M.A./M.Sc Mathematics

(Effective from the admitted batch of 2021-22)

Scheme and Syllabus

DEPARTMENT OF MATHEMATICS
COLLEGE OF SCIENCE AND TECHNOLOGY
ANDHRA UNIVERSITY, VISAKHAPATNAM

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.		Elective I	4	20%	80%
4.		Elective II	4	20%	80%
5.		Elective III	4	20%	80%
6.	M 3MC	Moocs course	4		
Total Credits for Semester III			24		

Electives I-III to be chosen from the following list of electives for semester III.

List of electives for semester III			
S.No	Course Code	Name of the Course	Credits
1.	M 303	Number Theory I	4
2.	M 304	Universal Algebra I	4
3.	M 305	Lattice Theory I	4
4.	M 306	Commutative Algebra I	4
5.	M 307	Semigroups I	4
6.	M 308	Fuzzy Set Theory and Applications	4
7.	M 309	Operations Research	4
8.	M 310	Mathematical Biology	4

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.		Elective IV	4	20%	80%
4.		Elective V	4	20%	80%
5.		Elective VI	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		

Electives IV-VI to be chosen from the following list of electives for semester IV.

List of electives for semester IV				
S.No	Course Code	Name of the Course	Credits	Pre-requisite
1.	M 403	Number Theory II	4	Number Theory I
2.	M 404	Universal Algebra II	4	Universal Algebra I
3.	M 405	Lattice Theory II	4	Lattice Theory I
4.	M 406	Commutative Algebra II	4	Commutative Algebra I
5.	M 407	Semigroups II	4	Semigroups I
6.	M 408	Operator Theory	4	-
7.	M 409	Banach Algebra	4	-
8.	M 410	Nonlinear Functional Analysis	4	-

The main objective of this academic program M.A./M.Sc Mathematics, is to promote mathematical aptitude and nurture the interests of the students to pursue mathematics. Further, it aims at motivating the young minds for research in mathematical sciences and work on challenging problems.

PROGRAM OUTCOMES: (5-8)

PO 1: To provide comprehensive curriculum to groom the students into qualitative mathematicians.
PO 2: Enable students to enhance their mathematical skills and understand the fundamental concepts of mathematics.
PO 3: To provide qualitative education through effective teaching learning processes by introducing projects and participative learning.
PO 4: To encourage collaborative learning and application of mathematics to real life situations.
PO 5: To inculcate the curiosity for mathematics in students and to prepare them for future research.
PO 6: Strengthen students competencies and confidence to succeed in competitive examinations, which include NBHM,GATE, CSIR NET, APSET and all such others.

PROGRAM SPECIFIC OUTCOMES: (5-8)

PSO 1: Understand the nature of abstract mathematics and explore the concepts in further details.
PSO 2: Pursue research in challenging areas of mathematics.
PSO 3: Develop abstract mathematical thinking.
PSO 4: Apply the knowledge of mathematical concepts in interdisciplinary fields.
PSO 5: Model the real-world problems into mathematical equations and draw the inferences by finding appropriate solutions.

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 objectives/outcomes: (5-8)

CO 1: To introduce the basic concepts of group theory and study the structure of groups.
CO 2: To introduce the concepts of conjugacy and G sets and prove cayley theorem. To introduce explicitly the properties of permutation groups
CO 3: To determine structure of any abelian groups. To determine structure of finite nonabelian groups through Sylow theorems.
CO 4: To introduce concepts of ring theory. To introduce different types of ideals. To apply Zorn's lemma on the set of ideals.
CO 5: To introduce prime elements and irreducible elements in a commutative integral domain. To study the domains UFD, PID and ED

Mapping of COs with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	*	*		*	*	*
CO 2	*	*	*	*	*	*
CO 3	*	*	*	*	*	*
CO 4	*	*			*	*
CO 5	*			*	*	*

Course Specific Outcomes (3-5)

CSO 1: To study structure of groups. To study fundamental theorem of homomorphism, fundamental theorem of finitely generated abelian groups and Sylow theorems.
CSO 2: To understand the concept of group actions. To study the permutation groups.
CSO 3: To understand the structure theorems of rings using the study of ideals and to understand the properties of class of domains UFD, PID and ED and study relations among them.

