

ANDHRA UNIVERSITY
Department of Mathematics

M.A/M.Sc(Mathematics) (for the students of AU Campus only)
(w.e.f. 2009-2010 admitted batch)

First Year:

First Semester: (All papers are compulsory)

M101: Algebra – I	No. of credit points:6
M102: Real Analysis	No. of credit points:6
M103: Topology – I	No. of credit points:6
M104: Differential Equations – I	No. of credit points:6
M105: Discrete Mathematics	No. of credit points:6

Second Semester: (the first four papers are compulsory and the fifth paper is C B C S)

M201: Algebra – II	No. of credit points:6
M202: Linear Algebra	No. of credit points:6
M203: Topology – II	No. of credit points:6
M204: Complex Analysis	No. of credit points:6
M205: C B C S: Discrete Mathematics and Coding Theory	No. of credit points:6

Second Year:

Third Semester: (The first four papers are compulsory and the fifth paper is C B C S)

M301: Functional Analysis (Compulsory) No. of credit points:6

M302: (Stream A): The candidate has to choose one of the following three papers.

M302(1): Number Theory – I : No. of credit points:6

M302(2): Universal Algebra –I: No. of credit points:6

M302(3): Fractal Geometry : No. of credit points:6

M303: (Stream B): The candidate has to choose one of the following three papers.

M303(1): Lattice Theory – I :No. of credit points:6

M303(2): Operations Research – I :No. of credit points:6

M303(3): Mathematical Biology :No. of credit points:6

M304: (Stream C): The candidate has to choose one of the following three papers.

M304(1): Commutative Algebra – I: No. of credit points:6

M304(2): Semigroups – I : No. of credit points:6

M304(3): Operator Theory : No. of credit points:6

M305: CBCS :Linear Algebra and Number Theory: No. of credit points: 6

Fourth Semester: (All papers are compulsory)

M401: Measure and Integration (Compulsory): No. of credit points:6

M402: (Stream A): The candidate has to choose one of the following three papers.:

M402(1): Number Theory – II (Prerequisite Number Theory – I):
No. of credit points:6

M402(2): Universal Algebra – II (Prerequisite Universal Algebra – I):
No. of credit points:6:

M402(3): Differential Equations – II: No. of credit points:6

M403: (Stream B): The candidate has to choose one of the following three papers.

M403(1): Lattice Theory – II (Prerequisite Lattice Theory – I):
No. of credit points:6

M403(2): Operations Research – II (Prerequisite Operations
Research – I): No. of credit points:6

M403(3): Mathematical Bio-economics (Prerequisite Mathematical Biology):
No. of credit points:6

M403(4): Banach Algebras No.of credit points: 6

M404: (Stream C): The candidate has to choose one of the following three papers.

M404(1): Commutative Algebra–II (Prerequisite Commutative Algebra–I)
No. of credit points: 6

M404(2): Semigroups – II (Prerequisite Semigroups – I): No. of credit points: 6

M404(3): Nonlinear Functional Analysis: No. of credit points: 6

M404(4): Graph Theory: No. of credit points: 6

M405: Partial Differential Equations (Compulsory): No. of credit points:6

Viva-Voce Examination (at the end of fourth semester for 100 marks): No.of credit points: 6

There will be an examination at the end of each semester in which each paper is for 85 marks and the remaining 15 marks will be taken as the average of two mid examinations – (1) written examination and (2) on line examination.

All the papers in the first and fourth semesters are compulsory. In each of the second and third semesters, the first four papers are compulsory and the fifth paper is placed for choice based credit system(C B C S).The candidate has to choose one paper from each of the three streams(in each of the third and fourth semesters) so that the examinations are completed within 5 days in each semester. There will be a Viva-Voce examination at the end of Fourth semester for 100 marks with no.of credit points: 6

ANNEXURE-I (Syllabus)

**ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
I-SEMESTER
M 101 ALGEBRA – I**

UNIT I: Normal subgroups - Quotient groups - Isomorphism theorems – Automorphisms - Conjugacy and G-Sets - Cyclic Decomposition - Alternating group A_n – Simplicity of A_n .
Chapters 5 and 7 of the prescribed text book.

UNIT II: Direct Products - finitely generated abelian groups - Invariants of a finite abelian group - Sylow theorems - Groups of orders p^2 , pq .
Chapter 8 of the prescribed text book.

UNIT III : Ideals, Homomorphisms, Sum and direct sum of ideals, Maximal and Prime Ideals.
Chapter 10.1, 10.2, 10.3, 10.4 of the Prescribed text book.

UNIT IV: Nilpotent and Nil Ideals, Zorn's Lemma, unique factorization domains, Principal ideal domains, Polynomial rings over UFD
Chapter 10.5, 10.6 and Chapter 11 of the prescribed text book.
Prescribed Book : Basic Abstract Algebra: P. B. Bhattacharya, S. K. Jain and S. R. Nagapaul,
Second edition, reprinted in India 1997, 2000, 2001

**ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
I-SEMESTER
M 102 REAL ANALYSIS**

UNIT I: Definition and existence of the Riemann Stieltjes integral, Properties of the integral, integration and differentiation – the fundamental theorem of calculus – integration of vector valued functions – Rectifiable curves.

Chapter 6 of the text book.

UNIT II: Sequences and series of the functions – Pointwise and uniform convergence – uniform convergence and continuity – Uniform convergence and integration – uniform convergence and differentiation.

Sections 7.1 to 7.18 of Chapter 7 the of text book.

UNIT III: The Stone-Weierstrass Theorem - Power series – Abel's theorem – inversion in the order of summation – Taylor's theorem – uniqueness of power series.

Sections 7.26 to 7.33 of Chapter 7 and Sections 8.1 to 8.5 of Chapter 8 of the text book.

UNIT IV: Functions of several variables – linear transformations – Derivatives in an open subset of \mathbb{R}^n – Chain rule – Partial derivatives – The contraction principle – The inverse function theorem – the implicit functions theorem.

Sections 9.1 to 9.29 of Chapter 9 of the text book.

