

**Department of Mathematics**  
**Faculty of Sciences, Jamia Millia Islamia, New Delhi**

**M.A./ M.Sc. Mathematics (Self-Financed)**  
**Course Structure and Syllabus**

(w.e.f. 2024-25)

**1<sup>st</sup> Semester**

S. No.	Code	Papers	Credits
1.	<a href="#">MAS-101</a>	Real Analysis	4
2.	<a href="#">MAS-102</a>	Theory of Ordinary Differential Equations	4
3.	<a href="#">MAS-103</a>	Linear Algebra	4
4.	<a href="#">MAS-104</a>	Numerical Analysis	4
5.	<a href="#">MAS-105</a>	Classical Mechanics	4

**MAS-101 Real Analysis**

**L/T/P: 4/0/0**

- Unit-1: Countability of sets. Open and Closed sets on real line, Length of intervals, Lebesgue Measure on the real line, Outer and Inner Lebesgue measure, Lebesgue measurable sets, Properties of measurable sets
- Unit-2: Algebra,  $\sigma$ -algebra, Borel sets and their measurability, non-measurable sets. Measurable functions, Measurability of characteristic functions, step functions, and continuous functions, Borel measurable functions
- Unit-3: Riemann integral and its deficiency, Lebesgue integral of bounded function, Comparison of Riemann and Lebesgue integrals, Properties of Lebesgue integral for bounded measurable function, The Lebesgue integral for unbounded functions, Integral of non-negative measurable functions, General Lebesgue integral
- Unit-4: Pointwise convergence, Convergence almost everywhere, Uniform Convergence almost everywhere, Convergence in measure, Lebesgue Bounded Convergence Theorem, Fatou's Lemma, Monotone Convergence Theorem, Lebesgue Dominated Convergence Theorem. Lebesgue sets, Absolutely Continuous Functions,  $L^p$ -spaces, Properties of  $L^p$ -space,  $L^p$ -space as a normed space, Holder's inequality, Minkowski's inequality and Schwartz's inequality

Books Recommended

- H.L. Royden; *Real Analysis (2nd ed.)*, The Macmillan Co., New York, (1968).
- G. de Barra; *Measure Theory and Integration*, New Age International, (2013).
- Jain, P. K., Gupta; *Lebesgue measure and Integration*, Willey Eastern Ltd., New Age Int. Ltd., New Delhi, (1994).
- I. K. Rana; *An Introduction to Measure and Integration*, American Mathematical Society, (2002).

**MAS-102 Theory of Ordinary Differential Equations**

**L/T/P: 4/0/0**

- Unit-1: Existence & uniqueness theorem, General theory of homogenous and non-homogenous equations with constant coefficients, Theory of equations with variable coefficients, Method of variation of parameters and the formula for particular integral in terms of Wronskian.
- Unit-2: System of linear differential equations: Differential operator and operator method, Basic theory of linear system in normal form, Homogeneous linear systems with constant coefficients, Matrix method for homogeneous linear systems with constant coefficients: n equations in n unknowns.
- Unit-3: Linear homogeneous Boundary Value Problems, Eigen values and Eigen functions, Sturm Liouville Boundary Value Problems, Non-homogeneous Boundary Value Problems.
- Unit-4: Green's functions and the solution of Initial and Boundary Value Problems in terms of Green's functions, Concept of stability, asymptotic stability and instability of a solution of the autonomous system  $dx/dt = F(x,y)$ ,  $dy/dt = G(x,y)$

Books Recommended

- Earl A. Coddington, *An Introduction to Ordinary Differential Equation*, Dover Publications (1989)
- Boyce and Diprime, *Elementary Differential Equations and Boundary Value Problems*. Wiley (2009)
- D. Somasundaram, *Ordinary Differential Equations: A First Course*, Narosa Publication.
- S. L. Ross, *Differential Equations*, Wiley, India.