Course Syllabus:

UNIT-I

Groups: Homomorphisms-Subgroups and cosets.
Normal subgroups: Normal Subgroups and Quotient groups-Isomorphism thorems- Automorphisms.
12 hours
(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

Normal Subgroups: Conjugacy and G-sets.
Permutation Groups: Cyclic decomposition-Alternating group A_n-Simplicity of A_n. 12 hours
(Section 5.4 of chapter 5 and sections 7.1 to 7.3 of the Chapter 7 in the Prescribed Text Book.)

UNIT-III

Structure thorems of groups: Direct products-Finitely generated abelian groups-Invariants of a finite abelian group-Sylow theorems. 12 hours
(Sections 8.1 to 8.4 of the Chapter 8 in the Prescribed Text Book.)

UNIT-IV

Ideals and Homomorphisms: Ideals-Homomorphisms-Sums and direct sums of ideals- Maximal and prime ideals-Nilpotent and nil ideals-Zorn's lemma. 12 hours
(Sections 10.1 to10.6 of the Chapter 10 in the Prescribed Text Book.)

UNIT-V

Unique factorization domains and Euclidean domains: Unique factorization domains-Principal ideal domains-Euclidean domains-Polynomial rings over UFD 12 hours
(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, 2nd Edition, John Wiley &Sons
2. Algebra : Thomas W. Hungerford, Springer
3. Algebra : Serge Lang, Revised Third Edition, Springer

Learning Outcomes (4-5)

LO 1: The study of powerful concepts like conjugacy and G- sets, permutation groups and Sylow theorems introduces to new proof techniques.
LO 2: The study on structure theorems on groups based on the study of cyclic groups motivates analogous study on other algebraic structures.
LO 3: The study on structure theorems of rings using the study of ideals gives more insight on the study of ideals
LO 4: The study on UFD as a generalization of fundamental theorem of arithmetic, PID based on ideals and ED is division algorithm applied on polynomials introduces to fundamental techniques adapted in advanced algebra

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 Objectives/Outcomes: (5-8)

CO 1: Describe elementary concepts on metric spaces to get the general idea that is relevant to Euclidean spaces.
CO 2: To study the continuity and its properties of real valued functions in metric spaces.
CO 3: Describe the derivatives of real valued functions defined on intervals or segments, and study its properties.
CO 4: Introduce Riemann-Stieltjes integral as a generalization of Riemann integral and discuss the existence of this integral.
CO 5: To study differentiation of integrals and further the extension of integration to vector valued functions.

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	*	*			*	
CO 2	*	*			*	*
CO 3	*	*	*	*	*	*
CO 4	*	*				*
CO 5		*		*	*	*

Course Specific Outcomes: (3-5)

CSO 1: The students will be able to understand fundamental concepts, like neighborhood, limit point, interior point, open sets, closed sets, compact sets, perfect sets and connected sets.
CSO 2: The student will learn the concepts of continuity and differentiation and their properties, which will be useful for their further studies of other courses in Mathematics.
CSO 3: The student will be able to understand the existence and properties of Riemann-Stieltjes integral and its extension to vector valued functions and finding lengths of smooth curves.

Course syllabus

UNIT–I

Basic Topology: Metric spaces, Compact sets, Perfect sets, Connected sets. 12 Hours

Chapter 2, Sections 2.15 to 2.47 of the Prescribed Text Book.

UNIT –II

Continuity: Limits of functions, Continuous Functions, Continuity and Compactness, Continuity and Connectedness, Discontinuities, Monotone functions, Infinite limits and Limits at Infinity. 12 Hours

Chapter 4 of the Prescribed Text Book.