TEXT BOOK:

Walter Rudin – Principles of Mathematical Analysis (3rd edition), McGraw-Hill, International Book Company, 1976, International Student Edition.

ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
I-SEMESTER
M 103 TOPOLOGY-I

UNIT I: Finite sets – Countable and uncountable sets – infinite sets and the axiom of choice – well ordered sets – the maximum principle

Sections 6, 7, 9, 10 and 11 of Chapter I

UNIT II: Topological spaces – Basis for a Topology – The order topology – The product topology on $X \times Y$ – the subspace topology – closed sets and limit points

Sections 12 to 17 of Chapter 2

UNIT III: Continuous functions – the product topology – Metric spaces – the metric topology

Sections 18 to 21 of Chapter 2

UNIT IV: Connected spaces – connected subspaces of the real line – Compact spaces – compact subspaces of the real line – limit point compactness – Local compactness

Sections 23, 24, 26 to 29 of Chapter 3

Extent and content as in the book: Topology by James R. Munkers, Second edition, Pearson education Asia – Low price edition

ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
I-SEMESTER

M 104 DIFFERENTIAL EQUATIONS – I

UNIT I: Linear Differential equations of Higher Order: Preliminaries – Higher order linear differential equations – a modeling problem – Linear independence – equations with constant coefficients – equations with variable coefficients – wronskian – variation of parameters – some standard methods – method of Laplace transforms. Chapter 2 of prescribed text book.

UNIT II: Solutions of Differential equations in Power Series : Preliminaries – Second order linear equations with Ordinary points – Legendre equations with Legendre Polynomials – Second order equations with regular singular points – Properties of Bessel functions.

Chapter 3 of prescribed text book.

UNIT III : Systems of Linear Differential Equations : Preliminaries – Systems of First order equations – Model for arms competitions between two nations – Existence and uniqueness theorem – Fundamental matrix – Non homogeneous linear systems – Linear systems with constant coefficients – Linear systems with periodic coefficients. Chapter 4 of prescribed text book.

UNIT IV: Existence and Uniqueness of solutions: Preliminaries – successive approximations – Picard's theorem – Some examples – Continuation and dependence on initial conditions – Existence of solutions in the large – Existence and Uniqueness of solutions of systems – Fixed point method. Chapter 5 of prescribed text book.

Text book: S. G. Deo, V. Lakshmikantham and V. Raghavendra: Text book of Ordinary Differential Equations, Second edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997.

ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
I-SEMESTER

M 105 DISCRETE MATHEMATICS

UNIT I: Graphs, digraphs, network, multigraph, Elementary results, structure based on connectivity, characterizations, theorems on trees, tree distances, binary trees. Chapters 1, 2 and 3 of textbook I

UNIT II: Eulerian graphs, Hamiltonian graphs, Spanning trees, Fundamental cycles, unrestricted graphs, minimal spanning trees, kruskal algorithm, prims algorithm

Chapter 4 of text book I and 8.5 of text book II

UNIT III: Definitions of lattices, Modular lattices and distributive lattices. Chapter I of text book of III

UNIT IV: Basic properties, Boolean polynomials, ideals, minimal forms of Boolean polynomials, Application of Lattices, Switching circuits. Chapter 2 of text book III

Text Book I: Graph Theory applications By L. R. Foulds, Narosa publishing House, New Delhi

Text Book II: Discrete Mathematical Structures by Kolman and Busby and Sharen Ross, Prentice Hall of India-2000 3rd Edn.

Text Book III: Applied Abstract Algebra by Rudolf Lidl and Gunter Pilz, Published by Springer verlag.

ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
II-SEMESTER

M 201 ALGEBRA – II

UNIT I: Algebraic extension of fields: Irreducible polynomials and Eisenstein's criterion. Adjunction of roots. Algebraic extensions, Algebraically closed fields.

Chapter 15 of the prescribed text book

UNIT II: Normal and separable extensions: Splitting fields, Normal extensions, multiple roots, finite fields, separable extensions. Chapter 16 of the prescribed text book

UNIT III: Galois theory: Automorphism groups and fixed fields, fundamental theorem of Galois theory, Fundamental theorem of algebra.. Chapter 17 of the prescribed text book

UNIT IV: Applications of Galois theory to classical problems: Roots of unity and cyclotomic polynomials, cyclic extensions, polynomials solvable by radicals, symmetric functions, Ruler and compass constructions. Chapter 18 of the prescribed text book

Prescribed Book: Basic Abstract Algebra: P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Second edition, Cambridge University Press, printed and bound in India at Replika Press Pvt. Ltd., 2001.

ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
II-SEMESTER
M 202 LINEAR ALGEBRA

UNIT I: Elementary Canonical Forms: Introduction-Characteristic Values-Annihilating Polynomials-Invariant Subspaces-Simultaneous Triangulation-Simultaneous Diagonalization
Sections 6.1, 6.2, 6.3, 6.4, 6.5 of chapter 6 in Prescribed Text book

UNIT II: Direct-sum Decompositions-Invariant Direct Sums-The Primary Decomposition Theorem-Cyclic Subspaces and Annihilators-Cyclic Decompositions and the Rational Form.
Sections 6.6, 6.7, 6.8 of Chapter 6 and Sections 7.1, 7.2 of Chapter 7 in Prescribed Text book

UNIT III: The Jordan Form-Computation of Invariant Factors-Semi-Simple Operators
Sections 7.3, 7.4, 7.5 of Chapter 7 in Prescribed Text book

UNIT IV: Bilinear Forms: Bilinear Forms- Symmetric Bilinear Forms-Skew Symmetric Bilinear Forms-Group Preserving Bilinear Forms.

Sections 10.1, 10.2, 10.3, 10.4 of Chapter 10 in Prescribed Text book

Prescribed Text Book: Linear Algebra second edition By Kenneth Hoffman and Ray Kunze, Prentice-Hall of India Private Limited, New Delhi-110001, 2002

ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
II-SEMESTER
M 203 TOPOLOGY II

UNIT I: The countability axioms-the separation axioms, Normal Spaces, the Urysohn lemma-
Sections 30 to 33 of Chapter 4.