**MAS-103 Linear Algebra****L/T/P: 4/0/0**

- Unit-1: An overview of Vector Space and Subspace, Basis, Dimension; Linear Transformation and their algebra; Isomorphism between Linear transformations and Matrices; Similarity and Equivalency; Eigenvalues and Eigenvectors; Minimal polynomial; Dual Spaces and Annihilator.
- Unit-2: Canonical Forms; Invariant Subspaces; Cyclic Subspaces; Direct Sum Decomposition and Primary Decomposition Theorem; Bilinear, Quadratic and Hermitian Forms; Definition, Examples and their Classification.
- Unit-3: Inner Product Space; Norm and Normed Linear Space; Schwarz Inequality; Orthogonal and Orthonormal Sets; Gram-Schmidt Orthogonalization process; Orthogonal Complement; Orthogonal Projection; Bessel's Inequality.
- Unit-4: Linear Operator; Trace and Transpose; Adjoint of Linear Operator; Self-adjoint Operators; Symmetric and Skew-symmetric Operators; Normal Operators; Unitary Operators; Positive operators; The Spectral theorem.

## Books Recommended

1. K. Hoffman and R. Kunze, *Linear Algebra*, Prentice Hall of India (2006)
2. Seymour Lipschutz, *Theory and Problems of Linear Algebra*, Tata McGraw Hill.
3. Gilbert Strang, *Linear Algebra and its Applications*, Cengage Learning, India Edition
4. G. Schay: *Introduction to Linear Algebra*, Narosa (1997)
5. G. C. Cullen: *Linear Algebra with Applications*, 2nd Edition, Addison Wesley.
6. David C. Lang: *Linear Algebra and its Applications*, 3 Edition, Pearson

**MAS-104 Numerical Analysis****L/T/P: 4/0/0**

- Unit-1: Lagrange's form of interpolating polynomial, Existence and uniqueness of interpolating polynomial, Hermite, Piecewise and Cubic spline interpolation. Approximation: Weighted least squares approximation for discrete data, Method of least squares for continuous functions, Gram-Schmidt orthogonalization process, approximation of functions using Chebyshev polynomials.
- Unit-2: Numerical integration: Gauss Quadrature methods and error estimation. Numerical solution of Initial Value Problems: Runge-Kutta method of order four for system of equations and for second and higher order differential equations. Shooting method, Linear and nonlinear Boundary Value problems by Finite difference methods. Stability and convergence analysis of finite difference scheme.
- Unit-3: Numerical solution of partial differential equations: Parabolic equations- finite difference approximation to partial derivatives, explicit methods and Crank-Nicolson method, stability analysis. Elliptic equations- Standard five-point formula, Jacobi's iteration method and Leibmann's method. Hyperbolic equations: Explicit finite difference method.
- Unit-4: Finite element methods for ordinary differential equations: Functionals, variational methods. method of weighted residuals, finite element analysis of one and two-dimensional problems.

## Books Recommended

1. Gerald & Wheatlay: *Applied Numerical Analysis*, Pearson
2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, *Numerical Methods for Scientific and Engineering Computations*, New Age Int. New Delhi.
3. G. D. Smith, *Numerical Solutions of Partial Differential Equations*, Clarendon Press Oxford
4. M. K. Jain, and R. K. Jain, *Computational Methods for Partial Differential Equations*, New Age Int. New Delhi
5. J. N. Reddy, *An Introduction to Finite Element Method*, McGraw Hill, 2005.
6. S. D. Conte & Carl De Boor, *Elementary Numerical Analysis*, McGraw Hill, NY

**MAS-105 Classical Mechanics****L/T/P: 4/0/0**

- Unit-1: Moments and Products of inertia, Perpendicular and Parallel axis theorem, Principal moment of inertia and principal axes, Kinetic energy, Theorem of Konig, Angular momentum
- Unit-2: Euler's dynamical equations, Euler's angles, Constraints, Degree of freedom, Principle of Virtual work, Ideal constraints, D' Alembert's principle, Generalized coordinates, Generalized velocity, Generalized forces for a holonomic system.
- Unit-3: Lagrange's equations of motion, Lagrange function, Techniques of calculus of variations, Hamilton's principles, Principle of least action.
- Unit-4: Hamilton's equations of motion, Canonical transformation, Lagrange's and Poisson brackets, Hamilton-Jacobi Poisson equations.

## Books Recommended

1. Sygne and Griffith, *Principle of Mechanics*, McGraw Hill Company, 1959.
2. N.C. Rana and P.S. Joag, *Classical Mechanics*, McGraw Hill Company
3. K. Sankara Rao, *Classical Mechanics*, PHI India, 2005.
4. Madhumagal Pal, *A Course on Classical Mechanics*, Narosa Publication, 2008.
5. C. Fox, *An Introduction to the Calculus of Variation*, Dover Publication, 1988.