



COMPULSORY

PAPER – I

ADVANCED ABSTRACT ALGEBRA

Introduction- Permutation group, Normal Subgroup, Revisited Normaliser and commutator subgroup, three isomorphism theorem, Correspondence theorem, Maximum Normal Subgroup, Automorphism and Inner Automorphism, centre of group.

Normal Series, Normal and Subnormal series, Composition series
Jordan Holder theorem, Solvable group Nilpotent group.

Ring and Ideals - Definitions, Maximum and prime Ideals, Nilpotent and Nil Ideals Zorn's Lemma (Statement Only) its application to obtain maximal ideals.

Modules and vector space - Definition and examples sub modules, quotient modules, Direct sums, Modules generated by a set R Homomorphism of Modules, isomorphism theorem, exact sequence of modules, short exact sequence, cyclic modules, simple modules. semi simple modules Schur's Lemma, free modules Representation of Linear mapping, Rank of Linear mapping, Rank Nullity theorem.

Field Theory - Extension field, Algebraic and transcendental extension, separable and inseparable extension, Normal extension perfect field finite field, primitive elements, Algebraically closed field, Automorphism of extension, Galois extension, fundamental theorem of Galois theory.

Canonical Form - Similarity of Linear transformation invariant sub spaces Reduction to triangular form, Nilpotent transformation, Primary decomposition theorem, Jordan blocks and Jordan Form. Noetherian and Artinian modules and rings, Hilbert's basis theorem Wedderburn theorem.

REFERENCES :

1. P.B. Bhattacharya S.K. Jain and S.R. Nagpaul Basic Abstract Algebra (2nd Ed Cambridge University Press, Indian Edition 1997)
2. I.S. Luther and I.B.S. Passi, Algebra Vol. I Groups, Narosa Publishing House 1996
3. Surjeet and Quazizameeruddin Modern Algebra Vikas Publishing House Pvt. Ltd. 1990
4. N. Jacobson Basic Algebra Vols. I & II Hindustan Publishing Company 1980
5. S. Lang Algebra, 3rd Edition Addison Wesley. 1993.



COMPULSORY

PAPER- II

REAL ANALYSIS & MEASURE THEORY

Definition and existence of Riemann - stieltjes integral, Properties of the Integral, Integration and differentiation, the fundamental theorem of Calculus, Integration of vector - valued functions Rectifiable curves.

Rearrangements of terms of a series, Riemann's theorem

Sequences and series of functions, point wise and uniform convergence. Cauchy criterion for uniform convergence, Weierstrass M-Tests, Abel's and Dirichlet's tests for uniform convergence uniform convergence and continuity, uniform. convergence and Riemann - Stieltjes integration uniform convergence and differentiation , Weierstrass approximation theorem, Power series uniqueness theorem for power series, Abel's and Tauber's theorems.

Functions of several variables, linear transformations, Derivatives in an open subset of \mathbb{R} Chain rule, Partial derivatives, interchange of the order of differentiation, derivatives of high orders, Taylor's theorem, Inverse function theorem, Implicit function theorem, Jacobians, extreme Problems with constraints. Lagrange's multiplier method, Differentiation of integrals, Partitions unity, Differential forms, Stoke's theorem. Lebesgue outer measure, measurable set Borel and Lebesgue measurability Non measurable set measurable function.

Reiman and Lebesgue Integral, Integration of non - negative function, the general Integral, Integration of series.

Theory of Differentiation and integration, The Four – derivatives function of Bounded variations.

Measure and outer measure Extension of a measure: Uniqueness of extension on completion of measure, measure spaces, integration with respect to a measure.

The L^p Spaces , convex function, Jordon,s Inequality. Holder and Minkowski Inequality completeness of L^p

REFERENCES :

1. Walter Rubin Principles of Mathematical Analysis (3rd edition) McGraw Hill Kogakusha 1976 International student edition.
2. P.K. Jain and V.P. Gupta Lebesgue Measure and Integration , new age International Limited published, New Delhi 1986 (Reprint 2000)



**COMPULSORY
PAPER- III
TOPOLOGY**

Definition and examples of topological spaces. Closed sets Closure, Dense subsets. Neighbourhoods interior exterior and boundary. Accumulation points and derived sets. Bases and sub - bases. Subspaces and relative topology.

Alternate methods of defining a topology in terms of Kuratowski Closure Operator and Neighbourhood Systems.

Continuous Functions and homeomorphism.