UNIT II: The Urysohn metrization theorem- the Tietze extension theorem. - Tychonoff's theorem-
the stone-cech compactification..Sections 34 to 35 of Chapter 4 and 37 and 38 of Chapter 5.

UNIT III: Local finiteness-The Nagata-Smirnov Metrization theorem - Complete metric spaces
Sections 39, 40 of chapter 6.

UNIT IV: Compactness in metric spaces-Point wise and compact convergence- Ascoli's theorem -
Baire space. Sections 45, 46 and 47 of chapter 7 and Section 48 of Chapter 8.

Content and extent as in the book

Topology by James R. Munkres, Second edition, Pearson education, Asia-low price edition

ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
II-SEMESTER
M 204 COMPLEX ANALYSIS

UNIT-I: Elementary properties and examples of analytic functions: Power series- Analytic
functions- Analytic functions as mappings, mobius transformations.

(\$1, \$2, \$3 of chapter-III of prescribed text book)

UNIT-II : Complex Integration: Riemann- Stieltjes integrals- Power series representation of
analytic functions- zeros of an analytic functions- The index of a closed curve.

(\$1, \$2, \$3 \$4 of chapter-IV of prescribed text book)

UNIT-III: Cauchy's theorem and integral formula- the homotopic version of cauchy's theorem and
simple connectivity- Counting zeros; the open mapping theorem.

(\$5, \$6, \$7 of chapter-IV of prescribed text book)

UNIT-IV: Singularities: Classifications of singularities- Residues- The argument
principle.Rouche's Theorem,,Maximum modulus Theorem,Schwarz's Lemma

(\$1, \$2, \$3 of chapter-V and \$1, \$2 of chapter VI of prescribed text book)

Prescribed text book: Functions of one complex variables by J.B.Conway : Second edition, Springer International student Edition, Narosa Publishing House, New Delhi.

ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
II-SEMESTER

M 205 : C B C S: DISCRETE MATHEMATICS AND CODING THEORY

UNIT I: Graphs, digraphs, network, multi graph, elementary results , structure based on connectivity, characterisation, theorems on trees, tree distances, binarytrees

Chapters 1, 2 and 3 of text book I

UNIT II: Eulerian graphs, Hamiltonian graphs, Spaning trees, Fundamental cycles, Minimal spanning trees,

(Chapter 4 of text book I)Kruskal algorithm, Prims algorithm (8.5 of text book II)

UNIT III: Introduction to Coding Theory: Introduction, Basic assumptions, correcting and detecting codes, Information rate, The effects of error detection and correction, Finding the most likely code word transmitted, Some basic algebra, Weight and distance, Maximum likelihood decoding, Reliability of M L D, Error detecting codes, Error corer correcting codes

Articles 1.1 to 1.12 of Chapter 1 of TEXT BOOK III

UNIT IV: Linear codes: Linear codes, Two Important subspaces, Independence, Basis, Dimension, Matrices, Bases for $C=\langle S \rangle$ and C , Generating matrices and Encoding, Parity check matrices, Equivalent codes, Distance of a Linear code, Cosets, M L D for Linear codes, Reliability of Linear codes-Articles 2.1 to 2.12 of TEXT BOOKIII

TEXT BOOK I: Graph Theory applications By L.R.Foulds, Narosa publishing House, New Delhi

TEXT BOOK II: Discrete mathematical structures by Kolman and Busby and Sharon Ross
Prentice Hall of India-2000, (Third Edition)

TEXT BOOK III: Coding Theory by D. G. Hoffman, D. A. Lanonard, C. C. Lindroes

ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
III-SEMESTER

M 301 FUNCTIONAL ANALYSIS

UNIT I: Banach spaces: The definition and some examples, continuous linear transformation, The Hahn-Banach theorem, the natural imbedding of N in N^{**} , The open mapping theorem.
Sections 46-50, Chapter 9.

UNIT II: The conjugate of an operator, Hilbert spaces: The definition and some simple properties, orthogonal complements, orthonormal sets. Section 51 of Chapter 9 and Sections 52-54, Chapter 10.

UNIT III: The conjugate space H^* , the adjoint of an operator, Self-adjoint operators, Normal and Unitary operators, Projections.. Sections 55-59, Chapter 10.

UNIT IV: Finite-dimensional spectral theory: Matrices, determinants and the spectrum of an operator, the spectral theorem. A survey of the situation.. Sections 60-63, Chapter 11.

Text Book: Introduction to Topology and Modern Analysis by G. F. Simmons, McGraw Hill Book Company. Inc-International student edition.

References:

1. Functional Analysis by B. V. Limaye, Willey Eastern Limited, Bombay 1981.
2. First Course in Functional Analysis, C. Goffman and George Pedrick, Prentice Hall of India Private Limited, New Delhi-110001

STREAM – A
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
III-SEMESTER
M 302(1)-NUMBER THEORY- I

UNIT-I:- ARITHMETICAL FUNCTIONS AND DIRICHLET MULTIPLICATION:-

Introduction- The Mobius function $\mu(n)$ – The Euler quotient function $\varphi(n)$ - A relation connecting φ and μ - A product formula for $\varphi(n)$ - The Dirichlet product of arithmetical functions- Dirichlet inverses and the Mobius inversion formula- The Mangoldt function $\Lambda(n)$ - multiplicative functions- multiplicative functions and Dirichlet multiplication- The inverse of a completely multiplicative function-Liouville's function $\lambda(n)$ - The divisor functions $\sigma_\alpha(n)$. Generalized convolutions. Chapter-2:- Articles 2.1 to 2.14

UNIT-II:- AVERAGES OF ARITHMETICAL FUNCTIONS:- Introduction- The big oh notation. Asymptotic equality of functions- 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 $\varphi(n)$ - An application to the distribution of lattice points visible from the origin- The average order of $\mu(n)$ and $\Lambda(n)$ -The partial sums of a Dirichlet product- Applications to $\mu(n)$ and $\Lambda(n)$ - Another identity for the partial sums of a Dirichlet product.

