

**ANDHRA UNIVERSITY**  
**Department of Mathematics**  
**M.A./M.Sc Mathematics Program**  
**Curriculum and Syllabus**  
**(with effect from 2021-22 admitted batch)**

**Program structure**

**Credits at a glance**

S.No	Nature of the Course(s)	Credits
1	Core courses	56
2	Electives	24
3	Moocs courses	08
4	Project	04
5	Comprehensive viva voce	04
Total number of credits		96

**M.A./M.Sc Mathematics Semester I**

S.No	Course Code	Name of the Course	Credits	Assessment	
				Internal	End sem
1.	M 101	Algebra - I	4	20%	80%
2.	M 102	Real Analysis - I	4	20%	80%
3.	M 103	Topology - I	4	20%	80%
4.	M 104	Differential Equations	4	20%	80%
5.	M 105	Linear Algebra	4	20%	80%
Total Credits for Semester I			20		

**M.A./M.Sc Mathematics Semester II**

S.No	Course Code	Name of the Course	Credits	Assessment	
				Internal	End sem
1.	M 201	Algebra - II	4	20%	80%
2.	M 202	Real Analysis - II	4	20%	80%
3.	M 203	Topology - II	4	20%	80%
4.	M 204	Complex Analysis	4	20%	80%
5.	M 205	Discrete Mathematics	4	20%	80%
Total Credits for Semester II			20		

**M.A./M.Sc Mathematics Semester III**

S. No	Course Code	Name of the Course	Credits	Assessment	
				Internal	End sem
1.	M 301	Functional Analysis	4	20%	80%
2.	M 302	Calculus of Variations	4	20%	80%
3.	M 303	Elective I (Number Theory I)	4	20%	80%
4.	M 305	Elective II (Lattice Theory I)	4	20%	80%
5.	M 306	Elective III (Commutative Algebra I)	4	20%	80%
6.	M3MC	Moocs course	4		
Total Credits for Semester III			24		

**M.A./M.Sc Mathematics Semester IV**

S.No	Course Code	Name of the Course	Credits	Assessment	
				Internal	End sem
1.	M 401	Measure and Integration	4	20%	80%
2.	M 402	Partial Differential Equations	4	20%	80%
3.	M 403	Elective IV (Number Theory II)	4	20%	80%
4.	M 405	Elective V (Lattice Theory II)	4	20%	80%
5.	M 406	Elective VI (Commutative Algebra II)	4	20%	80%
6.	M 4PRO	Project	4		
7.	M 4MC	Moocs course	4		
8.	M 4CV	Comprehensive Viva voce	4		
Total Credits for Semester IV			32		

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A/M.SC MATHEMATICS  
I-SEMESTER  
M 101 ALGEBRA I  
(w.e.f. 2021-22 admitted batch)

**Course type: Theory**

**Course category: Core**

**Credits: 4**

**Course Syllabus:**

**UNIT-I ( 12 Hours)**

**Groups:** Homomorphisms-Subgroups and cosets.**Normal subgroups:** Normal Subgroups and Quotient groups-Isomorphism theorems- Automorphisms. (Sections 4.2, 4.3 of the Chapter 4 and sections 5.1 to 5.3 of the Chapter 5 in the Prescribed Text Book.)

**UNIT-II ( 12 Hours)**

**Normal Subgroups:** Conjugacy and G-sets.

**Permutation Groups:** Cyclic decomposition-Alternating group  $A_n$ -Simplicity of  $A_n$ .

(Section 5.4 of chapter 5 and sections 7.1 to 7.3 of the Chapter 7 in the Prescribed Text Book.)

**UNIT-III ( 12 Hours)**

**Structure theorems of groups:** Direct products-Finitely generated abelian groups-Invariants of a finite abelian group-Sylow theorems.

(Sections 8.1 to 8.4 of the Chapter 8 in the Prescribed Text Book.)

**UNIT-IV( 12 Hours)**

**Ideals and Homomorphisms:** Ideals-Homomorphisms-Sums and direct sums of ideals- Maximal and prime ideals-Nilpotent and nil ideals-Zorn's lemma.

(Sections 10.1 to 10.6 of the Chapter 10 in the Prescribed Text Book.)

**UNIT-V( 12 Hours)**

**Unique factorization domains and Euclidean domains:** Unique factorization domains-Principal ideal domains-Euclidean domains-Polynomial rings over UFD

(Sections 11.1 to 11.4 of the Chapter 11 in the Prescribed Text Book.)

**Prescribed Text Book:**

Basic Abstract Algebra: P. B. Bhattacharya, S. K. Jain and S. R. Nagapaul, Second edition, reprinted in India 1997, 2000, 2001.

**Reference Books:**

1. Topics in Algebra : I. N. Herstein, 2<sup>nd</sup> Edition, John Wiley & Sons
2. Algebra : Thomas W. Hungerford, Springer
3. Algebra : Serge Lang, Revised Third Edition, Springer

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc. Mathematics  
I-SEMESTER  
M102 REAL ANALYSIS-I  
(w.e.f. 2021-2022 Admitted Batch)

**Course type: Theory**

**Course category: Core**

**Credits: 4**

**Course syllabus**

**UNIT-I (12 Hours)**

Basic Topology: Metric spaces, Compact sets, Perfect sets, Connected sets.  
Chapter 2, Sections 2.15 to 2.47 of the Prescribed Text Book.

**UNIT-II ( 12 Hours)**

Continuity: Limits of functions, Continuous Functions, Continuity and Compactness, Continuity and Connectedness, Discontinuities, Monotone functions, Infinite limits and Limits at Infinity.  
Chapter 4 of the Prescribed Text Book.

**UNIT-II ( 12 Hours)**

Differentiation: The Derivative of a Real Function, Mean value theorems, the Continuity of Derivatives, L'Hospital's Rule, Derivatives of Higher order, Taylor's theorem, Differentiation of vector-valued functions.  
Chapter 5 of the Prescribed Text Book.

**UNIT-IV( 12 Hours)**

The Riemann-Stieltjes integral: Definition and Existence of the Integral, Properties of the integral, Change of variable.  
Chapter 6, Sections 6.1 to 6.19, of the Prescribed Text Book.

**UNIT-V( 12 Hours)**

The Riemann-Stieltjes integral continued: Integration and Differentiation, The Fundamental theorem of Calculus, Integration by parts, Integration of vector-valued functions, Rectifiable curves.  
Chapter 6, Sections 6.20 to 6.27, of the Prescribed Text Book.

Prescribed Text Book: Walter Rudin, Principles of Mathematical Analysis, International Student Edition, 3<sup>rd</sup> Edition, 1985.

