1. **ALGEBRA**

**Unit – I COUNTING PRINCIPLE**
Another counting principle - class equation for finite groups and its applications - Sylow’s theorems (For theorem 2.12.1, First proof only).- Solvable groups - Direct products - Finite abelian groups- Modules.

- **Chapter 2**: Sections 2.11 and 2.12 (Omit Lemma 2.12.5), 2.13 and 2.14 (Theorem 2.14.1 only)
- **Chapter 4**: Section 4.5
- **Chapter 5**: Section 5.7 (Lemma 5.7.1, Lemma 5.7.2, Theorem 5.7.1)

**Unit – II LINEAR TRANSFORMATIONS**

- **Chapter 6**: Sections 6.4, 6.5, 6.6 and 6.7

**Unit – III TRACE AND TRANSPOSE**
Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form - Extension fields – Transcendence of e.

- **Chapter 5**: Section 5.1 and 5.2
- **Chapter 6**: Sections 6.8, 6.10 and 6.11 (Omit 6.9)

**Unit – IV ROOTS OR POLYNOMIALS**
Roots or Polynomials - More about roots – Elements of Galois theory.

- **Chapter 5**: Sections 5.3, 5.5 and 5.6

**Unit – V FIELDS**
Finite fields - Wedderburn’s theorem on finite division rings- Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four - Square theorem.

- **Chapter 5**: Section 5.7 (omit Lemma 5.7.1, Lemma 5.7.2 and Theorem 5.7.1)
- **Chapter 7**: Sections 7.1, 7.2 (Theorem 7.2.1 only), 7.3 and 7.4

**Text Book:**

**Books for Supplementary Reading and Reference**


2. MODERN ALGEBRA

Unit I GROUP THEORY
A counting principle – Normal Subgroups and Quotient groups – Homomorphism – Cayley’s theorem – Permutation groups – Another counting principle – Sylow’s theorems.

Unit II RING THEORY
Homomorphism of rings – Ideals and quotient rings – More ideals and quotient rings – Polynomial rings – Polynomials over the rational field – polynomials over commutative rings.

Unit III MODULUS

Unit IV FIELDS

Unit V TRANSFORMATIONS
Triangular form – Hermitian, Unitary and Normal transformations.

Text Book
   UNIT – I - Chaper II : Sec 2.5, 2.6, 2.7, 2.10, 2.11, 2.12
   UNIT – II - Chapter III : Sec 3.3, 3.4, 3.5, 3.9, 3.10, 3.11
   UNIT – III- Chapter IV : Sec 4.1, 4.2, 4.3, 4.4, 4.5
   UNIT – IV- Chapter V : Sec 5.1, 5.3, 5.5, 5.6 and Chapter VII: Sec 7.1
   UNIT – V - Chapter VI : Sec 6.4, 6.5 and 6.10

Books for Supplementary Reading and Reference:


3. REAL ANALYSIS

Unit I: FUNCTIONS OF BOUNDED VARIATION
Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation – Additive property of total variation - Total variation on \([a, x]\) as a function of \(x\) - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.

Infinite Series: Absolute and conditional convergence - Dirichlet’s test and Abel’s test - Riemann’s theorem on conditionally convergent series. The Riemann - Stieltjes Integral - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts. Change of variable in a Riemann integral - Reduction to a Riemann integral - Euler’s summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper and lower integrals - Riemann’s condition - Comparison theorems.

Chapter 6: Sections 6.1 to 6.8 (Apostol)
Chapter 7: Sections 7.1 to 7.14 (Apostol)
Chapter 8: Sections 8.8, 8.15, 8.17, 8.18 (Apostol)

Unit II: THE RIEMANN-STIELTJES INTEGRAL
Integrators of bounded variation - Sufficient conditions for the existence of Riemann-Stieltjes integrals - Necessary conditions for the existence of Riemann-Stieltjes integrals - Mean value theorems for Riemann - Stieltjes integrals - The integrals 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 integral - Riemann-Stieltjes integrals depending on a parameter - Differentiation under the integral sign - Lebesgue criteria on for the existence of Riemann integrals.

Infinite Series and infinite Products

Chapter 8: Sections 8.20, 8.21 to 8.26

Power series
Multiplication of power series - The Taylor’s series generated by a function - Bernstein’s theorem - Abel’s limit theorem - Tauber’s theorem.