Chapter -3:- Articles 3.1 to 3.12

UNIT-III:- SOME ELEMENTARY THEOREMS ON THE DISTRIBUTION OF PRIME NUMBERS:- Introduction- Chebyshev's functions $\psi(x)$ and $\vartheta(x)$ - Relations connecting $\vartheta(x)$ and $\pi(x)$ - Some equivalent forms of the prime number theorem-Inequalities for $\pi(n)$ and p_n - Shapiro's Tauberian theorem- Applications of Shapiro's theorem- An asymptotic formula for the partial sums $\sum_{p \leq x} (1/p)$ - The partial sums of the Mobius function. Chapter-4:- Articles 4.1 to 4.9

UNIT-IV :- CONGRUENCES:- Definition and basic properties of congruences- Residue classes and complete residue systems- Linear congruences- Reduced residue systems and the Euler- Fermat theorem- Polynomial congruences modulo p . Lagrange's theorem- Applications of Lagrange's theorem- Simultaneous linear congruences. The Chinese remainder theorem- Applications of the Chinese remainder theorem- Polynomial congruences with prime power moduli.

Chapter -5:- Articles 5.1 to 5.9

TEXT BOOK: Introduction to Analytic Number Theory- By T.M.APOSTOL-
Springer Verlag-New York, Heidelberg-Berlin-1976.

STREAM – A
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
III-SEMESTER

M 302(2) : UNIVERSAL ALGEBRA-I

UNIT-I:- Definitions of Lattices – Isomorphisms of Lattices and Sub lattices- Distributive and Modular Lattices- Complete lattices- Equivalence relations- Algebraic lattices- Closure operators.

UNIT-II:- Definition and examples of algebras- Isomorphic algebras and sub algebras – Algebraic lattices and sub universes – The irredundant Basis theorem- Congruences and Quotient algebras- Homomorphisms – The homomorphism and isomorphism theorems.

UNIT-III:- Direct products- Factor congruences – Directly indecomposable algebras- Sub direct products- Subdirectly irreducible algebras- Simple algebras- Class operators- Varieties.

UNIT-IV:- Terms- Term algebras- Free algebras- Identities and Free algebras – Birkhoff’s theorem- Malcev conditions- The Centre of an algebra.

Prescribed Book: A course in Universal algebra- Stanley Burris, H.P. Sankappanavar, Springer-Verlag, New York- Heidelberg- Berlin.

STREAM – A
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
III-SEMESTER

M 302(3): FRACTAL GEOMETRY

UNIT-I:- Fractal examples- The triadic cantor dust- Construction by Tremas- Co-ordinates- Construction by translations- Iterated function systems- The Sierpinski gasket- Constructions by Tremas and by iterated functions systems- Space of strings- Turtle graphics- Sets defined recursively- The Koch curve – Heighway’s dragon- Sierpinski dragon - Number systems.

UNIT-II:- Metric topology- Metric spaces- Ultrametric spaces- Functions on metric spaces- Continuous functions- Isometries and similarities- Contraction mapping theorem- Separable and compact spaces- Number system.

UNIT-III:- Uniform convergence- Continuous curves- Space filling curves- The Hausdorff metric- Convergence of sets- Metrics for the strings.

UNIT-IV:- Topological dimension- Small inductive dimension- Number systems- Large inductive dimension- Separation of sets- Sum theorems.

Prescribed Book:

Measure, Topology and Fractal Geometry- Gerald A. Edgar- Springer- Verlag, 1990.

STREAM - B
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.Sc. MATHEMATICS-III SEMESTER
M 303(1) LATTICE THEORY-I

UNIT-I:- Partially Ordered sets- Diagrams- Special subsets of a poset –length- lower and upper bounds- the minimum and maximum condition- the Jordan Dedekind chain conditions – Dimension functions. (Sections 1 to 9 of chapter I of the prescribed text book)

UNIT-II:- Algebras-lattices- the lattice theoretic duality principle- semilattices- lattices as posets- diagrams of lattices- semi lattices, ideals-bound elements of Lattices-atoms and dual atoms-complements, relative complements, semi complements-irreducible and prime elements of a lattice-the homomorphism of a lattice-axioms systems of lattices.

(Sections 10 to 21 of chapter II of the prescribed text book)

UNIT-III:- Complete lattices- complete sublattices of a complete lattice- conditionally complete lattices- lattices – compact elements, compactly generated lattices- subalgebra lattice of an algebra-closure operations- Galois connections, Dedekind cuts- partially ordered sets as topological spaces.

(Sections 22 to 29 of chapter III of the prescribed text book)

UNIT-IV:- Distributive lattices-infinately distributive and completely distributive lattices-modular lattices-characterization of modular and distributive lattices by their sublattices- distributive sublattices of modular lattices- the isomorphism theorem of modular lattices, covering conditions-meet representations in modular and distributive lattices- some special subclasses of the class of modular lattices-preliminary theorems – modular lattices of locally finite length- the valuation of a lattice, metric and quasi metric lattices- complemented modular lattices.

(Sections 30 to 40 of Chapters IV and V of the prescribed text book)

Prescribed Text Book: Introduction to Lattice Theory, by Gabor Szasz, Academic Press, New York.

Book for reference: General Lattice Theory by G. Gratzner, Academic Press, New York.

STREAM – B
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
III-SEMESTER

M 303(2) OPERATIONS RESEARCH – I

UNIT I : Linear Programming: The Simplex Method – Overall Idea of the Simplex Method – Development of the Simplex Method – Primal Simplex method – Dual Simplex Method – Special cases in Simplex Method Applications – Sensitivity Analysis.

Sections 3.1 to 3.7 of the Chapter 3 in the Text Book

UNIT II : Revised Simplex Method and Duality: Mathematical Foundations – Revised (Primal) Simplex Method – Definition of the Dual Problem – Solution to the Dual Problem – Economic Interpretation of the Dual Problem.