Reference: Tom M. Apostol, Mathematical Analysis, Narosa Publishing House, 2<sup>nd</sup> Edition, 1985.

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A/M. Sc. MATHEMATICS  
I-SEMESTER  
M103 TOPOLOGY-I  
(w.e.f. 2021-2022 admitted batch)

**Course type: Theory**  
**4**

**Course category: Core**

**Credits:**

**Course Syllabus**

**UNIT-I (12 Hours)**

Sets and Functions: Sets and Set inclusion – The algebra of sets – Functions – Products of sets – Partitions and equivalence relations – Countable sets – Uncountable sets – Partially ordered sets and lattices. (Chapter I: Sections 1 to 8 of the prescribed text book). 14 hours

**UNIT-II ( 12 Hours)**

Metric spaces: The definition and some examples – Open sets – Closed sets – Convergence, Completeness and Baire's theorem . 10 hours  
(Chapter 2: Sections 9 to 12 of the prescribed text book).

**UNIT-III( 12 Hours)**

Metric spaces (Continued): Continuous mappings, Spaces of continuous functions – Euclidean and Unitary spaces.(Chapter 2: Sections 13 to15 of the prescribed text book)

Topological spaces: The definition and some examples – Elementary concepts– (Chapter 3: Sections 16 to 17 of the prescribed text book). 12 hours

**UNIT-IV( 12 Hours)**

Topological spaces (continued): Open bases and open sub bases, Weak Topologies, The function algebras  $C(X, \mathbb{R})$  and  $C(X, \mathbb{C})$ . (Chapter 3: Sections 18 to 20 of the prescribed text book).

Compactness: Compact spaces – Heine – Borel theorem (Chapter 4: Section 21). 12 hours

**UNIT-V( 12 Hours)** Compactness (continued): Product of Spaces – Tychonoff's theorem and locally Compact spaces – Compactness for metric spaces – Ascoli's theorem. (Chapter 4: Sections 22 to 25 of the prescribed text book).  
12 hours

Prescribed Text Book: Introduction to Topology and Modern Analysis by G. F. Simmons International Student edition – McGraw – Hill Kogakusha, Ltd.

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc MATHEMATICS  
I – SEMESTER  
M104 DIFFERENTIAL EQUATIONS  
(w.e.f. 2021-22 admitted batch)

**Course type: Theory**

**Course category: Core**

**Credits: 4**

**Course syllabus**

**UNIT-I (12 Hours)**

Essential concepts from Real Function Theory – The basic problem -The fundamental existence and uniqueness theorem –examples to demonstrate the theory- continuation of solutions

( Sections 10.1, 10.2 of the prescribed text book)

**UNIT-II ( 12 Hours)**

Dependence of solutions on initial conditions – dependence of solutions on parameters (causal function f) - Existence and Uniqueness theorems for systems – existence and uniqueness theorems for Higher order equations – examples  
(Sections 10.3, 10.4 of the prescribed text book)

**UNIT-III ( 12 Hours)**

Introduction to the theory of Linear differential systems – Theory and properties of Homogeneous linear systems  
(Sections 11.1 - 11.3 of the prescribed text book)

**UNIT-IV( 12 Hours)**

Theory of non homogeneous linear systems – Theory and properties of the nth order homogeneous linear differential equations  
(Sections 11.4 - 11.6 of the prescribed text book)

**UNIT-V( 12 Hours)**

Theory of nth order Non homogeneous Linear equations – Sturm theory – Sturm Liouville Boundary value problems  
(Sections 11.7, 11.8, 12.1 of the prescribed text book)

Prescribed Text Book: Shepley L. Ross (2007). Differential Equations (3rd edition), Wiley India

<https://www.pdfdrive.com/differential-equations-e189333999.html>

Reference book: George F. Simmons (2017). Differential Equations with Applications and Historical Notes (3rd edition). CRC Press. Taylor & Francis.

<https://www.pdfdrive.com/differential-equations-with-applications-and-historical-notes-third-edition-e186014046.html>

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A/M.Sc. MATHEMATICS  
I-SEMESTER  
M105 LINEAR ALGEBRA  
( w.e.f. 2021- 2022 admitted batch)

**Course type: Theory**

**Course category: Core**

**Credits: 4**

**Course Syllabus**

**UNIT-I (12 Hours)**

Introduction, Characteristic Values, Similar Matrices, Diagonalizable Operators, Annihilating Polynomials, Minimal Polynomials, Cayley – Hamilton Theorem .

(Sections 6.1 - 6.3 of Chapter 6 in the Prescribed Text Book)

**UNIT - II (12 Hours)**

Invariant Subspaces, T-conductor of a vector, T-annihilator of a vector, Simultaneous Triangulation; Simultaneous Diagonalization.

(Sections 6.4 - 6.5 of Chapter 6 in the Prescribed Text Book)

**UNIT-III ( 12 Hours)**

Direct – Sum Decompositions, Projections, Invariant Direct Sums, The Primary Decomposition Theorem.

(Sections 6.6 – 6.8 of Chapter 6 in the Prescribed Text Book)

**UNIT-IV( 12 Hours)**

Cyclic Subspaces and Annihilators, T-cyclic Subspace Generated by a Vector, Companion Matrices, Complementary Subspaces, I-admissible Subspaces, Cyclic Decompositions and Rational form, Generalized Cayley – Hamilton Theorem Invariant Factors.

(Sections 7.1, 7.2 of Chapter 7 in the Prescribed Text Book).

**UNIT-V( 12 Hours)**

The Jordan Forms, Elementary Jordan Matrix with Characteristic Value , Computation of Invariant Factors, Elementary Matrices, Smith Normal Forms, Summary; Semi-Simple Operators.

(Sections 7.3 – 7.5 in the Prescribed Text Book)

**Prescribed Text Book:** Linear Algebra by Kenneth Hoffman and Ray Kunze, Prentice- Hall India Pvt. Ltd, 2<sup>nd</sup> Edition, New Delhi.

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A/M.SC MATHEMATICS  
II-SEMESTER  
M 201 ALGEBRA -II  
(w.e.f. 2021-22 admitted batch)

**Course type: Theory**

**Course category: Core**

**Credits: 4**

**Course Syllabus**

**UNIT-I (12 Hours)**

Algebraic extension of fields: Irreducible polynomials and Eisenstein's criterion-Adjunction of roots-Algebraic extensions- Algebraically closed fields.  
(Sections 15.1 to 15.4 of the Chapter 15 in the prescribed text book.)

**UNIT-II ( 12 Hours) ( 12 Hours)**

Normal and separable extensions: Splitting fields-Normal extensions-multiple roots-finite fields.  
(Sections 16.1 to 16.4 of the Chapter 16 in the prescribed text book.)