UNIT –III

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. 12 Hours

Chapter 5 of the Prescribed Text Book.

UNIT-IV

The Riemann-Stieltjes integral: Definition and Existence of the Integral, Properties of the integral, Change of variable. 12 Hours

Chapter 6, Sections 6.1 to 6.19, of the Prescribed Text Book.

UNIT-V

The Riemann-Stieltjes integral continued: Integration and Differentiation, The Fundamental theorem of Calculus, Integration by parts, Integration of vector-valued functions, Rectifiable curves. 12 Hours

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, 3rd Edition, 1985.

Reference: Tom M. Apostal, Mathematical Analysis, Narosa Publishing House, 2nd Edition, 1985.

Learning Outcomes: (4-5)

LO 1: To identify the closed sets, open sets, compact sets, perfect sets connected sets, and properties of respective sets.

LO 2: To understand the basic theory of continuous functions, images of compact sets, images of connected sets, types of discontinuities.

LO 3: To understand the significance of differentiable functions, their properties, mean value theorems and Taylor's theorem.

LO 4: To recognize Riemann-Stieltjes integral as a generalization of Riemann integral, and to know about various sufficient conditions for the existence of Riemann-Stieltjes integral and their properties.

LO 5: To understand the differentiation of integrals, the fundamental theorem of calculus, integration by parts which are useful to evaluate integrals of certain functions. Further, to understand the integration of vector valued functions and to find the length of a rectifiable curve.

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 Course category: Core Credits: 4

Course Objectives/ outcomes : (5-8)

CO 1: To get acquaintance with concepts of sets and functions and their properties which are basic tools to study Mathematics
CO 2: To introduce metric spaces and some elementary concepts in metric spaces
CO 3: To study the concept of continuous functions and their properties, Euclidean and Unitary spaces
CO 4: To understand broader concept of topology and topological spaces, as a generalization of metric spaces and study some basic results in topological spaces
CO 5: To study the concept of compactness and compact spaces . Some important theorems in compact spaces

Mappings of POs with COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	*	*	*	*	*	*
CO2	*	*	*	*	*	*
CO3	*	*	*	*	*	*
CO4	*	*	*	*	*	*
CO5	*	*	*		*	*

Course Specific out comes: (3-5)

CSO 1: This will be useful to study several branches in the field of abstract Mathematics
CSO2: This is enable to study different types of topological spaces and metric spaces
CSO3: This forms a base for the study of Modern Analysis and Topological algebras

Course Syllabus

UNIT-I

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

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

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

Topological spaces (continued): Open bases and open sub bases, Weak Topologies, The function algebras C(X, R) and C(X, 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 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.

Learning Outcomes: (4-5)

LO 1 : Will be able to handle operations on sets and functions and their properties
LO 2: To understand the concepts of Metric spaces, open sets, closed sets, convergence, some important theorems like Cantor's intersection theorem and Baire's theorem
LO 3: To be familiar with the concept of Topological spaces, continuous functions in more general and characterize continuous functions in terms of open sets, closed sets etc.
LO 4: To explain the concept of compactness in topological spaces
LO 5: To characterise compactness in metric spaces and their properties

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 Objectives/Outcomes: (5-8)

CO 1: Familiarize with essential concepts of real function theory that help to grasp the theory of ordinary differential equations
CO 2: To introduce basic theorems in theory of ordinary differential equations pertaining to existence, uniqueness, continuation of solutions.
CO 3: To understand dependence of solutions on initial conditions and parameters
CO 4: Transform nth order differential equations in to differential systems and extend the theory to differential systems.
CO 5: To study the qualitative behaviour of solutions of homogeneous and non homogeneous linear equations and systems

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	*	*				
CO2	*	*			*	*
CO3	*	*	*	*	*	*
CO4	*	*				*
CO5		*			*	*

