# M.A./ M.Sc. Mathematics (Self-Financed)

## Course Structure and Syllabus

**(w.e.f. 2024-25)**

### 2nd Semester

| S. No. | Code | Papers | Credits |
|---|---|---|---|
| 1. | MAS-201 | General Topology | 4 |
| 2. | MAS-202 | Advanced Group Theory | 4 |
| 3. | MAS-203 | Theory of Partial Differential Equations | 4 |
| 4. | MAS-204 | Complex Analysis | 4 |
| 5. | MAS-205 | Operations Research | 4 |

**MAS-201 General Topology L/T/P: 4/0/0**

Unit-1: Topology: definition and examples, standard topology, Basis, subbasis, lower limit topology, order topology, subspace topology, limit point, derived set, closed sets, closure, interior and boundary of a set, dense subsets, continuous functions, rules for constructing continuous functions, homeomorphism, pasting lemma, topology generated by metric

Unit-2: Convergence in topological spaces, sequence lemma, countable basis, examples, first and second countable spaces, Lindelof's space, separation axioms, Hausdorff space, Urysohn's lemma, Tietz extension theorem

Unit-3: Connected spaces, examples, path connected, path connected and continuous maps, components, path components, locally connected and locally path connected, compact spaces, continuous maps and compactness,

Unit-4: Product topology, projection maps, product of first and second countable spaces, comparison with box topology, product of compact spaces, tube lemma, Tychnoff's theorem

Books Recommended


1. James R. Munkres: *Topology, A first course*, Prentice Hall of India Pvt. Ltd., New Delhi, 2000
2. M. H. Mortad: *Introductory Topology*, Second Edition, World Scientific
3. G. F. Simmons: *Introduction to Topology* and Modern Analysis
4. J. L. Kelley: *General Topology*, Springer; 1975


**MAS-202 Advanced Group Theory L/T/P: 4/0/0**

Unit-1: Review of Groups and properties, Automorphisms and conjugate elements, Relation of conjugacy, Conjugate classes, Class equation of a finite group and related results, Similar permutations, Partition of a positive integer, Conjugate classes in Symmetric groups, Dihedral groups and their elementary properties.

Unit-2: Sylow's theorems, Sylow's p-subgroup and application of Sylow's theorem, p-groups and its applications, External and Internal direct products and related results, Indecomposable groups, Structure theory of finite abelian groups, Subgroup generated by a subset of a group, Commutator subgroup of a group.

Unit-3: Action of a group on a set, Kernel of an action, Stabilizer subgroups and orbit decomposition, Class equation of an action, Transitive actions, Equivalence of an action, Subnormal and normal series of a group, Refinement and length of a subnormal series.

Unit-4: Composition series of a group, Jordan-Holder theorem, Solvable groups and related results, n-th derived subgroups, Upper central and lower central series of a group, Nilpotent groups, Relation between solvable and nilpotent groups, Zassenhaus theorem, Schreier refinement theorem.

Books Recommended


1. I. N. Herstein, *Topics in Algebra*, 3rd ed., Wiley, New York, 1996.
2. J. B. Fraleigh, *A first Course in Abstract Algebra*, Pearson Edu. Ltd., U.S.A. 2014.
3. J. A. Gallian, *Contemporary Abstract Algebra*, Narosa Publ. House, New Delhi, 1998.
4. S. Singh and Q. Zameeruddin: *Modern Algebra*, Vikas Publ. House, New Delhi, 2002.
5. I. S. Luthar and I.B.S. Passi, *Algebra, Vol.1: Groups*, Narosa Pub. House, New Delhi, 1999.
6. M. Artin, *Algebra*, Prentice-Hall of India, New Delhi, 1994.

**MAS-203 Theory of Partial Differential Equations L/T/P: 4/0/0**

Unit-1: Classification of partial differential equations and examples.
**First order equations:** Cauchy problems, Method of characteristics, Quasilinear and non-linear equations. Cauchy-Kowalewski's theorem, Monge cone, Lagrange's method, Conservation laws and shocks.

Unit-2: **Second order equations:** Preliminaries, Classification, Characteristics, Canonical forms. Riemann's method and applications, Separation of variables method for the heat, Laplace and wave equations.