**UNIT-II ( 12 Hours)I( 12 Hours)**

Normal and separable extensions: Separable extensions.  
Galois Theory: Automorphism groups and fixed fields- fundamental theorem of Galois Theory.  
(Section 16.5 of the Chapter 16 and Sections 17.1 to 17.2 of the Chapter 17 in the prescribed text book.)

**UNIT-IV( 12 Hours)**

Galois Theory: Fundamental theorem of algebra. Galois Theory and Applications of Galois Theory to Classical problems: Roots of unity and cyclotomic polynomials-Cyclic extensions  
(Section 17.3 of the Chapter 17 and sections 18.1 and 18.2 of the Chapter 18 in the prescribed text book.)

**UNIT-V( 12 Hours)**

Applications of Galois Theory to Classical problems: Polynomials solvable by radicals-symmetric functions-Ruler and compass constructions.  
(Sections 18.3 and 18.4 of the Chapter 18 in the prescribed text book.)

Prescribed Text 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  
M202 REAL ANALYSIS-II  
(w.e.f. 2021-2022 Admitted Batch)

**Course type: Theory**

**Course category: Core**

**Credits: 4**

**Course syllabus**

**UNIT-I (12 Hours)**

Sequences and Series of Functions: Discussion of Main problem, Uniform Convergence, Uniform Convergence and Continuity, Uniform Convergence and Integration, Uniform convergence and differentiation.

12 Hours

Chapter 7, Section 7.1 to 7.18, of the Text Book.

**UNIT-II ( 12 Hours)**

Sequences and Series of Functions continued: The Stone-Weierstrass Theorem.

12 Hours

Chapter 7, Sections 7.26 to 7.33, of the Text Book.

Power Series

Chapter 8, Sections 8.1 to 8.5, of the Text Book.

**UNIT-III ( 12 Hours)**

Some Special Functions: The Exponential and Logarithmic Functions, The Trigonometric functions, Fourier Series, Parseval's theorem.

12 Hours

Chapter 8, Sections 8.6 and 8.7, 8.9 to 8.16, of the Text Book.

**UNIT-IV( 12 Hours)**

Functions of several variables: Linear transformations, Differentiation, The Contraction principle, The Inverse Function theorem.

12

Hours

Chapter 9, Sections 9.4 to 9.25, of the Text Book.

**UNIT-V( 12 Hours)**

Functions of several variables continued: The implicit Function theorem, The Rank theorem, Determinants, Derivatives of higher order, Differentiation of integrals.

12

Hours

Chapter 9, Sections 9.26 to 9.42, of the Text Book.

Text Book: Walter Rudin, Principles of Mathematical Analysis, International Student Edition, 3<sup>rd</sup> Edition, 1985.

Reference: Tom M. Apostol, Mathematical Analysis, Narosa Publishing House, 2<sup>nd</sup> Edition, 1985.

DEPARTMENT OF MATHEMATICS  
M.A/M. Sc. MATHEMATICS  
II-SEMESTER  
M203: TOPOLOGY-II  
(w.e.f. 2021-2022 admitted batch)

**Course type: Theory**

**Course category: Core**

**Credits: 4**

**Course Syllabus**

**UNIT-I (12 Hours)**

Separation:  $T_1$  spaces and Hausdorff spaces – Completely regular spaces and normal spaces – Urysohn's lemma and the Tietze's extension theorem. (Chapter 5: Sections 26 to 28 Prescribed text book)

**UNIT-II ( 12 Hours):**

Separation (continued): The Urysohn imbedding theorem – The Stone – Chech compactification. (Chapter 5: Sections 29 to 30 Prescribed text book).

Connectedness: Connected spaces– connectedness of  $\mathbb{R}^n$  and  $\mathbb{C}^n$ . (Chapter 6: Section 31 Prescribed text book).

12 hours

**UNIT-II ( 12 Hours)**

Connectedness (continued): The components of a space – Totally disconnected spaces – Locally connected spaces. (Chapter 6: Sections 32 to 34 Prescribed text book)

12 hours

**UNIT-IV( 12 Hours)**

Approximation: The Weierstrass approximation theorem - The Stone-Weierstrass theorems (Chapter 7: Section 35 to 36 Prescribed text book).

12 hours

**UNIT-V( 12 Hours)**

Approximation (continued): --Locally compact Hausdorff spaces – The extended Stone-Weierstrass theorems. (Chapter 7: Sections 37 to 38 Prescribed text book ).

12 hours

Prescribed text book: Introduction to Topology and Modern Analysis by G. F. Simmons, International Student edition – McGraw – Hill Kogakusha, Ltd.

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc MATHEMATICS  
II – SEMESTER  
M204 COMPLEX ANALYSIS  
(w.e.f. 2021-22 admitted batch)

**Course type: Theory**

**Course category: Core**

**Credits: 4**

**Course syllabus**

**UNIT-I (12 Hours)**

Power series- Analytic functions - Analytic functions as mappings, Mobius transformations

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

**UNIT-II ( 12 Hours)**

Power series representation of analytic functions- zeros of an analytic function - The index of a closed curve

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

**UNIT-III ( 12 Hours)**

Cauchy's theorem and integral formula- Counting zeros, the Open mapping theorem

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

**UNIT-IV( 12 Hours)**

Classification of singularities – residues and related results

(\$1, \$2 of chapter-V of the prescribed text book)

**UNIT-V( 12 Hours)**

The maximum principle – Schwarz's lemma and related results.

(\$1, \$2 of chapter-VI of the prescribed text book)

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

<https://www.pdfdrive.com/page-1-john-b-conway-functions-of-one-complex-variable-second-edition-%C2%BA-springer-verlag-e33663415.html>

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A/M.Sc. MATHEMATICS  
II-SEMESTER  
M205 DISCRETE MATHEMATICS  
( w.e.f. 2021- 2022 admitted batch)

**Course type: Theory**

**Course category: Core**

**Credits: 4**

**Course Syllabus**

**UNIT-I (12 Hours)**

Basic Ideas, History, Initial Concepts, Summary, Connectivity , Elementary Results, Structure Based on Connectivity .

(Chapters – 1 & 2 of Text Book 1)

**UNIT-II ( 12 Hours)**

Trees, Characterizations, Theorems on Trees, Tree Distances, Binary trees, Tree Enumeration, Spanning trees, Fundamental Cycles, Summary.

(Chapter – 3 of Text Book 1)

**UNIT-III ( 12 Hours)**

Traversability, Introduction, Eulerian Graphs, Hamiltonian Graphs, Minimal Spanning Trees, J.B.Kruskal's Algorithm, R.C.Prim's Algorithm. (Chapter 4 of Text Book 1 and Section 7.5 of Text Book 2) 12 hours

**UNIT-IV( 12 Hours)**

Poset Definition, Properties of Posets, Lattice Definition, Properties of Lattices.