Course Specific Outcomes: (3-5)

CSO 1: This will enable the students to understand and appreciate the inter dependency of various fields in mathematics.
CSO 2: This forms a base for pursuing further studies in the field of differential equations as well as related areas.
CSO 3: This offers a platform for the students to understand, apply mathematics to real world problems and offer solutions

Course syllabus

Unit I: Essential concepts from Real Function Theory – The basic problem -The fundamental existence and uniqueness theorem –examples to demonstrate the theory- continuation of solutions – 12 hours

(Sections 10.1, 10.2 of the prescribed text book)

Unit II: 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 – 12 hours
(Sections 10.3, 10.4 of the prescribed text book)

Unit III: Introduction to the theory of Linear differential systems – Theory and properties of Homogeneous linear systems – 12 hours
(Sections 11.1 - 11.3 of the prescribed text book)

Unit IV: Theory of non homogeneous linear systems – Theory and properties of the nth order homogeneous linear differential equations – 12 hours
(Sections 11.4 - 11.6 of the prescribed text book)

Unit V: Theory of nth order Non homogeneous Linear equations – Sturm theory – Sturm Liouville Boundary value problems – 12 hours
(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

Learning outcomes: (4-5)

LO 1: To comprehend the bridge between the real function theory and theory of ordinary differential equations
LO 2: To understand the basic theory behind existence, uniqueness, continuity of solutions of ordinary differential equations
LO 3: To realize the dependence of solutions on various parameters involved in the differential equations
LO 4: To recognise the significance studying differential systems and its utility in understanding higher order differential equations
LO 5: To figure out qualitative behaviour of solutions of differential equations of various orders.

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 Objective/Outcomes:(5-8)

CO-1: To introduce the essential concepts of linear transformations on finite dimensional vector spaces.
CO-2: To understand the utilization of ordered basis to represent linear transformations by matrices.
CO-3: To select a single linear operator on finite dimensional vector space and to take it apart to see what makes it tick.
CO-4: To characterise the smallest subspace of a vector space which is invariant under linear operator.
CO-5:To decompose a linear operator on a finite dimensional vector space into a direct sum of operators which are elementary.

Mappings of Cos with POs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	*	*	*	-	*	*
CO-2	*	*	*	-	*	*
CO-3	*	-	*	*	*	*
CO-4	*	*	-	*	*	*
CO-5	*	*	*	*	*	*

Course Specific Outcomes:(3-5)

CSO-1: This will enable the students to understand the relation between linear transformations and matrices.
CSO-2: This is basic requirement for further studies in the field of direct products and canonical forms.
CSO-3: This will help the students to apply the concepts in matrices to vector spaces.

Course Syllabus

Unit - I

Introduction, Characteristic Values, Similar Matrices, Diagonalizable Operators, Annihilating Polynomials, Minimal Polynomials, Cayley – Hamilton Theorem . 12 hours
(Sections 6.1 - 6.3 of Chapter 6 in the Prescribed Text Book)

Unit - II

Invariant Subspaces, T-conductor of a vector, T-annihilator of a vector, Simultaneous Triangulation; Simultaneous Diagonalization. 12 hours

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

Unit – III

Direct – Sum Decompositions, Projections, Invariant Direct Sums, The Primary Decomposition Theorem. 12 hours

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

Unit – IV

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. 12 hours

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

Unit – V

The Jordan Forms, Elementary Jordan Matrix with Characteristic Value , Computation of Invariant Factors, Elementary Matrices, Smith Normal Forms, Summary; Semi-Simple Operators. 12 hours

(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, 2nd Edition, New Delhi.

Learning Outcomes:(4-5)

LO-1: To bridge the relation between matrix theory and vector spaces.
LO-2: To understand the applications of Cayley-Hamilton Theorem.
LO-3: To find an inverse of a linear transformation(a matrix) using Cayley-Hamilton Theorem.
LO-4: To find the Jordan forms of a complex matrix with a given characteristic polynomial.
LO-5: To understand the relation between semi-simple operators and diagonalizable operators.