First and Second Countable spaces. Lindelof's theorems. Separable spaces. Second Countability and Separability.

Separation. axioms $T_0, T_1, T_2, T_3, \dots, T_4$: Their Characterizations and basic properties. Uryhohn's lemma Tietze extension theorem.

Compactness- Continuous functions and compact sets. Basic properties of compactness Compactness and finite intersection property. Sequentially and countably compact sets. Local compactness and one point compactification, Stone - vech compactification. Compactness in metri spaces. Equivalence of compactness countable compactness and sequential compactness in metric spaces.

Connected spaces. Connectedness on the real line .Components Locally Connected spaces.

Tychon off product topology in .terms of standard sub - base and its characterizations projection maps. Separation axioms and product spaces. Connectedness and product spaces. Compactness and product spaces (Tychonoff's Theorem.) Countability and product

Spaces. Embedding and metrization Embedding lemma and Tychonoff embedding, the urysohn metrization Theorem.

Nets and filters. Topology and convergence of nets. Hausdorffness and nets. Compactness and nets. Filters and Their convergence, Canonical way of converting nets to filters and vice- verse. Ultra- filters and Compactnes.

REFERENCES :

1. G.F. Simmons Introduction to Topology and Modren Analysis. McGraw Hill
2. J.N. Shrama, Toplogy Krishna Prakashan Mandir Merrut.
3. M.J. Mansfield Introduction to Topology Van Nostrand Princeton New Jersey 1963
4. Jame R Munkres Topology, A First coure Prentice hall, Incorporated, 1974
5. K.D. joshi Introduction to General Topology New Age International (P) Ltd. New Dehli
6. JDugundji Topology Boston Allyn and Bacon, 1966 [OP]
7. B. Mendelson Introduction to Topology Dover Publication, 1990



**COMPULSORY
PAPER IV
COMPLEX ANALYSIS**

Complex Integration. Cauchy-Goursat. Theorem. Cauchy's integral Formula. Higher order derivatives. Morera's Theorem. Cauchy's inequality and Liouville's theorem. The fundamental theorem of algebra. Taylor's theorem. Maximum modulus principle Schwarz Lemma. Laurent's series. Isolated singularities. Meromorphic functions. The argument

principle. Rouché's theorem Inverse function theorem.

Residues. Cauchy's residue theorem. Evaluation of Integrals.

Bilinear transformations. their properties and classifications. Definitions and examples of conformal mappings.

Spaces of analytic functions. Hurwitz's theorem, Montel's theorem Riemann mapping theorem.

Weierstrass factorisation theorem. Gamma function and its properties Riemann Zeta function. Riemann's functional equation. Runge's theorem, Mittag - Leffler's theorem Analytic Continuation. Uniqueness of direct analytic continuation. Uniqueness of analytic continuation along a curve. Power series method of analytic continuation Schwarz Reflection principle Monodromy theorem and its consequences. Harmonic functions on a disk. Harnack's inequality and theorem. Dirichlet problem. Green's function.

Canonical products. Jensen's formula. Poisson– Jensen's formula. Poisson– Jensen

formula. Hadamard's three circles theorem. Order of an entire function. Exponent of Convergence. Borel's theorem. Hadamard's factorization theorem.

The range of an analytic function. Bloch's theorem. The little Picard theorem. Schottky's theorem. Montel Carathéodory and the Great Picard theorem.

REFERENCES :

1. J.B. Conway Functions of one complex variable Springer Verlag International student Edition Narosa Publishing House 1980
2. D. Sarason Complex Function theory. Hindustan Book Agency Delhi 1994
3. S.Ponnusamy Foundation of Complex Analysis Narosa publishing house 1997
4. J.N. Sharma Functions a complex variable, Krishna Prakash Mandir Meerut
5. B.S. Tyagi Functions of a Complex Variable Kedarnath Ram Nath Prakashan Meerut 1981



OPTIONAL
PAPER- I

ADVANCED DISCRETE MATHEMATICS

Formal Logic - Statement and Notation, Connectives- Negation, conjunction Disjunction, Truth Table, Conditional and Biconditional, statement well formed formula, Tautology, Equivalent formula, Duality Law functionally complete set of connectives, two state Devices and statement logic, Normal form, Principle conjunctives and Principle Disjunctive, Normal forms, The theory of inference for the statement, calculus, Rules of Inference, Automatic theorem proving, the predicate calculus, Quantifiers, Predicate formulas, Free and Bound variables Inference theory of predicate calculus, valid formulas, over finite Univers, valid formulas, involving quantifiers formulas Involving more than one quantifiers.

