

M.Sc. MATHS

FIRST YEAR

PAPERS	Subject	Max. Marks	Exam Hrs
1	Algebra I	100	3
2	Real Analysis	100	3
3	Differential Geometry and Differential Equations	100	3
4	Set Topology and Theory of Relativity	100	3
5	Analytical Mechanics and Tensor Analysis	100	3

SECOND YEAR

PAPERS	Subject	Max. Marks	Exam Hrs
1	Algebra II	100	3
2	Complex Analysis	100	3
3	Functional Analysis	100	3
4	Graph Theory	100	3
5	Optimization Techniques	100	3

FIRST YEAR

Paper – 1

ALGEBRA

UNIT – I

Definition of a group – Examples of group – Some Preliminary lemmas – Sub groups – A counting Principle – Normal Sub groups and quotient groups – Homomorphisms and auto – morphisms.

UNIT – II

Cayley's theorem – Permutation groups – Anolnes counting principle and Aylouc's theorem.

UNIT – III

Definition and examples of ring – Some special classes of rings – Homomorphisms – Ideals and quotient rings – the field of quotients of an integral domain.

UNIT – IV

Euclidean rings – A particular Euclidean rings – Ploynomial rings – Polynomials over the rational field and polynomial rings over commutative rings.

UNIT – V

Elementary basic concepts of vector spaces – Lineor Independence and bases Dual spaces – Innter product spaces and modules.

Text Books :

1. Content and treatment as in the book “ TOPICS IN ALGEBRA” , by I.N. Herstem Vikas Publishing House (Second Edition), New Delhi. 1975. for units I to IV chapters 2,3 and 4 (except sections 2.13 and 2.14).

Paper – 2
REAL ANALYSIS

UNIT – I

Derivatives : Definition of Derivatives – Derivatives and continuity – Algebra of derivatives – The chain rule – one sided derivatives and infinite derivatives Function with non Zero derivatives and local extrema – Rolle theorem – The mean value theorem for derivatives – Intermediate – Value theorem for derivatives and Taylor’s formula with remainder.

UNIT – II

The Riemann – Stieltjes Integral :- The definition of Riemann – Stieltjes integral – Linear properties – Integration by parts – Change of variables in a Riemann – Stieltjes integral – Reduction to a Riemann step function as integrators – Reduction of a Riemann – Stieltjes integral to a finite sum – Euler’s summation formula – Monotonically increasing integrations – upper and lower integrals – Additive and linear properties of upper and lower integrals – Riemann’s condition – comparison theorems – Integrators of bounded variation – sufficient condition – existence of Riemann – Stieltjes integrals and necessary conditions for existence of Riemann – Stieltjes integral.

UNIT – III

Riemann – Stieltjes Integrals continued : Mean-value theorems for Riemann – Stieltjes integrals – The integral as a function of the interval – Second fundamental theorem of integral calculus – change of variable in a Riemann integral – Second mean – value theorem for Riemann – Integrals – Riemann – Stieltjes integrals depending on a parameter – Differentiation under the integral sign and interchanging the order of integration.

UNIT – IV

Infinite products :- Infinite products Test for convergence of product – Absolute convergence – Rearrangement of factors in a product – Tannery’s theorem – Infinite product for trigonometric functions and hyperbolic functions and Bernoulli numbers.

Lebesgue Measure :- Outer measure – Measurable sets and Lebesgue measure – A non measurable set – Measurable functions and Lebesgue’s three principles.

UNIT – V

Lebesgue Integral :- Lebesgue integral of bounded measurable function over a set of finite measure
Integral of a non negative function – General Lebesgue Integral – Derivative of monotonic function – Functions of bounded variation – Derivation of an integral – Absolute continuity.

Reference Books :

1. Content and Treatment as in the book “Mathematical Analysis” by Tom Apostol Narpsa Publishing House, Madras, 1985. (For units I to III).
2. For Unit -IV : Content and treatment in chapter – 8 (section 87, 88, 89, 91, 92, 94) of “Advanced Calculus” by G.A. GIBSON MAC MILLIAN Publishing Company, New York, 1954 and chapter – 3 (section 2, 3, 4, 5, 6) of Real analysis by H.L. Royden, Mac Millian Publishing Company, New York, 1986.
3. For Unit – V : Content and treatment as in chapter – 4 (section 2, 3, 4 only) and chapter – 5 (1, 2, 3, 4 only) of Real Analysis by H.L. Royden, Mac Millian Publishing Company, New York, 1986.