(Chapter 1-A of Text Book 3)

**UNIT -V (12 Hours)**

Definitions of Modular and Distributive Lattices and its Properties.

(Chapter 1-B of Text Book 3)

**Prescribed Text books:**

**Text Book 1 :** Graph Theory Applications by L.R.Foulds, Narosa Publishing House, New Delhi.

**Text Book 2 :** Discrete Mathematical Structures by Kolman and Busby and Sharen Ross, Prentic Hall of India – 2000, 3<sup>rd</sup> Edition

**Text Book 3 :** Applied Abstract Algebra by Rudolf Lidl and Gunter Pilz , Published by Springer- Verlag.

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc. Mathematics  
III-SEMESTER  
M301 FUNCTIONAL ANALYSIS  
(w.e.f. 2021-2022 Admitted Batch)

**Course type: Theory**

**Course category: Core**

**Credits: 4**

**Course syllabus**

**UNIT-I (12 Hours)**

BANACH SPACES: The definition and some examples, Continuous linear transformations, The Hahn-Banach theorem. 12

Hours

Chapter 9, Sections 46-48, of the Text Book.

**UNIT-II ( 12 Hours)**

Banach Spaces continued: The natural imbedding of  $N$  in  $N^{**}$ , Then open mapping theorem, The Conjugate of an operator. 12

Hours

Chapter 9, Sections 49-51, of the Text Book.

**UNIT-III ( 12 Hours)**

HILBERT SPACES: The definition and some simple properties, Orthogonal complements, Orthonormal sets. 12

Hours

Chapter 10, Sections 52 to 54, of the Text Book.

**UNIT-IV( 12 Hours)**

Hilbert Spaces continued: The Conjugate space  $H^*$ , The adjoint of an operator, Self-adjoint operators, Normal and unitary operators, Projections. 12

Hours

Chapter 10, Sections 55 to 59, of the Text Book.

**UNIT-V( 12 Hours)**

FINITE-DIMENSIONAL SPECTRAL THEORY: Matrices, Determinants and the spectrum of an operator, The spectral theorem, A survey of the situation.

12 Hours

Chapter 11, of the Text Book.

Text Book: G.F.Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, International Student Edition, 1963.

Reference: Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, 2001.

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc MATHEMATICS  
M302 CALCULUS OF VARIATIONS  
III SEMESTER  
(w.e.f. 2021-22 admitted batch)

**Course type: Theory**

**Course category: Core**

**Credits: 4**

**Course syllabus**

**UNIT-I (12 Hours)**

Variation and its properties- Euler's equation-Functionals of the form  $\int_{x_2}^{x_1} F(x, Y, Y') dx$ -  
Functionals dependent on higher order derivatives-Functionals dependent on the functions of  
several independent variables  
(Sections 1-5 of Chapter 6 of the prescribed textbook)

**UNIT-II ( 12 Hours)**

Variational problems in parametric form – some applications – An elementary problem with  
moving boundaries-Moving boundary problem for a functional of the form  $\int_{x_2}^{x_1} F(x, Y, Y') dx$   
(Sections 6,7 of Chapter 6 and sections 1,2 of chapter 7 of the prescribed text book)

**UNIT-III ( 12 Hours)**

Extremals with corners –one sided variations and related problems  
(Sections 3,4 of Chapter 7 of the prescribed text book)

**UNIT-IV( 12 Hours)**

Field of extremals – The function  $E(x,y,p,y')$  – Transforming the Euler equations to the  
canonical form  
– 12 hours  
(Sections 1-3 of Chapter 8 of the prescribed text book)

**UNIT-V( 12 Hours)**

Constraints of the form  $\Phi(x, Y) = 0$  – Constraints of the form  $\Phi(x, Y, Y') = 0$  – Isoperimetric  
problems  
(Sections 1-3 of Chapter 9 of the prescribed text book)

**Prescribed Text book:** Differential Equations and the Calculus of Variations, L. Elsgolts, 1977,  
Mir Publications

<https://www.pdfdrive.com/differential-equations-and-calculus-of-variations-e188012441.html>

Reference book: A.S. Gupta, Calculus of Variations with Applications, PHI Learning Private Limited, 2009

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A/M.SC MATHEMATICS  
III-SEMESTER  
M 303 NUMBER THEORY-I  
(w.e.f. 2021-22 admitted batch)

Course type: Theory

Course category: Elective

Credits: 4

**Course Syllabus:**

**UNIT-I (12 Hours)**

**ARITHMETICAL FUNCTIONS AND DIRICHLET MULTIPLICATION:**

Introduction- The Mobius function  $\mu(n)$  – The Euler totient function  $\varphi(n)$ - A relation connecting  $\varphi$  and  $\mu$  - 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.

(Sections 2.1 to 2.14 of the Chapter 2 in the Prescribed Text Book.)

**UNIT-II (12 Hours)**

**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 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  $\Lambda(n)$ . (Sections 3.1 to 3.12 of Chapter 3 in the Prescribed Text Book.)

12 hours

**UNIT-III (12 Hours)**

**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 – The partial sums of the Mobius function. Brief sketch of an elementary proof of prime number theorem.

(Sections 4.1 to 4.10 of the Chapter 4 in the Prescribed Text Book.)

**UNIT-IV( 12 Hours)**

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.

(Sections 5.1 to 5.8 of the Chapter 5 in the Prescribed Text Book.)

**UNIT-V( 12 Hours)**

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  $\chi$

DIRICHLET'S THEOREM FOR PRIMES IN ARITHMETIC PROGRESSION

Introduction- Dirichlet's theorem for primes of the form  $4n-1$  and  $4n+1$ - The plan of the proof of Dirichlet's theorem

(Sections 6.5 to 6.10 & 7.1 to 7.3 of the Chapters 6 and 7 in the Prescribed Text Book.)

**Prescribed Text Book:**

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

**Reference Books:**

1. An Introduction to the theory of numbers, 5<sup>th</sup> edition by Ivan Niven Herbert S. Zuckerman and Hugu L. Montgomery, John Wiley & Sons INC. publications, U.K., 2008.
2. Elementary Number Theory, 7<sup>th</sup> edition by David M. Burton, 2011.



ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc. MATHEMATICS  
III-SEMESTER  
M304 UNIVERSAL ALGEBRA-I  
( w.e.f. 2021- 2022 admitted batch)

**Course type: Theory**

**Course category: Elective**

**Credits: 4**

**Course Syllabus**

**UNIT-I (12 Hours)**

Definitions of Lattices, Isomorphic Lattices and Sublattices, Distributive and Modular Lattices.  
(Sections 1, 2, 3 of Chapter-I of the Prescribed Text Book)

**UNIT-II ( 12 Hours)**

Complete Lattices, Equivalence Relations, Algebraic Lattices, Closure Operators.  
(Sections 4, 5 of Chapter-I of the Prescribed Text Book)

**UNIT-III ( 12 Hours)**

Definition and Examples of Algebras, Isomorphic Algebras, Subalgebras, Algebraic Lattices  
Subuniverses, The Irredundant Basis Theorem.  
(Sections 1, 2, 3, 4 of Chapter-II of the Prescribed Text Book)

**UNIT-IV( 12 Hours)**

Congruences and Quotient Algebras, Homomorphisms, The Homomorphism and Isomorphism  
Theorems. (Sections 5, 6 of Chapter-II of the Prescribed Text Book)

**UNIT-V( 12 Hours)**

Direct Products, Factor Congruences, Directly Indecomposable Algebras, Subdirect Products,  
Subdirectly Irreducible Algebras and Simple Algebras. (Sections 7, 8 of Chapter-II of the  
Prescribed Text Book)

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

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A/M.Sc. MATHEMATICS  
III - SEMESTER  
M305 LATTICE THEORY-I  
( w.e.f. 2021-2022 admitted batch)

**Course type: Theory**

**Course category: Elective**

**Credits: 4**

**Course Syllabus**

**UNIT-I (12 Hours)**

Set Theoretical Notations, Relations, Partly Ordered Sets, Diagrams, Special Subsets of a Partly Ordered Set, Length, Lower and Upper Bounds, The Minimum and Maximum Condition, The Jordan Dedekind Chain Condition, Dimension Functions.

( Sections 1 to 9 of Chapter I of the Prescribed Text Book)

**UNIT-II ( 12 Hours)**

Algebras, Lattices, The Lattice Theoretic Duality Principle, Semilattices, Lattices as Partly Ordered Sets, Diagrams of Lattices, Sublattices and Ideals.

( Sections 10 to 16 of chapter II of the Prescribed Text Book)

**UNIT-III ( 12 Hours)**

Bound Elements of Lattices, Atoms and Dual Atoms, Complements, Relative Complements, Semicomplements, Irreducible and Prime Elements of a Lattice, The Homomorphism of a Lattice, Axioms Systems of Lattices.

( Sections 17 to 21 of Chapter II of the Prescribed Text Book)

**UNIT-IV( 12 Hours)**

Complete Lattices, Complete Sublattices of a Complete Lattice, Conditionally Complete Lattices,  $\sigma$ -Lattices, Compact Elements, Compactly Generated Lattices.

(Sections 22 to 25 of Chapter III of the Prescribed Text Book)

**UNIT-V( 12 Hours)**

Subalgebra Lattice of an Algebra, Closure Operations, Galois Connections, Dedekind Cuts, Partly Ordered Sets as Topological Spaces. (Sections 26 to 29 of chapter III of the Prescribed Text Book)

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

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc. MATHEMATICS  
III - SEMESTER  
M306 COMMUTATIVE ALGEBRA- I  
(w.e.f. 2021-2022 admitted batch)

Course type: Theory

Course category: Elective

Credits: 4

**Course Syllabus**

**UNIT-I (12 Hours)**

Rings and ring homomorphisms, Ideals, Quotient rings, Zero divisors, Nilpotent Elements, Units, Prime Ideals and Maximal Ideals, Nilradical and Jacobson Radical.

**UNIT-II ( 12 Hours)**

Operations on Ideals, Extension and Contraction.

**UNIT-II ( 12 Hours)I( 12 Hours)**

Modules and Module Homomorphism, Submodules and Quotient Modules, Operations on Submodules, Direct Sum and Product, Finitely Generated Modules.

**UNIT-IV( 12 Hours)**

Exact Sequences, Tensor Product of Modules, Restriction and Extension of Scalars, Exactness Properties of the Tensor Product, Algebras, Tensor Product of Algebras.

**UNIT-V( 12 Hours)**

Rings and Modules of Fractions, Local Properties, Extended and Contracted Ideals in Rings of fractions.

**Prescribed Text book:** Introduction to Commutative Algebra, By M.F. ATIYAH and I.G. MACDONALD, Addison-Wesley Publishing Company, London.

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A/M. Sc. MATHEMATICS  
III-SEMESTER  
M 307 SEMIGROUPS - I  
(w.e.f. 2021-2022 admitted batch)

Course type: Theory

Course category: Elective

Credits: 4

**Course Syllabus**

**UNIT-I (12 Hours)**

Basic definitions, monogenic semigroups, ordered sets, semilattices and lattices, binary relations, equivalences.

**UNIT-II ( 12 Hours)**

Congruences - Free semigroups, Ideals and Rees' congruences, Lattices of equivalences and congruences.

**UNIT-III ( 12 Hours)**

Green's equivalences. The structure of D-classes, regular semigroups.

**UNIT-IV( 12 Hours)**

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

**UNIT-V( 12 Hours)**

Congruences on completely 0-simple semigroups. 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).

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

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A/M. Sc. MATHEMATICS  
III-SEMESTER  
M 308 FUZZY SET THEORY AND APPLICATIONS  
(w.e.f. 2021-2022 admitted batch)

**Course type: Theory**

**Course category: Elective**

**Credits: 4**

**Course Syllabus**

**UNIT-I (12 Hours)**

From Classical (Crisp) sets to Fuzzy sets:- Introduction-Crisp sets: An overview-fuzzy set: Basic types-Fuzzy sets. Basic Concepts- Characteristics and significance of the paradigm shift (CH-1 of (I)). Fuzzy sets versus Crisp sets-Additional Properties of a cuts- Representations of Fuzzy sets-Extension principle for Fuzzy sets (CH-2 of (I)).

14 hours

**UNIT-II ( 12 Hours)**

Operations on Fuzzy sets - Types of Operations - Fuzzy Compliments - Fuzzy Inter sections: t-norms - Fuzzy unions; t-Conorms - Combinations of operations - Aggregation Operations (CH-3 of (I)).

**UNIT-III ( 14 Hours)**

Fuzzy Arithmetic -Fuzzy Numbers - Linguistic variables - Arithmetic operations on intervals - Arithmetic operations on Fuzzy numbers - Lattice of fuzzy numbers - Fuzzy equations (CH-4 of (I)).

**UNIT-IV( 12 Hours)**

Fuzzy Relations - Crisp versus fuzzy relations - Projections and Cylindric Extensions - Binary Fuzzy Relations - Binary Relations on a Single set - Fuzzy Equivalence Relations . (Sections 1 to 5, CH-5 of (I)).