Algebraic Structure - Algebraic system, semigroup and Monoids, Definition and examples (Including these pertaining to concatenation operation) Homomorphism, of semigroup and monoids, congruence relation and quotient semigroups, subsemigroup and submonoids, Direct product Basic Homomorphism theorem.

Lattices – Lattice as partial ordered sets their properties, Lattice as Algebraic, system. sublattice, Direct Product and Homomorphism, Complete, Complemented, and Distributive lattice.

Boolean Algebras - Boolean Algebra as lattice, various Boolean Identities The switching Algebra, subAlgebra, Direct Products and Homomorphism Join - Irreducible Elements, Atom and Minterm, Boolean form and their Equivalence Minterm Boolean forms, sum of products, and products of sum canonical forms Minimization Boolean function, Application of Boolean Algebra, Switching Theory (Using AND, OR and NOT Gates)

Grammar and Language - Phrase Structure Grammar, Rewriting Rules Derivation, Sentential forms, context-sensitive context. Free and Regular grammars and Language Notation of syntax, Analysis, Polish Notation, Conversion of Infix expression to polish Notation the rename polish Notation.

Introductory Computability Theory - Finite state machines and their transition Table Diagrams, Equivalence of finite state machines, Reduced Machines. Homomorphism. Finite Automata Acceptors, Non Deterministic Finite Automata and equivalence of its power to that of Deterministic Finite Automata.

Graph Theory - Definition of (Undirected) Graphs, Paths, Circuits Cycles & Subgraphs Induced, subgraph, Degree of vertex. Connectivity, Planar Graphs and their properties. Trees, Euler's formula for connected Planar Graphs. Complete and complete Bipartite graphs, Kuratowski's Theorem (Statement Only) and its use. Spanning trees, Cut sets, Fundamental cut sets and cycles. Minimal Spanning Trees, Matrix. Representation of Graphs. Euler's Theorem on the Existence of Eulerian Paths Directed Graphs, In degree and out degree of a vertex Weighted undirected Graphs.

REFERENCES :

1. JP Tremblay & R Manohar Discrete Mathematical Structure with application to computer sciences McGraw Hill Book Co. 1997
2. Seymour Lepschutz. Finite Mathematics (International edition 1993) McGraw Hill book Co. New York.
3. N Deo Graph Theory with application to Engineering and Computer Sciences Prentice hall of India.
4. S. Wiitala Discrete Mathematics A unified approach McGraw Hill Book Co New York.
5. C.I. Liu Elements of Discrete mathematics McGraw Hill Book Col.
6. M.K. Gupta Discrete Mathematics Krishna Prakashan Mandir (P) Ltd. Meerut.

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OPTIONAL
PAPER– II
DIFFERENTIAL GEOMETRY OF MANIFOLDS

Definition and examples of differentiable manifolds. Tangent spaces jacobian map. One parameter group of transformation, Lie. derivatives. Immersions and imbeddings. Distribution exterior algebra. Exterior derivative.

Topological groups. Lie groups and lie algebras, Product of two. Liegroups. One parameter subgroups and exponential maps. Examples of Liegroups. Homomorphism and isomorphism. Lie Transformation Groups. General linear groups. Principal fibra bundle. Linear frame bundle. Associated fibre bundle. Vector bundle. Tangent bundle. Induced bundle.' Bundle homomorphisms.

Riemann ion manifolds. RiemaMian connection Curvature tensors. Sectional curvative Schur's theorem. Geodesics in a Riemannian manifold. Projective curvature tensor. Conformal curvature tensor.

Submanifolds & hypersurfaces Normals. Gauss's fomulae Weingarten equations Lines of curvature, Generalized Gauss and Mainard-Codozzi equations.

Almost complex manifolds. Nijenhuis tensor. Contravariant and covariant almost analytic vector field F - Connection.

Recommended Books :

1. R.S. Mishra Structures on a differentiable manifolds and their applications Chandrama Prakashan, Allahabad 1984
2. B.B. Sinha An Introduction to modern Differential Geometry kalyani publishers New Delhi 1982

References :

3. R.S. Mishra Acourse in tensors with applications to Riemannian Geometry, Pthishola Private Limited Allahabaad 1973
4. K Yano and M.Kon Structure of Manifods World scientific publishing company Private Limited 1984.