Paper – 3

DIFFERENTIAL GEOMETRY AND DIFFERENTIAL EQUATION

UNIT – I

The theory of space curves :- Arc length Tangent – Normal and Binormal – Curvature and Torsion of a curve given as the intersection of two surfaces – contact between curves and tangent surface – Involute and evolute – Intrinsic equations – fundamental existence theorem for space curves and Helices. Local intrinsic Properties of a surface :

UNIT – II

Definition of a surface – curves on a surface – Surface of revolution – Helicoids – Metric – Direction coefficient – families of Curves – Iso metric correspondence and Intrinsic properties. Local Intrinsic properties of a surface continued: Geodesics – Canonical geodesic equations – normal property of geodesics – existence theorems – Geodesic parallels – Geodesic curvature – Gauss – Bonnet theorems – Gaussian curvature – surface of constant curvature

UNIT – III

– conformal mapping and geodesic mapping. Differential geometry of surface in the large :- Compact surfaces whose points are umbilics – Hilbert's lemma – Compact surfaces of constant Gaussian or mean curvature – complete surfaces – characterization of complete surfaces – Hilbert's theorem (statement only) and conjugate points on geodesics.

UNIT – IV

The general solution of homogeneous equation the use of a known Solution to find another – the method of variation of parameters – Series Solution of First order equations – Second order linear equations – Ordinary Points – Regular singular Points and regular singular Points Continued. Legendre Polynomials – Properties of Legendre Polynomials. Bessel Functions – The gamma Function and properties of Bessel Functions.

UNIT – V

Origins of First – Order Partial differential equations – linear equations of the First order – Integral Surfaces Passing through a given curve – Surfaces orthogonal to a given system of surface – Compatible systems of First order equations and Jacobi's Charpit's method.

Text Books:

1. For units I and II : Content and treatment as in the chapters 3, 5 and 6 of the book “Differential equations with applications and historical notes” by George F Simmons, Tata McGraw Hill Publishing Company, New Delhi.
2. For Units III and V : Content and treatment as in the chapters 2, 3 and 5 of the book. “Elements of partial differential equations” by I. Sneddon, McGraw Hill International Edition, New Delhi, 1985.

Paper – 4

SET TOPOLOGY AND THEORY OF RELATIVITY

UNIT – I

Sets and functions : Sets and set inclusion, the algebra of sets, functions, product of sets. Partition and equivalence relations, countable sets, uncountable sets, Partially ordered sets and lattices.

Metric Spaces : Definitions and examples, open sets and closed sets, convergence, completeness and Baire's theorem, continuous mappings, space of continuous functions, Euclidean and Unitary spaces.

UNIT – II

Topological spaces : Definition and examples, elementary concepts, open base and open subbase, weak topologies and the function algebra.

Compactness: Compact spaces product of spaces, Tychonoff's theorem and locally compact spaces and compactness for metric spaces, Ascoli's theorem.

UNIT – III

Separation axioms : T₁ spaces, Hausdorff's spaces, completely regular spaces and normal spaces, Urysohn's lemma, the Tietze extension Theorem. The Urysohn's imbedding theorem, the Stone-Čech compactification.

UNIT – IV

Theory of Relativity:- Space time transformation – Four dimensional formulation of theory of Relativity, Relativity Mechanics, Optics and Electro-magnetism.

UNIT – V

General transformations in the space – time continuum. Geometrization of gravitation. – Experiment tests of Einstein's theory of Relativity.

Reference Book :

1. Introduction to Topology and Modern analysis by C.F. Simmons.
2. Contents as in chapters 1 to 8 of theory of Relativity by R.K. Pathria, Hindustan Publishing Corporation (India), New Delhi.

