's series method, Runge Kutta 4th order method, Predictor-corrector method.

Books Recommended:

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

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, 2026-27

Code of the Course	**: MAT9115T**
Title of the Course	**: MULTIVARIABLE CALCULUS**
Level of the Course	**: NHEQF Level 7**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Specific Elective (DSE)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

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

Learning Objective :

The aim of the course is to cover the theory, practice, and application of differentiable functions in several variables.

Learning Outcomes :

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

- Compute and understand the geometric and physical meaning behind derivatives and directional derivatives of functions of several variables.
- Understand coordinate systems (spherical, cylindrical, rectangular) and be able to choose the right set-up for a practical problem.
- Integrate functions and vector fields along paths, surfaces, and solid regions and apply this to real-world problems. Understand the physical meaning of Green and Stokes theorems.
- Build geometric intuition and visual reasoning, building on what you learned in linear algebra.

Syllabus: UNIT I

Limits and Continuity of functions defined on Euclidean Spaces: Review of vector algebra in R^n, Real-valued functions of several variables, Level sets (level curves, level surfaces, etc), Vector valued functions of several variables, Sequences in R^n and their limits, Neighbourhoods in R^n, Limits and continuity of scalar- and vector-valued functions of several variables. (12 Lecture hours)

UNIT II

Differentiation: Partial derivatives, Differentiability of a real-valued function of several variables, the concept of (total) derivative, Gradient and directional derivatives, Chain Rule, Euler's Theorem, Higher order partial derivatives, Mixed Derivative Theorem, Mean Value Theorem and Taylor's Theorem for functions of several variables, Review of quadratic forms, Hessian matrix, Local maxima/minima and saddle points, Constrained maxima and minima of real-valued functions of several variables, Differentiation of vector-valued functions of several variables, Jacobians, Chain Rule, Contraction principle in R^n , Implicit function theorem, Inverse function theorem. (12 Lecture hours)

UNIT III

Multiple Integrals: Definition of double and triple integral of a function defined and bounded on a rectangle, Geometric interpretation, Basic properties of double and triple integrals, Iterated integrals, Fubini's Theorem, Integrability and the integral over arbitrary bounded domains, Change of variables, Polar, cylindrical and spherical coordinates, and integration using these coordinates. (12 Lecture hours)

UNIT IV

Line Integrals: Paths (parameterized curves) in R^n , Smooth and piecewise smooth paths, Closed paths, Equivalence and orientation preserving equivalence of paths, Definition of the line integral of a vector field over a piecewise smooth path, Basic properties of line integrals, First and Second Fundamental Theorems of Calculus for Line Integrals, Green's Theorem (rectangular domains only) and its applications to evaluation of line integrals.

(12 Lecture hours)

UNIT V

Surface Integrals: Parameterized surfaces, smoothly equivalent parameterizations, Area of such surfaces, Definition of surface integral, Curl and divergence of a vector field, Stokes' theorem, Gauss' Divergence theorem and their applications. (12 Lecture hours)

Books Recommended:

1. Apostol T. : Calculus, John Wiley.
2. Ghorpade S.R. and Limaye B.V. : A Course in Multivariable Calculus and Analysis, Springer
3. Edwards C.H. : Advanced calculus of several variables, Dover Publications Inc
4. Courant R. and John F. : Introduction to Calculus and Analysis, Vol. 2, Springer Verlag.

M. Sc./M.A. MATHEMATICS, SEMESTER - IV, 2026-27

Code of the Course : **MAT9116T**

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

Level of the Course : **NHEQF Level 7**

Credit of the Course : **4**

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

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

Prerequisites :

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

Learning Objective :

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

Learning Outcomes :

After completion of this course, students will be able to

- Understand functions approximations.
- Find numerical solutions of Ordinary and Partial differential equations.
- Solve numericaly linear and non-linear boundary value problems of ordinary differential equations by finite difference methods.