Sections 4.1 to 4.3 of the Chapter 4 and sections 5.1 to 5.4 of Chapter 5 in the Text Book.

UNIT III: Transportation Model and Net Works: Definitions and Applications of the Transportation – Solution of the Transportation Problem – The Assignment Model – The Transshipment Model – Network Definitions – Minimal Spanning Tree problem – Shortest – Route Problem

Sections 6.1 to 6.5 of the Chapter 6 and sections 8.1 to 8.3 of the Chapter 8 in the Text Book.

UNIT IV : Network Models and Project Scheduling: Maximal Flow Problem – Minimum Cost Capacitated Flow Problem – Arrow (Network) Diagram Representations – Critical Path Calculations – Construction of the Time Chart and Resource Leveling.

Sections 8.4 to 8.6 of the Chapter 8 and sections 13.1 to 13.3 of the Chapter 13 in the Text Book.

Text Book: Operations Research, An Introduction: Hamdy A Taha, Maxwell Macmillan International Edition, New York, 1992.

STREAM – B
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
III-SEMESTER

M 303(3): MATHEMATICAL BIOLOGY

Unit I: Autonomous differential equations - Equilibrium solutions - Stability nature of equilibrium solutions, single species growth models involving exponential, logistic and Gompertz growths. Harvest models – bifurcations and break points. (Sections 1 and 2 of the Text Book)

Unit II: Lotka Volterra predator – prey model – phase plane analysis, General predator prey systems – equilibrium solutions – classification of equilibria – existence of cycles – Bendixson-Dulac’s negative criterion – functional responses. (Sections 7 and 8 of the text book)

Unit III: Global bifurcations in predator prey models – Freedman and Wolkowicz model - type IV functional response – Hopf bifurcation – Homoclinic orbits – Global bifurcations using Allee effect in prey – Competition models – Lotka – Volterra Competition model – exploitation competition models (Sections 9 and 12 of the text book)

Unit IV: Mutualism models – various types of mutualisms – cooperative systems – Harvest models and optimal control theory – open access fishery – sole owner fishery – Pontryagin’s maximum principle – Economic interpretation of Hamiltonian and adjoint variable. (Sections 13 and 14 of the text book)

Text book: Mark Kot, 2001, Elements of Mathematical Ecology, Cambridge University Press.

Reference: Nisbet and Gurney, 1982, Modelling Fluctuating Populations, John Wiley & Sons.

STREAM – C
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
III-SEMESTER

M 304(1): COMMUTATIVE ALGEBRA- I

UNIT-I: Rings and ring homomorphism, ideals, quotient rings, zero divisors, Nilpotent elements, units, prime ideals and Maximal ideals, nil radical and Jacobson radical, operations on ideals, Extensions and contractions.

UNIT-II: Modules and module homomorphisms, Sub modules and quotient modules, operations on submodules, Direct sum and product, finitely generated modules, exact sequences, Tensor product of modules, Restriction and extension of scalars, Exactness properties of the tensor product, algebras, tensor product of algebras.

UNIT-III: Local Properties, Extended and contracted ideals in rings of fractions.

UNIT-IV: Primary decompositions

Content and extent of chapters 1 to 4 of the prescribed text book.

Prescribed text book: Introduction to commutative algebra, By M.F. ATIYAH and I.G. MACDONALD, Addison-Wesley publishing Company, London.

STREAM – C
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
III-SEMESTER
M 304(2): SEMI GROUPS- I

UNIT-I: Basic definition, monogenic semigroups, ordered sets, semilattices and lattices, binary relations, equivalences and congruences.

UNIT-II: Free semigroups, Ideals and Rees' congruences, Lattices of equivalences and congruences. Green's equivalences, the structure of D-classes, regular semigroups.

UNIT-III: Simple and 0-simple semigroups, Principal factors, Rees' theorem, Primitive idempotents.

UNIT-IV: Congruences on completely 0-simple semi groups, The lattice of congruences on a completely 0-simple semigroup, Finite congruence free semigroups.

Contents of the syllabus-Chapters 1,2 and 3 of the text book.

Text Book: An introduction to semi group theory by J.M. Howie, 1976, Academic press, New York.

STREAM – C
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
III-SEMESTER
M 304(3) :OPERATOR THEORY

UNIT-I: Banach fixed point theorem- application of Banach's theorem to linear equations-application of Banach's theorem to differential equations-application of Banach's theorem to integral equations._Chapter 5 of the text book

UNIT-II: Approximation in normed spaces-Uniqueness, strict convexity-uniform approximation-Chebyshev polynomials – Splines._Sections 6.1 to 6.4 and 6.6 of Chapter 6 of the text book

UNIT-III: Spectral theory in finite dimensional Normed spaces-basic concepts-spectral properties of bounded linear operators-further properties of Resovent and spectrum-use of complex analysis in spectral theory._Sections 7.1 to 7.5 of Chapter 7 of the text book

UNIT-IV: Compact linear operator of normed spaces-Further properties of compact linear operators-Spectral properties of compact linear operators on normed spaces-further spectral properties of compact linear operators._Sections 8.1 to 8.4 of Chapter 8 of the text book.

Text book: Introductory Functional Analysis and Applications by Kreyszig, John Wiley and Sons, Delhi, 2001.

ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
III-SEMESTER
M 305: C B C S

LINEAR ALGEBRA AND NUMBER THEORY

UNIT I: Vector Spaces, Subspaces, Bases and dimension, Coordinates

Articles 2.1 to 2.4 of CHAPTER 1 OF TEXT BOOK I

UNIT II: Linear Transformations, The Algebra of Linear Transformations, Isomorphism, Representation of Linear Transformation by Matrices. Articles 3.1 to 3.4

UNIT III: Divisibility, Greatest Common Divisor, Prime numbers, The Fundamental Theorem of Arithmetic, The Euclidean Algorithm, Chapter 1 of Text book II

UNIT IV: Definition and Basic Properties of Congruences, Residue classes and Complete Residue Systems, Linear Congruences, Reduced Residue Systems, and the Euler Fermat Theorem Chapter 5 Of Text book II

TEXT BOOK I: LINEAR ALGEBRA by KENNETH HOFFMAN , RAY KUNZ
(Second Edition) Prentice Hall of India.