Paper – 5

ANALYTICAL MECHANICS AND TENSOR ANALYSIS

UNIT – I

Methods of dynamics in space. : Motion of practical motion of a system, moving frames of reference motion of rigid body and impulsive motion. Application of Dynamics in space – Motion of a Particle: Jacobian elliptic functions, single Pendulum, the spherical pendulum, the motion of a charged. Particle in an electro magnetic field and the effects on the Earth's rotation.

UNIT – II

Application of Dynamics in space – motion of a particle under no forces, the spinning top, gyroscopes and general motion of a rigid body.

UNIT – III

The equation of Lagrange and Hamilton : Introduction of Lagrange Equation Lagrange's equation continued, Hamilton's equations, action and Hamilton's principles The Hamilton – Jacobi equation and waves of constant action and phase spaces.

UNIT – IV

Tensor Analysis of coordinates – Properties of admissible transformations for coordinates – transformation by invariance – co-variance and contra-variance – The tensor concept – Contra-variance and covariant tensors and its laws – Algebra of tensors and relative tensors.

SECOND– YEAR

Paper – 6

ALGEBRA-II

UNIT – I

Extension fields, roots of Polynomials and more about roots.

UNIT – II

Treatments of Galois Theory and Solvability Radicals.

UNIT – III

The algebra of linear transformation, characteristic roots, matrices canonical forms and triangular form.

UNIT – IV

Nil potent transformation and their canonical forms, rational Canonical forms trace and transpose.

UNIT – V

Determinants, Hermitian, Unitary and Normal Transformation, quadratic forms finite fields and Wedder Burn's theorem on the finite division rings.

Text Book :

For units I to V content and treatment as in chapters V to VII of the book. "Topics in Algebra" by I.N. Herstein; Vikas Publishing House (Second edition), New York, 1975.

Paper – 7
COMPLEX ANALYSIS

UNIT – I

Fundamental theorems : Line integrals, rectifiable arcs, line integrals as functions of arcs, Cauchy's theorem for a rectangle and Cauchy's theorem for a circular disk.

Cauchy's integral formula : The index of a point with respect to a closed curve, the integral formula and higher derivatives.

Local properties of analytic functions : Removable singularities, Taylor's theorem, Zeros and Poles, the local mapping and the maximum principles.

UNIT – II

The general form of Cauchy's theorem : Chains and cycles, Simple connectivity, exact differentials in simply connected regions and multiply connected regions.

The calculus of Residues : The residue theorem, the argument principle and the evaluation of definite integrals.

Harmonic Functions : Definitions and basic properties the mean-value property, Poisson's Formula. Schwarz theorem and the reflection principle.

UNIT – III

Power series expansions : Weierstrass's theorem, the Taylor Series and the Laurent Series.

Partial Fractions and Factorization : Partial Fractions, infinite products and canonical products.

Entire functions : Jensen's Formula and Hadamard's theorem.

UNIT – IV

Normal Families : Equicontinuity, normality and compactness, Arzela's theorem, families of analytic functions and the classical definition.

The Riemann Mapping Theorem : Statement and the proof.

A closer look at Harmonic Functions: Functions with the mean value property and Harnack's Principle.

UNIT – V

Elliptic Function : Simply periodic functions and doubly periodic functions. The periodic module, Unimodular transformations, the canonical basis and the general properties of Elliptic functions.

The Weierstrass Theory : The Weierstrass – Function, the function $\zeta(z)$ and $\sigma(z)$ and the differential equation.

Reference Books:

1. For Units I to V content and treatment as in chapters 4, 5, 6 and 7 (except sections 5.24, 5.25, 6.12 to 6.14, 6.21 to 6.24, 6.41, 6.42, 6.51 to 6.55, 7.34 and 7.35) of the book, “Complex Analysis” by L.V. Ahlfors, Second Edition, McGraw Hill, Kogakusha limited, New Delhi, 1985.

Paper – 8

FUNCTIONAL ANALYSIS

UNIT – I

Banach spaces – Definition and examples – Holder's and Minkowski's inequalities
(*) continuous linear transformations – equivalence of various norms in l_p^n and locally compact normal linear space in finite separable iff N^* is so-conjugate spaces l_p^n and l_∞^n (*)
Natural imbedding of N into N^{**} - Any finite dimensional normal linear space is reflexive
- The open mapping theorem – The closed graph theorem – conjugate of an operator.