Syllabus:

UNIT I

Curve Fitting and Function approximations: Least square error criterion, Least square for non-linear data, Least square for continuous functions, Least square approximations using orthogonal polynomials, approximations of functions by Taylor series and Chebyshev polynomials. (12 Lecture hours)

UNIT II

Numerical solution of Ordinary differential equations: Taylors Series method, Runge-Kutta (R-K) method, Milne's Predictor-Corrector method, Adams-Moulton method, Adams-Bashforth method. (12 Lecture hours)

UNIT III

Numerical Solution of Partial differential equations: General Second order Linear PDE, Laplace's five-point finite difference approximations, Solution of Laplace's equation by Jacobi method and Gauss-Seidel method. (12 Lecture hours)

UNIT IV

Stability analysis: Single and Multistep methods.

Solution of linear boundary value problems of ODE's: Finite difference method, Finite difference approximations to higher order derivatives, Numerov method, Shooting method. (12 Lecture hours)

UNIT V

Finite Difference scheme for non-linear boundary value problems of the type $y' = f(x,y)$, $y'' = (x,y,y')$ and $y''' = f(x,y,y',y'')$, $y^{iv} = f(x,y,y',y'',y''')$ (12 Lecture hours)

Books recommended:

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
7. D. S. Chauhan, Paresh Vyas : Studies in Numerical Analysis, JPH, Jaipur

M. Sc./M.A. MATHEMATICS, SEMESTER - IV, 2026-27

Code of the Course : **MAT9117T**

Title of the Course : **GRAPH THEORY-II & CRYPTOLOGY**

Level of the Course : **NHEQF Level 7**

Credit of the Course : **4**

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

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

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject and opted Graph Theory-I as DSE in M.Sc. III semester.

Learning Objective :

This course is aimed to learning about Cryptology which involves hiding a message and getting it back in its original form along with higher concepts of Graph Theory. The use of Graph Theory concepts in Cryptology also is included.

Learning Outcomes :

After complication of this course, students will be able to

- Learning about the basic techniques in Cryptology and the basic ideas of secure transmission of data.
- Application of ideas of Graph Theory such as Graph Labeling in Cryptology.
- Applications of concepts such as Graph Colouring in various kinds of problems.

Syllabus:

UNIT I

Introduction to the Concepts of Security: The Need, Principles, Types of Attacks, Definitions and basic concepts of Cryptology: Cryptography, Cryptanalysis, Steganography, Plain Text, Cipher Text, Encryption, Decryption, Certain examples of Cryptology – in ancient Indian and modern contexts. (12 Lecture hours)

UNIT II

Cryptography Techniques: Substitution – Caesar Cipher, Hill Cipher; Transposition Technique – Rail Fence Technique, Vernam Cipher (One-Time Pad), Symmetric and

Asymmetric key Cryptography, Keys (Public and Private), Basic ideas of algorithms: DES (Data Encryption Standard), AES (Advanced Encryption Standard) and RSA algorithm.

(12 Lecture hours)

UNIT III

Graph Labelling: Harmonious, Felicitous, Sequential, Graceful, Magic and Antimagic; Applications of graph labelling in Cryptology. (12 Lecture hours)

UNIT IV

Digraphs: Types of Digraphs, Underlying Graphs, Accessibility, Arborescence, Spanning Arborescence, Euler Digraphs, Adjacency and Incidence Matrix of Digraphs, Paths in Digraphs, Strong Connectivity. (12 Lecture hours)

UNIT V

Chromatic Polynomial of Complete Graph K_n, Vertex Colouring – Vertex Decomposition (problem : Storing chemicals safely in a warehouse) and Domination (problem: Setting up communication links economically between a number of cities), Edge Colouring – Edge Decomposition into Matchings (problems: Electrical wire colouring on a display panel with connection points as vertices and wires as edges – multiple edges allowed; Scheduling examinations between teachers and students using bipartite graph). (12 Lecture hours)

Books Recommended:

1. Atul Kahate : Cryptography and Network Security, McGraw Hill Education (India), Chennai, India
2. Joan M. Aldous and Robin J. Wilson : Graphs and Applications : An Introductory Approach, Springer, London, UK.
3. C. Vasudev : Graph Theory with Applications, New Age International Publishers, India.
4. Prabhakar Gupta & Vineet Agrawal : Graph Theory, Pragati Prakashan, Meerut, India.
5. G. Suresh Singh : Graph Theory, PHI Learning, Eastern Economy Edition, Delhi, India.
6. Narsingh Deo : Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India, India.
7. Hari Kishan & Shiv Raj Pundir : Discrete Mathematics, Pragati Prakashan, Meerut, India.
8. Edited by Beril Sirmacek : Graph Theory : Advanced Algorithms and Applications, IntechOpen, London, UK.

