**SYLLABUS**

**M.Sc. Mathematics (Part-II)**

**Session 2026 onwards**

**SEMESTER-III**

**LIST OF ELECTIVES SUBJECTS : (ANY FIVE OF THE FOLLOWING )**

| Code | Title of Paper/Subject | Credit | Internal Assessment | External | Total |
|---|---|---|---|---|---|
| MM560 | Mathematical statistics | 5 | 30 | 70 | 100 |
| MM562 | Functional Analysis | 5 | 30 | 70 | 100 |
| MM563 | Field Theory | 5 | 30 | 70 | 100 |
| MM564 | Classical Mechanics | 5 | 30 | 70 | 100 |
| MM565 | Numerical Analysis | 5 | 30 | 70 | 100 |
| MM566 | Differentiable Manifold | 5 | 30 | 70 | 100 |
| MM567 | Introducton to computer and Programming using C | -- | 20 | 50 | 70 |
| MM567(P) | Software lab ( C Programming) | -- | 10 | 20 | 30 |
| MM568 | Complex Analysis -II | 5 | 30 | 70 | 100 |
| MM569 | Differential Equation-II | 5 | 30 | 70 | 100 |

# MM560 MATHEMATICAL STATISTICS

Time Allowed : 3 hours

External Exam : 70
Internal Assessment : 30
Total : 100

## INSTRUCTION FOR THE PAPER SETTER

The question paper will consist of five sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Section C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks each and section C will be of 30 marks

## INSTRUCTION FOR CANDIDATES

Candidates are required to attempt five question in all selecting two question from each sections A and B and compulsory question of section C.

### SECTION-A

Axiomatic approach to probability. Real random variables, distribution functions, discrete and continuous random variables, decomposition of a distribution function, Independence of events. Expectation of a real random variable. Linear properties of expectations, Characteristic functions, their simple properties.

Discrete probability distributions: Normal distribution, rectangular distribution, exponential distribution.

### SECTION-B

Theory of estimator: Population, sample, parameter and statistic, sampling distribution of a statistic, standard error. Interval estimation, Method of estimation, Properties of estimators, confidence intervals.

Exact Sampling Distribution: Chi-square distribution, Student's t distribution, Snedecor's F-distribution, Fisher's-Z distribution.

Hypothesis Testing: Null and Alternative hypothesis, Tests of hypotheses: most powerful and uniformly most powerful tests, likelihood ratio tests. Test of significance based on t, Z and F distributions, chi square test of goodness of fit

**Books Recommended:**

1. Goon, A.M., Gupta, M.k., & Dasgupta, B. (2003). An outline of statistical theory(vol 1&2). World Press Pvt Limited.

2. Lehmann, E.L., & Casella, G.(1998). Theory of point estimation (vol.31). Springer

Duration: 3 Hrs.

MM-802(FUNCTIONAL ANALYSIS)

Max. Marks: 100
Internal Assessment: 30
External Examination: 70

**Course Learning Outcomes:**

On completion of this course, the students will be able to:
CO-1 Understand the concept of norm and its completeness.
CO-2 Study the concept of Hahn-Banach Theorem, Open mapping theorem, Closed graphs.
CO-3 analyse the difference between Banach Spaces and Hilbert Spaces. Also check the totality of orthonormal sets.
CO-4 Understand the basic concepts of operators and its classification.

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of five sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

**SECTION-A**

Normed Linear spaces, Banach spaces, Examples of Banach spaces and subspaces. Continuity of Linear maps, Equivalent norms. Normed spaces of bounded linear maps. Bounded Linear functional. Hahn-Banach theorem in Linear Spaces and its applications.
Hahn-Banach theorem in normed linear spaces and its applications.Uniform boundedness principle, Open mapping theorem, Projections on Banach spaces, Closed graph theorem.

**SECTION-B**

The conjugate of an operator. Dual spaces of lp and C [a,b], Reflexivity. Hilbert spaces, examples, Orthogonality, Orthonormal sets, Bessel's inequality, Parseval's theorem. The conjugate space of a Hilbert spaces. Adjoint operators, Self-adjoint operators, Normal and unitary operators. Projection operators. Spectrum of an operator, Spectral Theorem, Banach Fixed Point Theorem, Brower's Fixed Point Theorem. Schauder Fixed Point Theorem, Picards Theorem. Applications of Fixed point theorem in differential equations and integral equations.

**Books Recommended**


1. G.F.Simmons: Introduction to Toplogy and modern Analysis, Chapters IX, X, XII and appendix one.

M.Sc Mathematics ( Sem -III)
MM 563 FIELD THEORY

Pass percentage: 35%
Time allowed : 3hours.

External Evaluation: 70
Internal Evaluation: 30

Course objective : The objective of the course is to help the students acquire skills to check irreducibility of polynominls by different tests and to provide framework for Galois Theory which helps in solvability of quintic equations.

Course learning outcomes: On completion of course, the student will be able to

CO-I : Understand irreducibility of polynominls using various irreducibility tests.
CO-II : Understand field extension particularly Normal extensions and Seperable extensions.
CO-III : Understand the concept of splitting field of a polynomial and its evaluation.
CO-IV : Understand Galois Theory and its applications particularly solving a quintic equation.
CO-V : Understand Fundamental Theorem of Algebra.

## INSTRUCTIONS FOR THE PAPER-SETTER/EXAMINER

The question paper will consist of three sections A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus and Section C will consist of one compulsory question having ten short answer type questions covering the entire syllabus uniformly. Each question in Sections A and B will be of 10 marks and Section C will be of 30 marks.

## INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all selecting two questions from each of the Sections A and B and compulsory question of Section C.