UNIT – II

Hilbert spaces – Some examples – orthogonal complements – Orthonormal results
– a Hilbert space H is separable if and only if every Orthonormal set is countable(*)
Orthogonal dimension of H (*). The conjugate space H^* - adjoint of an operator – self adjoint operators – normal and unitary operator projections.

UNIT – III

Finite dimensional spectral theory, matrices, Determinants and the spectrum of an operator, the spectral theorem.

UNIT – IV

The structure of commutative Banach Algebras. The Gelfand mapping applications of the formulae $r(x) = \|x\|^{1/n}$. Involutions in Banach algebras, the Gelfand Neumark Representations theorem.

Reference:

Introduction to Topology and Modern Analysis by C.F. Simmons.

Paper – 9
GRAPH THEORY

UNIT – I

Graphs and sub-graphs : Graphs and Simple graphs, graph Isomorphism, the incidence and adjacency matrices, sub-graphs, vertexdegrees, path problems.

Trees : Trees, cut edges and bounds, cut vertices, cayley's Formula and the connector problem.

UNIT – II

Connectivity : Connectivity, blocks and Construction of reliable communication network, Euler tours, Hamilton cycles, the Chinese postman problem and the traveling salesman problem.

UNIT – III

Matchings : Matchings and coverings in bipartite graphs, perfect matchings, the personnel assignment problem and the optimal assignment problem. Edge – Colourings : Edge chromatic number , Vizings's theorem and the tabling problem.

UNIT – IV

Independent Setss: Ramsey's theorem. Turan's theorem, Schur's theorem and a geometry problem.

Vertex Colorings: Chromatic numbers. Brook's theorem, Hajo's conjecture, chromatic polynomials, Girth and Chromatic number and a storage problem.

UNIT – V

Plan graphs: Plane and Planer graphs, dual graphs, Euler's Formula, bridges, kuratowski's theorem, the five colour theorem and the Four colour conjections non-Hamiltonian planer graphs and a planarity Algorithm.

Directed graphs: Directed path, directed cycles, a job sequencing problem, designing an efficient computer drum, making a road system one way and ranking the participants in a treatment.

Text Book:

1. For unit I to V, content and treatments as the chapters I to X (except section 1.9) of the book “Graph theory with applications” by J. A. Bondy and U.S.R Murthy, the MacMillan Press Limited, London, 1976.

Paper – 10
OPTIMIZATION TECHNIQUES

UNIT – I

The General Linear Programming Problem: The Linear – Programming problem – Properties of a solution to the linear programming program and generating extreme point solutions.

The Simplex Computational Procedures: Development of a minimum feasible solution – Computational procedure – The artificial basis techniques – A first feasible solution using slack variables – Geometric interpretation of the simplex procedure.

UNIT – II

The Revised Simplex Method: The general form of the inverse and the product form of the inverse.

The Duality Problems of Linear Programming: The Un-Symmetric primal – Dual problems – The Symmetric primal –Dual problem – Economic interpretation of the primal – Dual problems.

Degeneracy Problems: Perturbation techniques and example of Cycling.

UNIT – III

Additional Computation Techniques: Determining a first feasible solution – The dual simplex method and integer programming.

The Transportation Problem: The general transportation problem – Computational procedure for solving the transportation problem – Variation of transportation problem.

UNIT – IV

Decision Analysis and Games: Decision environments – Decision making under certainty – Decision making under risk – Decision under uncertainty and game theory.

UNIT – V

Probabilistic Inventory Model: Introduction – Continuous review models – Single period models and multi-period models.

Reference:

1. For units I to III the content and treatment as in chapter 3 to 7 and 9 to 10 of the book “Linear Programming Methods and Application” by Saul I. Gauses, McGraw Hill, Kogakusha Limited, 1975. fourth Edition, New Delhi.
2. For Units IV and V the content and treatment as in chapters 14 to 16 of the book “Operation Research – An Introduction” by Hamdy A. Taha, Macmillan Publishing Company, New York, 1987.