Chapter 7: Sections 7.18 to 7.26 (Apostol)

Unit III: SEQUENCES OF FUNCTIONS
Pointwise convergence of sequences of functions - Examples of sequences of real-valued functions - Definition of uniform convergence - Uniform convergence and continuity - The Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Uniform convergence and Riemann - Stieltjes integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence.

Fourier Series and Fourier Integrals
- Sufficient conditions for convergence of a Fourier series at a particular point – Cesaro summability of Fourier series- Consequences of Fejes’s theorem - The Weierstrass approximation theorem.

Chapter 9 : Sections 9.1 to 9.6, 9.8, 9.10, 9.11, 9.13 (Apostol)
Chapter 11 : Sections 11.1 to 11.15 (Apostol)

Unit IV MEASURE ON THE REAL LINE
Lebesgue Outer Measure - Measurable sets - Regularity - Measurable Functions – Borel and Lebesgue Measurability

Integration of Functions of a Real variable
Integration of Non- negative functions - The General Integral - Riemann and Lebesgue Integrals

Chapter 2 Sec 2.1 to 2.5 (de Barra)
Chapter 3 Sec 3.1, 3.2 and 3.4 (de Barra)

Unit V MULTIVARIABLE DIFFERENTIAL CALCULUS
Introduction - The Directional derivative - Directional derivative and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability – A sufficient condition for equality of mixed partial derivatives - Taylor’s theorem for functions of R^n to R^1

Implicit Functions and Extremum Problems
Functions with non-zero Jacobian determinants – The inverse function theorem- The Implicit function theorem- Extrema of real valued functions of severable variables- Extremum problems with side conditions.

Chapter 12 : Section 12.1 to 12.14 (Apostol)
Chapter 13 : Sections 13.1 to 13.7 (Apostol)

Text Book:

2. G. de Barra, Measure Theory and Integration, Wiley Eastern Ltd., New Delhi, 1981. (UNIT IV)

Books for Supplementary Reading and Reference:


4. DIFFERENTIAL EQUATIONS

Unit I  LINEAR DIFFERENTIAL EQUATIONS
Legendre polynomials – Legendre’s equation and its solution – Legendre polynomial of degree n – generating function for Legendre polynomials – Orthogonal properties of Legendre’s polynomials.

Unit II POLYNOMIAL OF ORDER n
Bessel’s equations and its solution – Bessel’s function of the first kind of order n- List of important results of Gamma and Beta functions – Hermite equation and its solution Hermite polynomial of order n – Orthogonal properties of the Hermite polynomials.

Unit III SPECIAL EQUATIONS
Hyperbolic function, General hyperbolic function – Hypogeometric equation –Solution of hypogeometric equations – Gauss Theore- Vandermonde’s Theorem – Kummer’s Theorem.

Unit IV LINEAR PARTIAL DIFFERENTIAL EQUATIONS OF ORDER ONE

Unit V NON LINEAR PARTIAL DIFFERENTIAL EQUATIONS OF ORDER ONE
Complex integral – Partial integral, Singular integral- Compatible system of first order equations – Charpit’s method of characteristic for solving non linear partial differential equations

Text Book:

Books for Supplementary Reading and Reference:
5. NUMBER THEORY

Unit I THE FUNDAMENTAL THEOREM OF ARITHMETIC
Introduction – Divisibility – Greatest Common Divisor – Prime Numbers – the Fundamental theorem of arithmetic – the serious of reciprocals of the primes – The Euclidean algorithm– The greatest common divisor of more than two numbers.

Unit II ARITHMETICAL FUNCTIONS AND DIRICHLET PRODUCT

Unit III MULTIPLICATIVE FUNCTION , DIRICHLET MULTIPLICATION AND THE DIVISOR FUNCTION

Unit IV AVERAGES OF ARITHMETICAL FUNCTIONS
Introduction – The big oh notation,Asymptotic equality of function – Euler’s summation formula – Some elementary asymptotic formulas –The average order of d(n)- The average order of the divisor functions $\sigma_\alpha(n)$ - The average order of $\varphi(n)$ - The average order of $\mu(n)$ and $\Lambda(n)$- The partial sums of a Dirichlet product.