M. Sc./M.A. MATHEMATICS, SEMESTER - IV, 2026-27

Code of the Course	**: MAT9118T**
Title of the Course	**: OPTIMIZATION TECHNIQUES-II**
Level of the Course	**: NHEQF Level 7**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Specific Elective (DSE)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)
Prerequisites	:

B.Sc./B.A. with Mathematics as a core subject 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 Substitution, Hessian matrix. (12 Lecture hours)

UNIT II

Method of Lagrange's Multipliers, Constraints in the form of inequalities: Kuhn Tucker Theorem, Kuhn-Tucker necessary and sufficient conditions, Saddle point. (12 Lecture hours)

UNIT III

Quadratic programming problem: Wolfe's algorithms and Beale's algorithm, Problems Based on Wolfe's and Beal's Method. (12 Lecture hours)

UNIT IV

Dynamic Programming Problem: Bellman's principle of optimality, Minimum path problem, Multiple stage decision problems, Single Additive Constraints multiplicatively separable return, Single Additive Constraints additively separable return, characteristics of DPP. (12 Lecture hours)

UNIT V

Project Scheduling, Network, Fulkerson's rule, Project Evaluation and Review Technique (PERT), Critical Path Method (CPM), Time-Cost Trade-Off. (12 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, 2026-27

Code of the Course	**: MAT9119T**
Title of the Course	**: MATHEMATICAL THEORY OF STATISTICS-II**
Level of the Course	**: NHEQF Level 7**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Specific Elective (DSE)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject 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. (12 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. (12 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. (12 Lecture hours)

UNIT IV

t and F sampling distribution with derivations, properties and applications. Large sample theory and applications. Determination of sample size. (12 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. (12 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, 2026-27

Code of the Course : **MAT9120T**

Title of the Course : **COSMOLOGY**

Level of the Course : **NHEQF Level 7**

Credit of the Course : **4**

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

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

Prerequisites :

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

Learning Objective :

The objective of this course empowers students to understand the fundamental principles, models, and theories of cosmology, equipping them to explore the evolution, structure, and dynamics of the cosmos.

Learning Outcomes:

After completion of this course, students will be able to

- Understand principle of cosmology, Einstein and de-Sitter universes.
- Understand the concept of static and non-static cosmological models, Hubble's law and FRW model.
- A deep understanding of the evolution and structure of the Universe.

Syllabus:

UNIT I

Cosmology: Principles of Cosmology, Static cosmological models, Einstein and de-Sitter Universes, their derivations, properties and comparison with the actual universe and some related problems. (12 Lecture hours)

UNIT II

Non static cosmological models, Hubble's law, Weyl's postulate, Derivation of Robertson-Walker Metric, Geometrical features of R-W metric. (12 Lecture hours)

UNIT III

Doppler effect, Surface brightness, source counts, Red shift, Particle and event Horizons, Friedman-Robertson-Walker cosmological models, Expressions for FRW model up to non-zero pressure. (12 Lecture hours)

UNIT IV

Einstein field equations and dynamics of the universe, Age of the universe, Matter dominated Universe, Radiation dominated universe, Cosmologies with a non-zero cosmological constant, Origin and evolution of the universe, Big Bang Theory, The steady state model, C-field theory. (12 Lecture hours)

UNIT V

Cosmological equations, Explosive creation, Alternative theory of gravitation, The Brans-Dicke theory, Cosmological solution in the Brans-Dicke theory. (12 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, 2026-27

Code of the Course : **MAT9121T**

Title of the Course : **ADVANCED NUMBER THEORY**

Level of the Course : **NHEQF Level 7**

Credit of the Course : **4**

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

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

Prerequisites :

B.Sc./B.A. with Mathematics as a core subject and basic knowledge of Abstract Algebra.