10 hours

**UNIT-V( 10 Hours)**

Fuzzy Compatibility Relations - Fuzzy Ordering Relations - Fuzzy Morphisms -  $\text{Sup} - i$  Compositions of Fuzzy Relations -  $\text{Inf} - w_i$  Compositions of fuzzy Relations. (Sections 6 to 10, CH-5 of (I)).

Prescribed Text Book: (1) G.J.KLIR and BO YUAN, "Fuzzy sets and Fuzzy Logic, Theory and Applications" Prentice - Hall of India Pvt. Ltd., New Delhi., 2008.

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./ M.SC. MATHEMATICS  
III-SEMESTER  
M309 OPERATIONS RESEARCH  
(w. e. f. 2021-2022 admitted batch)

**Course type: Theory**

**Course category: Elective**

**Credits: 4**

**Course Syllabus:**

**UNIT-I (12 Hours)**

**Linear Programming: Simplex Method:** Introduction-Fundamental properties of solutions-The computational procedure-Use of artificial variables.  
(Sections 4.1 to 4.4 of the Chapter 4 in the Prescribed Text Book.)

**UNIT-II ( 12 Hours)**

**Duality in Linear Programing:** Introduction-General Primal-Dual pair-Formulating a Dual problem-Prime-Dual Pair in matrix form-Duality theorems-Complementary slackness theorem-Duality and simplex method. (Sections 5.1 to 5.7 of the Chapter 5 in the Prescribed Text Book.)

**UNIT-III ( 12 Hours)**

**Duality in Linear Programing :** Economic Interpretation of Duality, Dual Simplex method  
**Post-optimal Analysis :** Introduction-Variation in the cost vector-Variation in the requirement vector-variation in the coefficient matrix-Structural variations- Applications of Post-optimal Analysis.  
(Sections 5.8, 5.9 and 6.1 to 6.6 of the Chapters 5 and 6 in the Text Prescribed Book.)

**UNIT-IV( 12 Hours)**

**Transportation Problem and Assignment Problem:** Introduction-General transportation problem-The transportation table-Solution of a transportation problem-Finding an initial basic feasible solution-Test for optimality-Degeneracy in Transportation problem-Transportation

Algorithm (MODI Method)- Introduction -Mathematical formulation of the problem-The Assignment method-Special cases in Assignment problem-A typical Assignment problem.

(Sections 10.1 to 10.3 and 10.8 to 10.11 of the Chapter 10 in the Prescribed Text Book.)

(Sections 11.1 to 11.5 of the Chapter 11 in the Prescribed Text Book.)

#### **UNIT-V( 12 Hours)**

**Games and Strategies:** Introduction-Two-person zero-sum games-some basic terms-The maximin-minimax principle-Games without saddle points-Mixed strategies-Graphic solution of  $2 \times n$  and  $m \times 2$  games.

(Sections 17.1 to 17.6 of the Chapter 17 in the Prescribed Text Book.)

**Prescribed Text Book:** Operations Research, Kanti Swarup, P.K. Gupta and Man Mohan Sultan Chand & Sons, New Delhi, 2006.

#### **Reference Books:**

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

2. Operations Research Theory, methods and Applications, S.D. Sarma, kedar nath Ram nath publications, 2008.

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc. MATHEMATICS  
III-SEMESTER  
M310 MATHEMATICAL BIOLOGY  
(w.e.f. 2021-22 admitted batch)

**Course type: Theory**

**Course category: Elective**

**Credits: 4**

**Course syllabus**

**UNIT-I (12 Hours)**

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 prescribed text book)

**UNIT-II ( 12 Hours)**

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 prescribed text book)

**UNIT-II ( 12 Hours)I( 12 Hours)**

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.

(Section 9 of the prescribed text book)

**UNIT-IV( 12 Hours)**

competition models - Mutualism models – various types of mutualisms – cooperative systems  
(Sections 12 and 13 of the prescribed Textbook)

**UNIT-V( 12 Hours)**

Harvest models and optimal control theory – open access fishery – sole owner fishery – Pontryagin’s maximum principle – Economic interpretation of Hamiltonian and adjoint variable.

(Section 14 of the prescribed text book)

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

<https://www.pdfdrive.com/elements-of-mathematical-ecology-e186548258.html>

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



ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc. Mathematics  
IV-SEMESTER  
M401 MEASURE AND INTEGRATION  
(w.e.f. 2021-2022 Admitted Batch)

**Course type: Theory**

**Course category: Core**

**Credits: 4**

**Course syllabus**

**UNIT-I (12 Hours)**

Lebesgue Measure: Introduction, Outer measure, Measurable sets and Lebesgue Measure, Littlewood's first principle.

Chapter 3, Sections 1 to 3, of the Text Book.

**UNIT-II ( 12 Hours)**

Lebesgue Measure Continued: A nonmeasurable set, Measurable functions, Littlewood's second principle, Littlewood's third principle.

Chapter 3, Sections 4 to 6, of the Text Book.

**UNIT-III ( 12 Hours)**

The Lebesgue Integral: The Riemann integral, The Lebesgue integral of a bounded function over a set of finite measure, The integral of a nonnegative function, The general Lebesgue integral.

Chapter 4, Sections 1 to 4 of the text book.

**UNIT-IV( 12 Hours)**

Differentiation and Integration: Differentiation of monotone functions, Functions of bounded variation, Differentiation of an integral, Absolute continuity, Convex functions.

Chapter 5 of the text book.

**UNIT-V( 12 Hours)**

The Classical Banach spaces: The  $L^p$  spaces, The Minkowski and Hölder inequalities, Convergence and Completeness, Approximation in  $L^p$ , Bounded linear functional on the  $L^p$  spaces.

Chapter 6 of the text book.

Text Book: H.L.Royden, Real Analysis, Macmillan Publishing Company, New York, 3<sup>rd</sup> Edition, 1988.

Reference: Inder K.Rana, An Introduction to Measure and Integration, 2<sup>nd</sup> Edition, Narosa Publishing House, 2002.