Unit-3: **Wave Equation:** Well-posedness of Cauchy problems for wave equation in $\mathbb{R}^n$, d'Alembert solution, Spherical means. Method of decent. Initial-boundary value problems on bounded domains in $\mathbb{R}$, and well-posedness. Uniqueness via energy method. Nonhomogeneous equations and Duhamel principle.

Unit-4: **Laplace equation:** Fundamental solution, Boundary value problems, Mean value property and its consequences, Poisson's formula. Existence theorem by Perron's method.
**Heat equation:** Fundamental solution, Initial and boundary value problems, Maximum principle, Uniqueness results. Green's functions for Heat equation and properties.

Books Recommended


1. F. John: *Partial differential equations*, Springer, (1982).
2. L.C. Evans: *Partial differential equations*, *Graduate Studies in Mathematics*, American Mathematical Society, Providence, RI, (1998).
3. G. B. Folland: *Introduction to Partial Differential Equations*, Princeton University Press; Revised edition (1996)
4. Y. Pinchover and J. Rubinstein: *An introduction to partial differential equations*, Cambridge, (2005)


**MAS-204 Complex Analysis L/T/P: 4/0/0**

Unit-1: Multivalued functions, Argument function, branch point, branch cut, Analytic functions, Cauchy Riemann equations, Harmonic functions, Review of complex line integral and its properties, ML-inequality, Cauchy-Goursat theorems for simply and multiply connected domains.

Unit-2: Index of a closed curve (winding numbers), Cauchy's integral formulas and their consequences: Derivatives of an analytic function, Cauchy's inequality theorem, Liouville's theorem, Morera's theorem, Fundamental theorem of integral calculus. Expansion of functions as power series: Taylor's theorem, Laurant's theorem.

Unit-3: Zeros and singularities of an analytic function, Characterization of a polynomial, Fundamental theorem of Algebra, Argument principal, Rouche's theorem, Residues, Cauchy residue theorem, Applications of residue theorem in evaluation of real integrals and sum of series.

Unit-4: Conformal mappings and their properties, Some elementary transformations, Bilinear (Möbius) transformation, Maximum modulus theorem, Riemann Mapping Theorem. Schwarz Lemma, Analytic Continuation.

Books Recommended


1. J. B. Conway, *Functions of one Complex variable*, Narosa Publishing House, New Delhi.
2. L.V. Ahlfors, "*Complex Analysis*: An introduction to the theory of analytic function of one complex variable", McGraw-Hill.
3. J. Brown, R. Churchill, "*Complex Variables and Applications*", McGraw Hill Higher Education.
4. S. Ponnusamy, "*Foundations of Complex Analysis*", Narosa Publication, New Delhi.


**MAS-205 Operations Research L/T/P: 4/0/0**

Unit-1: Theory of Simplex method, Two-Phase Simplex method, Big-M method. Duality in LPP, Weak duality theorem, Basic duality theorem, Complementary slackness conditions, Dual Simplex method,

Unit-2: Sensitivity Analysis, Discrete change in price vector, requirement vector and coefficient matrix, adding a new variable and new constraints, Integer Programming, Gomory's constraint method, Goal Programming,

Unit-3: Dynamic programming, Bellman's Principle of Optimality, Basic characteristics of Queuing models, Arrival and Departure pattern, Model-I (M/M/1: ∞/FCFS) Single server with infinite Capacity, Model-II (M/M/s: ∞/FCFS) Multiple servers with

infinite capacity, Model-III (M/M/1: N/ FCFS) Single server with finite capacity, Model-IV (M/M/s: N/FCFS) Multiple servers with finite capacity

Unit-4: Nonlinear Programming Problem (NLPP), Lagrange multiplier method, Graphical method for NLPP, Kuhn-Tucker Conditions for Constrained Optimization, Quadratic Programming, Wolfe's modified Simplex method, Separable Programming.

Books Recommended


1. H. A. Taha, *Operations Research*, 9th edition, Pearson Education, 2014.
2. Hillier and Lieberman, *Introduction to Operations Research*, McGraw Hill, 1995.
3. S. D. Sharma, *Operations Research*, Kedar Nath Ram Nath Publishers.
4. J. K. Sharma, *Operations Research – Theory and Application*, Macmillian Publication, 2009.