Learning Objective :

The objective of this course is to to understand the concepts of number theory and give an integrated approach to number theory and algebra.

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 to Mathematical audience.
- Collect and use numerical data to form conjectures about the integers.
- Understand the theory and application of factorization in algebraic number fields.
- Become familiar with advanced concepts such as Dedekind rings and Galois extension.

Syllabus:

UNIT I

Quadratic residue, Legendre's symbol and its properties, Quadratic reciprocity law, Jacobi symbol, Its properties, Sums of Two Squares, Some Diophantine Equations (The equation $ax + by = c$), Simultaneous linear equations. (12 Lecture hours)

UNIT II

Simple continued fraction, Finite continued fraction, Euler's rule, Convergent to continued fraction, Uniqueness of continued fraction, Euclidean algorithm. (12 Lecture hours)

UNIT III

Infinite simple continued fraction, Periodic continued fraction, The representation of an irrational number by an infinite continued fraction, Pell's equation. (12 Lecture hours)

UNIT IV

Polynomials, Algebraic numbers and integers, Algebraic number fields, Quadratic fields, Units in Quadratic fields, Primes in Quadratic fields. (12 Lecture hours)

UNIT V

Unique factorization, Primes in quadratic fields having the unique factorization property, localization, Prime ideals, Galois extension, Dedekind rings. (12 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.
4. Thomas Koshy : Elementary Number Theory with Applications, Academic Press, Elsevier

M. Sc./M.A. MATHEMATICS, SEMESTER - IV, 2026-27

Code of the Course : **MAT9122T**

Title of the Course : **FLUID DYNAMICS**

Level of the Course : **NHEQF Level 7**

Credit of the Course : **4**

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

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

Prerequisites :

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

Learning Objective :

The objective of 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

Hydrodynamics: Lagrange's and Euler's, Methods, Acceleration, Equation of Continuity, Stream lines, velocity potential, Euler's dynamical Equations, Bernoulli's Theorem, Lagrange's Equations under conservative forces. (12 Lecture hours)

UNIT II

Viscosity: Analysis of stress, Relation between stress and rate of strain, Navier-stokes equations and equation of energy in cartesian system of coordinates. (12 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. (12 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. (12 Lecture hours)

UNIT V

Unsteady motion of a plate, Theory of very slow motion of a sphere in viscous fluid. (12 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, 2026-27

Code of the Course	**: MAT9123T**
Title of the Course	**: SPECIAL FUNCTIONS**
Level of the Course	**: NHEQF Level 7**
Credit of the Course	**: 4**
Type of the Course	**: Discipline Specific Elective (DSE)**
Delivery type of the Course	**: Lecture** (40 Hours for content delivery and 20 Hours for subject/ class activity, problem solving, diagnostic assessment and formative assessment)

Prerequisites :

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

Syllabus:

UNIT I

Hypergeometric equations: Solution of Hypergeometric Differential Equation Hypergeometric series, Hypergeometric functions, Confluent Hypergeometric function and related simple properties, Simple problems on Generalized Hypergeometric functions.

(12 Lecture hours)

UNIT II

Legendre's polynomial Functions: Solution of Legendre's and associated Legendre's differential equations. Generating function, Recurrence relations, Simple properties of Legendre's functions of first and second kind. (12 Lecture hours)

UNIT III

Associated Legendre's function: Solution of associated Legendre's differential equations, Simple properties of associated Legendre's function of integral order, Rodrigues formula and orthogonality of Legendre's polynomials, Simple properties of associated Legendre's function. (12 Lecture hours)

UNIT IV

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. (12 Lecture hours)

UNIT V

Classical Orthogonal Polynomials: Generating functions, Recurrence relations, Rodrigues formula and other properties associated with the Laguerre and Hermite Polynomials. (12 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.