Unit V CONGRUENCES AND PRIMITIVE ROOTS
Definition and basic properties of congruences – Residues classes and complete residue systems – Linear congruences – Reduced residue systems and the Euler - The exponent of a number mod m.Primitive roots – Primitive and reduced residue systems – the nonexistence of primitive roots mod $2^\alpha$ for $\alpha \geq 3$ - the existence of primitive roots mod $p$ for odd primes $p$ – Primitive roots and quadratic residues.

Text Book:

Books for Reading and Reference:

3. S.B.MAlik, Basic Number Theory, Vikas Publishing Pvt Ltd.

6. TOPOLOGY

Unit I  TOPOLOGICAL SPACES AND CONTINUOUS FUNCTION
Connectedness and compactness: Connected subspace of the real line – Compact spaces – Compact subspaces of the real line

Unit II COUNTABILITY AND SEPARATION AXIOMS
The countability axioms – The separation axioms – Normal spaces _ The Urysohn lemma – The Urysohn metrization Theorems – The Tychonoff Theorem.

Unit III THE FUNDAMENTAL GROUP
Homotopy of paths - The fundamental group- Covering spaces – The fundamental Theorem of Algebra – The fundamental group of $S^n$.

Unit IV SEPARATION THEOREM IN THE PLANE
The Jordan separation Theorem – The Jordan curve Theorem – Imbedding graphs in the plane – The winding number of a simple closed curve – The Cauchy Integral formula.

Unit V CLASSIFICATION OF SURFACE
Fundamental group of surfaces – Homology of surfaces – Cutting and pasting – The classification Theorem – Constructing compact surface.

Text Book

Books for Supplementary Reading and Reference:
1. *Introduction to Topology and Modern Analysis*, G. F. Simmons, Tata Mcgraw Hill publications.
7. GRAPH THEORY

Unit I GRAPHS, SUBGRAPHS, TREES AND CONNECTIVITY

Unit II MATCHINGS, INDEPENDENT SETS AND CLIQUES
Matchings – Matchings and Coverings in Bipartite Graph- Perfect Matchings –Independent Sets – Ramsey’s Thorem.

Unit III EDGE COLOURINGS AND VERTEX COLOURINGS
Edges Chromatic Number – Vizing’s Theorm – the Timetabling Problem – Chromatic Number – Brooks’ Theorem – Hajos’ Conjecture – Chromatic Polynomials – Girth and Chromatic Number.

Unit IV DIRECTED GRAPHS

Unit V LABELINGS AND DOMINATION

Books for Reading and Reference:
1. J.A. Bondy and U.S.R. Murty, *Graph Theory with Applications*, North- Holland, 1976. (Unit I to Unit IV)
2. Dr. M. Murugan, *Graph Theory and Algorithms*, Muthali Publishing House, Anna Nager, Chennai (Unit V)
8. NUMERICAL METHODS

Unit I TRANSCENDAL AND POLYNOMIAL EQUATIONS
Bisection Method – Iteration Methods Based on First Degree Equation - Iteration Methods Based on Second Degree Equation- Methods for Complex Roots – Polynomial Equations.

Unit II SYSTEM OF LINEAR ALGEBRIC EQUATIONS AND EIGENVALUE PROBLEMS
Direct Methods- Error Analysis – Iteration Methods – Eigenvalues and Eigenvectors

Unit III INTERPOLATION AND APPROXIMATION

Unit IV DIFFERENTATION AND INTEGRATION

Unit V ORDINARY DIFFERENTIAL EQUATIONS
Numerical Methods – Singlestep Methods – Multistep Methods – Modified predictor – corrector method

Books for Reading and Reference:
2. Sastry, Introductory Methods of Numerical Analysis
3. P.Kandasamy, K Thilagavathy, k Gunavathi, Numerical Methods
9. STOCHASTIC PROCESS

Unit I LIMIT THEOREMS
Probability spaces, random variables, independence - Kolmogorov’s 0-1 law, Borel-Cantelli lemma - Integration, Expectation, Variance - Results from real Analysis - Some inequalities - The weak law of large numbers - The probability distribution function - Convergence of random variables - The strong law of large numbers

Unit II THE CENTRAL LIMIT THEOREM
The Birkhoff ergodic theorem - More convergence results - Classes of random variables - Weak convergence - The central limit theorem - Entropy of distributions - Markov operators - Characteristic function - The law of the iterated logarithm -