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc MATHEMATICS  
IV – SEMESTER  
M402 PARTIAL DIFFERENTIAL EQUATIONS  
(w.e.f. 2021-22 admitted batch)

**Course type: Theory**

**Course category: Core**

**Credits: 4**

**Course syllabus**

**UNIT-I (12 Hours)**

First Order Partial Differential Equations – Quasi linear PDEs – Pfaff's Equations

(Sections 2.1, 2.2 of the prescribed text book)

**UNIT-II ( 12 Hours)**

Nonlinear first order PDEs-Classification of the second order PDEs in two independent variables – wave, potential and Heat equations

(Sections 2.3, 3.1 and 3.3 of the prescribed text book)

**UNIT-II ( 12 Hours)I( 12 Hours)**

Hyperbolic Equations – Cauchy problem for one dimensional wave equation – The Fourier method of Separation of variables

(Sections 4.1, 4.3 of the prescribed text book)

**UNIT-IV( 12 Hours)**

Elliptic equations – Dirichlet problems involving Cartesian coordinates

(Section 5.1 of the prescribed text book)

**UNIT-V( 12 Hours)**

Parabolic Equations – Cauchy problem – Mixed type problems

(Sections 6.1, 6.2 of the prescribed text book)

Text book: Partial Differential Equations through Examples and Exercises, Endre Pap, Arpad Takaci and Djurdjica Takaci, Kluwer Texts in Mathematical Sciences, Volume 18,1997 Springer Science+Business Media, Dordrecht

<https://www.pdfdrive.com/partial-differential-equations-through-examples-and-exercises-e186588655.html>

Reference: Elements of Partial Differential Equations, Ian Sneddon, McGraw-Hill International editions, New Delhi

<https://www.pdfdrive.com/elements-of-partial-differential-equations-e186460086.html>

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A/M.SC MATHEMATICS  
IV-SEMESTER  
M 403 NUMBER THEORY-II  
(PRE-REQUISITE: NUMBER THEORY I)  
(w.e.f. 2021-22 admitted batch)

**Course type: Theory**

**Course category: Elective**

**Credits: 4**

**Course Syllabus:**

**UNIT-I (12 Hours)**

**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.

(Sections 9.1 to 9.8 of the Chapter 9 in the Prescribed Text Book.)

**UNIT-II ( 12 Hours)**

**PRIMITIVE ROOTS:** The exponent of a number mod  $m$ . Primitive roots- Primitive roots and reduced residue systems-The nonexistence of primitive roots mod  $2^\alpha$  for  $\alpha \geq 3$  - The existence of primitive roots and  $p$  for odd primes  $p$ . Primitive roots and quadratic residues- The existence of primitive roots mod  $p^\alpha$  - The existence of primitive roots mod  $2 p^\alpha$  - The nonexistence of primitive roots in the remaining cases- The number of primitive roots mod  $m$ .

(Sections 10.1 to 10.9 of the Chapter 10 in the Prescribed Text Book.)

**UNIT-III ( 12 Hours)**

**DIRICHLET SERIES AND EULER PRODUCTS:**

Introduction-The half- plane of absolute convergence of a Dirichlet series, The function defined by Dirichlet series, Multiplication of Dirichlet series, Euler Products, The half-plane of convergence of a Dirichlet series

(Sections 11.1 to 11.6 of the Chapter 11 in the Prescribed Text Book.)

**UNIT-IV( 12 Hours)**

**DIRICHLET SERIES AND EULER PRODUCTS:** Analytic properties of Dirichlet series- Dirichlet series with nonnegative coefficients- Dirichlet series expressed as exponential of Dirichlet series-Mean value formulas for Dirichlet series-An integral formula for the coefficients of a Dirichlet series-An integral formula for the partial sums of a Dirichlet series.

(Sections 11.7 to 11.12 of the Chapter 11 in the Prescribed Text Book.)

**UNIT-V( 12 Hours)**

Analytic proof the Prime Number Theorem: The plan of the proof, lemmas, A contour integral representation of  $\psi_1(x)/x^2$ , Upper bounds for  $|\zeta(s)|$  and  $|\zeta'(s)|$  near the line  $\sigma = 1$ , The non

vanishing of  $\zeta(s)$  on the line  $\sigma = 1$ , Inequalities for  $|1/\zeta(s)|$  and  $|\zeta'(s)/\zeta(s)|$ , Completion of the proof of the prime number theorem  
(Sections 13.1 to 13.7 of the Chapter 13 in the Prescribed Text Book.)

Prescribed Text Book:

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

**Reference Books:**

1. An Introduction to the theory of numbers, 5<sup>th</sup> edition by Ivan Niven Herbert S. Zuckerman and Hugu L. Montgomery, John Wiley & Sons INC. publications, U.K., 2008.
2. Elementary Number Theory, 7<sup>th</sup> edition by David M. Burton, 2011.

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc. MATHEMATICS  
IV- SEMESTER  
M404 UNIVERSAL ALGEBRA-II  
(PRE-REQUISITE: UNIVERSAL ALGEBRA-I)  
( w.e.f. 2021- 2022 admitted batch)

**Course type: Theory**

**Course category: Elective**

**Credits: 4**

**Course Syllabus**

**UNIT-I (12 Hours)**

Class Operators and Varieties, Terms, Term Algebras and Free algebras.  
(Sections 9, 10 of Chapter-II of the Prescribed Text Book).

**UNIT-II ( 12 Hours)**

Identities, Free Algebras and Birkhoff's Theorem- Mal'cev Conditions- The Centre of an Algebra. (Sections 11, 12, 13 of Chapter-II of the Prescribed Text Book)

**UNIT-III ( 12 Hours)**

Boolean Algebras, Boolean Rings.  
(Sections 1, 2 of Chapter-IV of the Prescribed Text Book)

**UNIT-IV( 12 Hours)**

Filters and Ideals, Stone Duality. (Sections 3, 4, of Chapter-IV of the Prescribed Text Book)

**UNIT-V( 12 Hours)**

Boolean Powers, Ultra Products and Congruence-Distributive Varieties, Primal Algebras.  
(Sections 5, 6, 7 of Chapter-IV of the Prescribed Text Book)

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

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc. MATHEMATICS  
IV-SEMESTER  
M405 LATTICE THEORY-II  
(PRE-REQUISITE: LATTICE THEORY-I)  
( w.e.f. 2021 – 2022 admitted batch)

**Course type: Theory**

**Course category: Elective**

**Credits: 4**

**Course Syllabus**

**UNIT-I (12 Hours)**

Distributive Lattices, Infinitely Distributive and Completely Distributive Lattices, Modular Lattices, Characterization of Modular and Distributive Lattices by their Sublattices.  
(Sections 30 to 33 of Chapter IV of the Prescribed Text Book)

**UNIT-II ( 12 Hours)**

Distributive Sublattices of Modular Lattices, The Isomorphism Theorem of Modular Lattices, Covering Conditions, Meet Representations in Modular and Distributive Lattices.  
(Sections 34 to 36 of Chapter IV of the Prescribed Text Book)

**UNIT-III ( 12 Hours)**

Boolean Algebras, De Morgan Formulae, Complete Boolean Algebras, Boolean Algebras and Boolean Rings.  
(Sections 42 to 44 of Chapter VI of the Prescribed Text Book).