TEXT BOOK II: Introduction to Analytic Number Theory by TOM M APOSTOL ,
Springer Verlag, New York

ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
IV-SEMESTER

M 401: MEASURE AND INTEGRATION

UNIT-I: Lebesgue measure: Introduction, Outer measure, measurable sets and Lebesgue measure, A non-measurable set, measurable functions, Littlewood three principles. Chapter 3 of the Text book.

UNIT-II: The Lebesgue Integral: The Riemann integral, the Lebesgue Integral of a bounded function over a set of finite measure, the integral of a non-negative function, the general Lebesgue integral, convergence in measure. Chapter 4 of the text Book.

UNIT-III: Differentiation and Integration: Differentiation of monotone functions, functions of bounded variation and differentiation of an integral, absolute continuity and convex functions Chapter 5 of the Text book

UNIT-IV: The Classical Banach spaces: The L_p spaces, the Holder's and Minkowski's inequality, convergence and completeness, approximations in L_p spaces, Linear functionals on L_p spaces.

Chapter 6 of the Text book

Text Book: H. L. Royden- Real Analysis, Macmillan Publishing Company, New York, Third Edition, 1988.

STREAM – A
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
IV-SEMESTER
M 402(1): NUMBER THEORY- II
(Prerequisite NUMBER THEORY-I)

UNIT-I :- FINITE ABELIAN GROUPS AND THEIR CHARACTERS:-

Characters of finite abelian groups- The character group- The orthogonality relations- for characters- Dirichlet characters- Sums involving Dirichlet characters-The nonvanishing of $L(1, \chi)$ for real nonprincipal χ .

Introduction- Dirichlet's theorem for primes of the form $4n-1$ and $4n+1$ - The plan of the proof of Dirichlet's theorem- Proof of Lemma 7.4- Proof of Lemma 7.5- Proof of Lemma 7.6- Proof of Lemma 7.7- Proof of Lemma 7.8- Distribution of primes in arithmetic progressions.

Chapters 6 & 7:- Articles 6.5 to 6.10 and 7.1 to 7.9

UNIT-II:- PERIODIC ARITHMETICAL FUNCTIONS AND GAUSS SUMS:- Functions periodic modulo k - Existence of finite Fourier series for periodic arithmetical functions- Ramanujan's sum and generalizations- Multiplicative properties of the sums $s_k(n)$ - Gauss sums associated with Dirichlet characters-Dirichlet characters with nonvanishing Gauss sums- Induced moduli and primitive characters- Further properties of induced moduli- The conductor of a character- Primitive characters and separable Gauss sums- The finite Fourier series of the Dirichlet characters- Polya's inequality for the partial sums of primitive characters.

Chapter 8:- Articles 8.1 to 8.12.

UNIT-III:- QUADRATIC RESIDUES AND THE QUADRATIC RECIPROCITY LAW:-

Quadratic residues- Legendre's symbol and its properties- Evaluation of $(-1/p)$ and $(2/p)$ - Gauss Lemma-The quadratic reciprocity law-Applications of the reciprocity law- The Jacobi symbol- Applications to Diophantine equations- Gauss sums and the quadratic reciprocity law.

Chapter 9:- Articles 9.1 to 9.9

UNIT-IV:- PRIMITIVE ROOTS:- The exponent of a number mod m . Primitive roots- Primitive roots and reduced residue systems-The nonexistence of primitive roots mod 2^α for $\alpha \geq 3$ - The existence of primitive roots mod p for odd primes p . Primitive roots and quadratic residues- The existence of primitive roots mod p^α - The existence of primitive roots mod $2p^\alpha$ - The non existence of primitive roots in the remaining cases- The number of primitive roots mod m . The index calculus- Primitive roots and Dirichlet characters-Real-valued Dirichlet characters mod p^α - Primitive Dirichlet characters mod p^α .

Chapter- 10:- Articles 10.1 to 10.13.

TEXT BOOK: Introduction to Analytic Number Theory- By T.M.APOSTOL-
Springer Verlag-New York, Heidelberg-Berlin-1976.

STREAM – A
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
IV-SEMESTER
M 402(2): UNIVERSAL ALGEBRA-II
(PRE-REQUISITE: UNIVERSAL ALGEBRA-I)

UNIT-I : Boolean Algebras- Boolean rings – Filters and ideals- Stone identity.

UNIT-II : Boolean Powers- Ultra products and congruences- Distributive varieties- Primal algebras- Boolean Products.

UNIT-III: Discriminator varieties – Quasi primal algebras – Functionally complete algebras – skew-free algebras- Semisimple varieties – Directly representable varieties.

UNIT-IV: First order Languages – First order structures and satisfaction – Reduced products and ultra products.

Content and extent as in the Book:-

A course in universal algebra- Stanley Burris and H.P. Sankappanarayan, Springer- Verlag, Berlin.

STREAM – A
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
IV-SEMESTER

M 402(3): DIFFERENTIAL EQUATIONS – II

UNIT I: Boundary value problems: Preliminaries – Sturm – Liouville Problem – Green’s function – Application of Boundary Value Problem – Picard’s theorem. Chapter 7 of prescribed text book.

UNIT II: Oscillations of second order equations: Fundamental results – Sturm’s Comparison theorem – Elementary linear oscillations – Comparison theorem of Hille – Wintner – oscillations of $x'' + a(t)x = 0$. Chapter 8 of prescribed text book.

UNIT III: Stability of linear and nonlinear systems: preliminaries – Elementary critical points – system of equations with constant coefficients – Linear equation with constant coefficients – Lyapunov stability – stability of quasi linear systems – second order linear differential equations. Chapter 9 of prescribed text book.