## SECTION:A

Fields ,examples, algebraic and Transcendental elements, irreducible elements, Guass Lemma, Eisenstein's Criterion, adjunction of roots, Kroneckor's theorem, algebraic extensions, algebraically closed fields, Splitting fields, Normal extensions, multiple roots, finite fields, seperable extensions, perfect extensions, perfect fields, primitive elements, Langrange's theorem on primitive element.

## SECTION :B

Automorphism groups and fixed fields, Galois extensions, Fundamental theorem of Galois theory Fundamental theorem of algebra, roots of unity and Cyclotomic polynomials, Cyclic extensions Polynomial solvable by radicals, Cyclotomic extension, quintic equation and solvability by radicals.

**Books Recommended:**


1. P.B. Bhattacharya, S.K Jain ,S.R.Nagpal: *Basic Abstract Algebra,2nd Edition,Cambridge University Press,2002.*
2. D.S. Dummit, Richard M Foote: *Abstract Algebra,John Wiley and Sons,2004.*
3. M. Artin: *Algebra, Prentice Hall of India, New Delhi,1994.*


~~MM 564 CLASSICAL MECHANICS~~

## MM 564-CLASSICAL MECHANICS

Pass percentage: 35%
Time allowed : 3hours.

External Evaluation: 70
Internal Evaluation: 30

**Objective:** The subject of Classical Mechanics is a perfect example of the power of mathematics to solve real physical problems and this course introduces the students to the Lagrangian version of Classical Mechanics which is indispensable for any study of Quantum Mechanical Methods

### INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus and Section C will consist of one compulsory question having ten short answer type questions covering the entire syllabus uniformly. Each question in Sections A and B will be of 10 marks and Section C will be of 30 marks.

### INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all selecting two questions from each of the Section A and B and compulsory question of Section C.

### SECTION-A

**Basic Principles:** Mechanics of a Particle and a System of Particles, Constraints, Generalized Coordinates, Holonomic and Non-Holonomic Constraints. D'Alemberts Principle and Lagrange'sEquations, Velocity Dependent Potentials and the Dissipation Function, Simple Applications ofthelagrangianformulation.
**Variational Principles and Lagrange's Equations:** Hamilton's Principle, Derivation of Lagrange's Equations from Hamilton's Principle, Extension of Hamilton's Principle to Non-Holonomic Systems.
**Conservation Theorems and Symmetry Properties:** Cyclic Coordinates, CanonicalMomentum and its Conservation, The Generalized Force, and Angular Momentum Conservation Theorem.
**The Two-Body Central Force Problem:** Reduction to the Equivalent One-Body Problem, The Equation of Motion, The Equivalent One Dimensional Problem and the Classification of Orbits, The Virial Theorem, Conditions for Closed Orbits, Bertrand's Theorem.

### SECTION-B

**The Kepler Problem:** Inverse Square Law of Force, The Motion in Time in the Kepler Problem, Kepler's Laws, Kepler's Equation, The Laplace-Runge-Lenz Vector.
**Scattering in a Central Force Field:** Cross Section of Scattering, Rutherford Scattering Cross Section, General Scattering Cross Section, Transformation of the Scattering Problem to Laboratory Coordinates.The Independent Coordinates of Rigid Body, The Transformation Matrix, The Euler Angles, The Cayley-Klein Parameters and Related Quantities, Euler's Theorem on the Motion of Rigid Bodies, Finite Rotations, Infinitesimal Rotations, The Coriolis Force.
**Pedagogy:** The instructor should lay emphasis on those techniques which naturally lend themselves to their quantum mechanical interpretations to enable the student to more naturally transform from the classical to the quantum.

RECOMMENDED BOOK

Herbert Goldstein: Classical Mechanics

Duration: 3Hrs

**MM566 Differential Manifold**

Max Marks: 100
External Examination: 70
Internal Assessment:30

**INSTRUCTIONS FOR THE PAPER-SETTER**

The question paper will consist of three sections A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus and Section C will consist of one compulsory question having ten short answer type questions covering the entire syllabus uniformly. Each question in Sections A and B will be of 10 marks and Section C will be of 30 marks.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions in all selecting two questions from each of the Section A and B and compulsory question of Section C.

Objective: The aim of this paper is to introduce to the students the theory of differentiable manifolds along with its applications and also the detailed study of Riemmanian manifolds based on the theory of submanifolds.

**SECTION-A**

Differentiable Manifolds, examples of differentiable manifolds, the local coordinate approach, Differentiable maps on manifolds, tangent vectors and tangent space, different approaches to tangent vectors, Cotangent space. Vector Fields, Lie-bracket of vector fields. Jacobian map, pull back map, integral curves. Tensors, Exterior product, Forms, Exterior derivative, Contraction, Lie-derivative.Affine Connection, Difference tensor, Covariant derivative of tensors.

**SECTION-B**

Torsion tensor and curvature tensor of a connection, properties of torsion and curvature tensor, Bianchi's identities, the Riemannian metric, Riemannian manifolds, Fundamental theoremof Riemannian geometry, Riemannian connection, Christoffel symbols, Riemannian curvature tensor and its properties.Sectional curvature, Theorem of Schur. Sub-manifolds and hyper-surfaces, Normals, induced connection, Gauss and Weingarten formulae and their applications.

BOOKS RECOMMENDED:

.Y. Matsushima: Differentiable Manifolds, Marcel Dekker, Inc. New York, 1972. .

U.C. De: Differential Geometry of Manifolds, Alpha Science Int. Ltd., Oxford, U.K. Hicks, N. J.: Notes on Differential Geometry (Relevant Portion), Van Nostrand