**UNIT-IV( 12 Hours)**

The Algebra of Relations, The Lattice of Propositions, Valuations of Boolean Algebras.  
(Sections 45 to 47 of chapter VI of the Prescribed Text Book)

**UNIT-V( 12 Hours)**

Ideals and Dual Ideals, Ideal Chains, Ideal Lattices, Distributive Lattices and Rings of Sets.  
(Sections 53 to 55 of chapter VIII 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.

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc. MATHEMATICS  
IV-SEMESTER  
M406 COMMUTATIVE ALGEBRA-II  
(PRE-REQUISITE: COMMUTATIVE ALGEBRA-I)  
( w.e.f. 2021-2022 admitted batch)

**Course type: Theory**

**Course category: Elective**

**Credits: 4**

**Course Syllabus**

**UNIT-I (12 Hours)**

Primary Decomposition, The First Uniqueness Theorem, The Second Uniqueness Theorem.

**UNIT-II ( 12 Hours):**

Integral Dependence, The Going-Up Theorem, Integrally Closed Integral Domains, The Going-Down Theorem, Valuation Rings.

**UNIT-II ( 12 Hours)I( 12 Hours):**

Chain Conditions.

**UNIT-IV( 12 Hours):**

Noetherian Rings, Hilbert's Basis Theorem, Primary decomposition of Noetherian rings.

**UNIT-V( 12 Hours):**

Artin Rings.

Prescribed Text Book : Introduction to Commutative Algebra by M.F.Atiya and I.G. Macdonald, Addison-Wesley Publishing Company, London.

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A/M. Sc. MATHEMATICS  
IV-SEMESTER  
M 407 SEMI GROUPS II  
(PRE-REQUISITE: SEMI GROUPS I)  
(w.e.f. 2021-2022 admitted batch)

**Course type: Theory**

**Course category: Elective**

**Credits: 4**

**Course Syllabus**

**UNIT-I (14 Hours)**

Union of Groups, Semi lattices of groups, bands, free bands. varieties of bands.

**UNIT-II ( 10 Hours):**

Introduction to inverse semi groups, preliminaries, the natural order relation on an inverse semi group, congruences on inverse semigroups

**UNIT-III ( 12 Hours)**

Fundamental inverse semi groups, anti-uniform semilattices. Bi-simple inverse semi groups

**UNIT-IV( 10 Hours):**

Simple inverse semigroups, representation of inverse semigroups.

**UNIT-V( 14 Hours):**

Orthodox semigroups, 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 Semigroup Theory by J. M. Howie, 1976, Academic press, New York.



ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc. Mathematics  
IV-SEMESTER  
M408 OPERATOR THEORY  
(w.e.f. 2021-2022 Admitted Batch)

**Course type: Theory**

**Course category: Elective**

**Credits: 4**

**Course syllabus**

**UNIT-I (12 Hours)**

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 ( 12 Hours)**

Approximation in Normed spaces, Uniqueness, Strict convexity, Uniform Approximation, Approximation in Hilbert space.

Chapter 6, Section 6.1 to 6.3, and 6.5, of the Text Book.

**UNIT-III ( 12 Hours)**Spectral theory in Finite dimensional Normed Spaces, Basic concepts, Spectral properties of Bounded linear operators, Further properties of Resolvent and Spectrum.

Chapter 7, Section 7.1 to 7.4, of the Text Book.

**UNIT-IV( 12 Hours)**

Compact linear operators on Normed Spaces, Further properties of Compact linear operators, Spectral properties of Compact Linear operators on Normed spaces, Further Spectral properties of Compact linear operators.

Chapter 8, Sections 8.1 to 8.4, of the Text Book.

**UNIT-V( 12 Hours)**

Operator Equations involving compact linear operators, Further theorems of Fredhm type, Fredhlm alternative.

Chapter 8, Sections 8.5 to 8.7, of the Text Book.

Text Book: Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, 2001.

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A/M. Sc. MATHEMATICS  
IV-SEMESTER  
M 409 BANACH ALGEBRA  
(w.e.f. 2021-2022 admitted batch)

**Course type: Theory**

**Course category: Elective**

**Credits: 4**

**Course Syllabus**

**UNIT-I (12 Hours)**

General preliminaries on Banach Algebras – The definition and examples – Regular and singular elements – Topological divisors of Zero – The spectrum

**UNIT-II ( 12 Hours):**

The formula for the spectral radius -The radical and the semi – simplicity.  
The structure of commutative Banach Algebras – The Gelfand mapping

**UNIT-III ( 12 Hours)**

Applications of the formula  $r(x) = \lim (\|x^n\|^{1/n})$ -- Involutions in Banach Algebras – The Gelfand – Neumark theorem.

**UNIT-IV( 12 Hours):**

Some special commutative Banach Algebras - Ideals in  $C(X)$  and the Banach – Stone theorem - The stone – Chech compactification – commutative  $C^*$  - algebras.

**UNIT-V( 12 Hours):**

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.  
(Contents of the syllabus-Chapters 12, 13, 14 and Appendices 1,2,3 of the text book).

**Text Book:** Introduction to Topology and Modern Analysis – By G.F. Simmons – International Student edition – McGraw – Hill Kogakusha L

ANDHRA UNIVERSITY  
DEPARTMENT OF MATHEMATICS  
M.A./M.Sc. Mathematics  
IV-SEMESTER  
M410 Nonlinear Functional Analysis  
(w.e.f. 2021-2022 Admitted Batch)

**Course type: Theory**

**Course category: Elective**

**Credits: 4**

**Course Syllabus**

**UNIT-I (12 Hours)**

Various Forms of Continuity, Geometry in Normed Spaces and Duality Mapping. Chapter 1, Sections 1.1 to 1.2 of the Text Book.

**UNIT-II ( 12 Hours)**

Gateaux and Fréchet derivative, Properties of derivative, Taylor's theorem, Inverse function theorem and Implicit function theorem, Subdifferential of convex functions.

Chapter 2 of the Text Book.

**UNIT-III ( 12 Hours)**

Banach's contraction principle and its generalization.

Chapter 4, Section 4.1 of the Text Book.

**UNIT-IV( 12 Hours)**

Nonexpansive mappings.

Chapter 4, Section 4.2 of the Text Book.

**UNIT-V( 12 Hours)**

Fixed Point Theorems of Brouwer and Schauder.

Chapter 4, Section 4.3 of the Text Book.

**Text Book:** Mohan C. Joshi and Ramendra K. Bose, Some Topics in Nonlinear Functional Analysis, Wiley Eastern Limited, Hyderabad, 1985.

**Reference:** V.I. Istratescu, Fixed Point Theory-An Introduction, Springer, 1981.