UNIT IV: Equations with deviating arguments: Preliminaries – equations with constant delay – Equations with piecewise constant delay – a few other types of delay equations. Chapter 11 of prescribed text book.

Text Book: S.G. Deo, V. Lakshminathan and V. Raghavendra: Text book of ordinary Differential equations, Second edition, Tata McGraw-Hill Publishing company Limited, New Delhi, 1997.

STREAM B
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
IV-SEMESTER
M 403(1) :LATTICE THEORY-II
(PRE-REQUISITE: LATTICE THEORY-I)

UNIT- I: Boolean algebras, De Morgan formulae- Complete Boolean algebras- Boolean algebras and Boolean rings- The algebra of relations- The lattice of propositions- Valuations of Boolean algebras.. (Sections 42 to 47 of chapters VI of the prescribed text book)

UNIT-II: Birkhoff lattices- Semimodular lattices- Equivalence lattices- Linear dependence- Complemented semimodular lattices. (Sections 48 to 52 of chapters VII of the prescribed text book)

UNIT-III: Ideals and dual ideals, Ideal chains- Ideal lattices- Distributive lattices and rings of sets. (Sections 53 to 55 of chapters VIII of the prescribed text book)

UNIT-IV: Congruence relation of an algebra- Permutable equivalence relations- The Schreier refinement theorem in arbitrary algebras- Congruence relations of lattices- Minimal congruence relations of some subsets of a distributive lattice- The connection between ideals and congruence relations of a lattice.. (Sections 56 to 61 of chapters IX of the prescribed text book)

Prescribed text book: Introduction to Lattice Theory by Gabor Szasz, Academic Press, New York.

Books for reference: General Lattice Theory by G. Gratzer, Academic Press, New York.

STREAM – B
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
IV-SEMESTER
M 403(2): OPERATIONS RESEARCH - II
(PRE-REQUISITE: OPERATIONS RESEARCH - I)

UNIT – I: Integer Programming: Illustrative Applications of Integer Programming – Solution Method of Integer Programming – Branch and bound Algorithm – Cutting Plane Algorithms – Zero-one Integer Problem. Sections 9.1 to 9.6 of the chapter 9 in the Text Book.

UNIT – II: Decision theory and Games: Decisions Under Risk – Decision Tree – Decisions Under Uncertainty – Game Theory..Sections 12.1 to 12.5 of the chapter 12 in the Text Book.

UNIT – III: Classical Optimization Theory: Unconstrained Extremal Problems – Constrained Extremal Problems.. Sections 19.1 to 19.3 of the Chapter 19 in the Text Book.

UNIT – IV: Non linear Programming: Unconstrained Non linear Algorithms – Constrained Non linear Algorithms. Sections 20.1 to 20.3 of the Chapter 20 in the Text Book.

Text Book: Operations Research, An Introduction: Hamdy A Taha, Maxwell Macmillan International Edition, New York,1992

STREAM – B
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
IV-SEMESTER

M 403(3): MATHEMATICAL BIOECONOMICS
(PRE-REQUISITE: MATHEMATICAL BIOLOGY)

Unit I: The open-access fishery, Opportunity cost, Economic inefficiency, Externalities, examples of open access resources, economic over fishing, Biological over fishing, optimal fishery management, The production function, The objective functional, The optimal harvest policy, Optimal equilibrium and approach, discount rates, Examples based on the Schaefer model. (Sections 2.1 to 2.6 of the text book.)

Unit II: Linear variational problems, linear control problem, singular solutions, Blocked intervals, impulse controls, infinite time horizon, the possibility of extinction, one-dimensional control problem, the classical variation problem, the maximum principle, linear variational problems, transversality conditions, the basic resource model, a non linear fishery model, feed back control. (Sections 2.7, 2.8, 4.1, 4.2 of the text book.)

Unit III: Economic interpretation of maximum principles, multi dimensional optimal control problems, Maximum principles for multi dimensions, Optimal investment in Renewable resource harvesting, singular, non singular and impulsive controls. (Sections 4.3 to 4.5 of the text book.)

Unit IV: The elementary theory of supply and demand, demand curves, utility of consumption and consumers' surplus, surplus curves, analysis of the firm, competitive equilibrium, monopoly, supply and demand in fisheries, the equilibrium supply curve of an open access fishery, finite demand elasticity, Bionomic instability, the discounted supply curve, optimal equilibrium. The monopoly solution, dynamic approach paths, alternative methods. (Sections 5.1 to 5.2 of the text book.)

Text book: Colin W. Clark, Mathematical Bioeconomics – The optimal management of Renewable Resources, John Wiley & Sons, 2005.

STREAM – B
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
IV-SEMESTER

M 403(4) :BANACH ALGEBRAS

UNIT - I :General preliminaries on Banach Algebras – The definition and examples – Regular and singular elements – Topological divisors of Zero – The spectrum – The formula for the spectral radius – The radical and the semi – simplicity.

UNIT - II : The structure of commutative Banach Algebras - The Gelfand mapping - Applications of the formula $r(x) = \lim_{n \rightarrow \infty} \|x^n\|^{1/n}$ – Involutions in Banach Algebras – The Gelfand – Neumark theorem.

UNIT - III : Some special commutative Banach Algebras - Ideals in $e(x)$ and the Banach – Stone theorem - The stone – each compactification – commutative C^* - algebras.

UNIT – IV : Fixed point theorems and some applications to analysis – Brouwer’s and Schauder’s fixed point theorems (without proofs) Picard’s theorem – Continuous curves – The Hahn – Mazurkiewicz theorem (without proof). Boolean rings – The stone representation theorem.

CONTENT AND EXTENT AS IN THE BOOK : Introduction to Topology and Modern Analysis – By G.F. Simmons – International Student edition – McGraw – Hill Kogakusha Ltd.

STREAM – C
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
IV-SEMESTER

M 404(1): COMMUTATIVE ALGEBRA-II
(PRE-REQUISITE: COMMUTATIVE ALGEBRA-I)

UNIT-I: Integral dependence, the going-up theorem-Integrally closed integral domains, the going-down theorem, valuation rings.