Unit III DISCRETE STOCHASTIC PROCESS
Conditional Expectation - Martingales - Doob’s convergence - Levy’s upward and downward theorems - Doob’s decomposition of a stochastic process - Random walks - The random walk on the free group - Markov process

Unit IV CONTINUOUS STOCHASTIC PROCESS
Brownian motion - Some properties of Brownian motion - The Wiener measure - Levy’s modulus of continuity - Stopping Times - Continuous time martingales - Doob inequalities - Self-intersection of Brownian motion - Recurrence of Brownian motion - Neighborhood of Brownian motion

Unit V SELECTED TOPICS

Books for Reading and Reference:
10. DIGITAL TOPOLOGY

Unit I  THE DIGITAL PLANE


Unit II  EMBEDDING THE DIGITAL PLANE

Line Complexes: Theorems on Line Complexes with proof, Euler’s Theorem on Line Complexes. Cellular Topology: Definition, Closed Models, Open Models, Theorems on open and closed models.

Unit III  AXIOMATIC DIGITAL TOPOLOGY


Unit IV  SEMI-TOPOLOGY

Definitions, Homeomorphic Spaces and Examples, The Associated Topological Spaces and Examples, Theorems, Classifications, Related Concepts, Theorems, Connectedness, Ordered Sets.

UNIT V  APPLICATIONS TO IMAGE PROCESSING


Text Books:

2. Digital Topology; Introduction and survey By T.Y.Kong and A.Rosenfield
11. FORMAL LANGUAGE AND AUTOMATA

Unit I THREE BASIC CONCEPTS
Languages – Grammars – Automata deterministic finite accepters – Deterministic finite accepters - Deterministic accepters and Transition groups – Languages and deterministic finite automata – Regular Languages, non deterministic finite accepters, equivalence of NFA and DFA reduction of the number of states in finite automata.

Unit II REGULAR EXPRESSION
Definitions – Languages associated with regular expressions, connection between regular expressions and regular Languages- Regular expressions denote regular Languages - Regular expressions for regular Languages, Regular, Regular grammars: Right and left, Linear grammars, Right linear grammars, generate regular Languages – Right linear Grammars for Regular Languages – Equivalence of regular Languages and Regular Grammars.

Unit III PROPERTIES OF REGULAR LANGUAGE
Closure properties of regular Languages: Closure under simplest operations – Closure under other operations, identifying non-regular Languages using the Pigeonhole Principle – A pumping Lemma – Context free Grammars: examples left most and rightmost derivations – Derivation trees – Relation between sentential forms and derivation forms. Parting and Ambiguity: Parting and membership – Ambiguity in Grammars and Languages.

Unit IV METHODS FOR TRANSFORMATION GRAMMAR

Unit V FUZZY GRAMMARS

Text Book
1. An introduction to formal Languages and Automata, Peter Linz 5th edition.
   Unit I: Chapter 1 : 1.2, Chapter 2.
   Unit II: Chapter 3.
   Unit III: Chapter 4: 4.1 and 4.3. and Chapter : 5.1 and 5.2.
   Unit IV: Chapter 6 : 6.1 and 6.2 and Chapter 8 : 8.1.
   Unit IV: Chapter 1: Section 1.4 and Chapter 4. Section 4.1 -4.4.
12. FUZZY GRAPH THEORY

Unit I FUZZY SETS AND FUZZY RELATIONS
Introduction - Fuzzy sets and Fuzzy sets operators – Fuzzy relations – Composition of Fuzzy relations – Properties of Fuzzy relations

Unit II FUZZY GRAPH
Introduction to fuzzy graph – Operations of fuzzy graphs – Paths and connectedness

Unit III FUZZY TREE AND FUZZY FOREST
Fuzzy Bridge and Fuzzy Cut Nodes – Fuzzy Forest and Fuzzy Trees – Geodesics – Triangle and Parallelogram laws

Unit IV FUZZY BIPARTITE GRAPHS

Unit V DOMINATION IN FUZZY GRAPHS
Fuzzy Independent set – Bounds – More Adjacency in Fuzzy graph – Automorphism of fuzzy graphs – Regular fuzzy graph

Books for Reading and Reference:
1. A. Nagoorgani, V.T. Chanrasekaran: A First Look at Fuzzy Graph Theory, Allied Publishers Pvt. Ltd. 2010