UNIT-II: Chain Conditions

UNIT-III: Noetherian rings- Primary decomposition of Noetherian rings, Artin rings

UNIT-IV: Discrete valuation rings, Dedekind domains, Fractional ideals.

Content and extent of Chapters 5 to 9 of the prescribed text book.

Prescribed Text Book : Introduction to commutative algebra by M.F.Atiya and I.G. Macdonald, Addison-Welsey Publishing Company, London.

STREAM – C
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
IV-SEMESTER

M404(2): SEMI GROUPS-II
(PREREQUISITE:SEMI GROUPS-I)

UNIT-I: Union of Groups, Semi lattices of groups, bands, free bands, varieties of bands.

UNIT-II: Introduction to inverse semi groups, preliminaries, the natural partial order on an inverse semi group, fundamental inverse semi groups, anti-uniform semilattices.

UNIT-III: Bi-simple inverse semi groups, simple inverse semi-groups, representation of inverse semi-groups.

UNIT-IV: Orthodox semi-groups, basic properties, the analogue of the Munn semi-group, uniform and anti-uniform bands, the structure of orthodox semi groups.

Contents of the syllabus: Chapters 4,5 and 6 of the text book.

Text Book: An introduction to semi-group theory by J.M.Howie, 1976, Academic press, New York.

STREAM – C
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
IV-SEMESTER

M 404(3) :NONLINEAR FUNCTIONAL ANALYSIS

UNIT-I:- Various forms of continuity- Geometry in normed spaces and duality mapping, Nemytskii, Hammerstein and Urysohn operators. Chapter 1 of the textbook

UNIT-II:- Gateaux and Frechet derivative, Properties of derivative, Taylor's theorem, Inverse function theorem and Implicit function theorem, Sub differential of convex functions.

Chapter 2 of the text book

UNIT-III:- Banach's contraction principle and its generalization, Nonexpansive mappings, Fixed point theorems of Brouwer and Schauder. Sections 4.1 to 4.3 of Chapter 4 of the text book.

UNIT-IV:- Fixed point theorems for multifunctions, common fixed point theorems, Sequences of contractions, generalized contractions and fixed points.

Sections 4.4 to 4.6 of Chapter 4 of the textbook.

Prescribed Book:

Some topics in Nonlinear functional analysis by Mohan C. Joshi and Ramendra k. Bose, Wiley Eastern limited- Hyderabad, 1985.

STREAM – C
ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
IV-SEMESTER

M 404(4) :GRAPH THEORY

UNIT I: Matching and Augmenting paths; The marriage problem; The personnel assignment problem; The optimal Assignment problem. (Chapter 4 of the Text Book)

UNIT II: Plane and planar graphs; Euler's formula, The platonic bodies, kurtowski's Theorem, Non-Hamiltonian plane graphs, The dual of a plane graph.

(Chapter 5 of the Text Book)

UNIT III: Vertex colouring; vertex colouring Algorithms; Critical graphs; cliques; Edge colouring; Map colouring. (Chapter 6 of the Text Book)

UNIT IV: Definitions; Indegree and outdegree; Tournaments; Traffic flow.

(Chapter 7 of the Text Book)

Text Book :A first look at GRAPH THEORY; John Clark & Derek Allan Holton, Allied Publishers Limited 1995.

ANDHRA UNIVERSITY
DEPARTMENT OF MATHEMATICS
M.A/M.SC MATHEMATICS
IV-SEMESTER

M 405: PARTIAL DIFFERENTIAL EQUATIONS

Unit I: Introduction to Partial differential equations – Definitions; Examples – Linear equations, Nonlinear equations, Linear systems, Nonlinear systems; Strategies for studying PDE – well posed problems, classical solutions, weak solutions and regularity, Typical difficulties (*Only short answer questions to be asked from this portion*) Transport equation – Initial value problem, Nonhomogeneous problem Laplace 's equation – Physical interpretation; Fundamental solution - Derivation of fundamental solution, Poisson's equation; Mean value formulas; Properties of harmonic functions- strong maximum principle, uniqueness, regularity, Local estimates for harmonic functions, Liouville's theorem, Harnack's inequality, Green's function – Derivation of green's function, Green's function for a half space, Green's function for a ball; Energy methods – Uniqueness, Dirichlet's principle. Chapter 1 – sections 1.1 – 1.3, Chapter 2 – sections 2.1, 2.2

Unit II: Heat Equation – physical interpretation; Fundamental solution – Derivation of the fundamental solution, Initial value problem, Nonhomogeneous problem; Mean value formula; Properties of solutions – strong maximum principle, uniqueness, regularity, Local estimates for the solutions of the heat equation; Energy methods – uniqueness, Backward uniqueness.

Chapter 2 – section 2.3

Unit III: Wave equation – Physical interpretation; Solution by spherical means – Solution for $n = 1$, d'Alembert's formula, Spherical means, Solution for $n = 3, 2$ Kirchhoff's and Poisson's formulas, Solution for odd n , Solution for even n ; Nonhomogeneous problem; Energy methods – uniqueness, Domain of dependence. Chapter 2 – section 2.4

Unit IV: Nonlinear first order Partial differential equation – Complete integrals, new solutions from envelops; Characteristics – Derivation of characteristic ODE; Examples for liner, quasilinear, fully nonlinear equations; Boundary conditions – Straightening the boundary, Compatibility conditions on boundary data, noncharacteristic boundary data; Local solution ; Applications to liner, quasilinear, fully nonlinear equations. Chapter 3 – sections 3.1-3.2

Text book: L.C. Evans, Partial differential equations, Graduate studies in Mathematics, Volume 19, AMS, 2002.

Reference books:

- 1 Fritz John, Partial Differential Equations, Narosa Publishing House, New Delhi, 1979
- 2 Phoolan Prasad and Renuka Ravindran, Partial Differential Equations, New Age International Publishers, New Delhi, 1996.
- 3 Ian Sneddon, Elements of Partial Differential Equations, McGraw-Hill International editions, Singapore.