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 objectives/outcomes: (5-8)

CO 1: To understand the concept of extensions of a field, based on the study of irreducible polynomials.
CO 2: To understand the concept of normal extensions and separable extensions based on the study multiplicity of roots of a polynomial
CO 3: To introduce the concept of group of automorphisms on a field. To introduce fixed fields. To prove the fundamental theorem of Galois theory.
CO 4: To apply Galois theory and prove the fundamental theorem of algebra. To study the properties of nth cyclotomic polynomial.
CO 5: To understand Galois theory and study its applications.

Mapping of COs with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	*	*		*	*	*
CO 2	*	*			*	*
CO 3	*				*	*
CO 4	*	*			*	*
CO 5	*	*	*	*	*	*

Course Specific Outcomes (3-5)

CSO 1: To understand the properties of the polynomial ring F[x] over a field F. To study various methods for testing of irreducibility of polynomials. To introduce finite extensions, algebraic extensions. Study on algebraically closed fields.
CSO 2: To introduce splitting fields of a polynomial. To study on multiplicity of roots. To understand finite field classification.
CSO 3: To study group of automorphisms of a field. To study the irreducibility of nth cyclotomic polynomial.
CSO 4: To apply Galois theory and study the solvability of polynomials. To apply Galois theory on other topics like symmetric functions

Course Syllabus

UNIT I

Algebraic extension of fields: Irreducible polynomials and Eisenstein's criterion-Adjunction of roots-Algebraic extensions- Algebraically closed fields. 12 hours
(Sections 15.1 to 15.4 of the Chapter 15 in the prescribed text book.)

UNIT II

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.) 12 hours

UNIT III

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.) 12 hours

UNIT IV

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 18.1and 18.2 of the Chapter 18 in the prescribed text book.) 12 hours

UNIT V

Applications of Galois Theory to Classical problems: Polynomials solvable by radicals-symmetric functions-Ruler and compass constructions. 12 hours
(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.

Reference Books:

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

Learning Outcomes (4-5)

LO 1: Introduces to various methods for testing of irreducibility of polynomials over fields.
LO 2: Study of multiplicity of roots of polynomial fields introduces to classification studies according to characteristics of fields
LO 3: The study of finite field theory forms a basis for fundamental research in algebra.
LO 4: The study of Galois theory introduces to new proof techniques.

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 Objectives/Outcomes: (5-8)

CO 1: Discuss the most important aspects of the problems that arise when limit processes are interchanged.

CO 2: Study the approximation of continuous complex function and its generalization and an introduction of power series.

CO 3: Study of exponential and logarithmic functions, the trigonometric functions and Fourier series and their properties.

CO 4: Discuss linear transformations on finite-dimensional vector spaces over any field of scalars and derivative of functions of several variables.

CO 5: Study the method of solving implicit functions. Interesting illustration of the general principle that the local behaviour of a continuously differentiable mapping near a point. Further study of derivatives of higher order and differentiation of integrals.

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	*	*	*			*
CO 2	*	*				
CO 3	*	*	*		*	*
CO 4	*	*				*
CO 5	*	*		*	*	*

Course Specific Outcomes: (3-5)

CSO 1: To determine whether important properties of functions are preserved under the limit operations, to study Stone's generalization of the Weierstrass theorem and the convergence of power series.

CSO 2: Detailed properties of exponential and logarithmic functions and its properties, trigonometric functions and Fourier series.

CSO 3: To study the method of solving implicit functions and derivatives of higher order and differentiation of integrals.

Course syllabus

UNIT–I

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

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

Some Special Functions: The Exponential and Logarithmic Functions, The Trignometric 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

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

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, 3rd Edition, 1985.

Reference: Tom M. Apostal, Mathematical Analysis, Narosa Publishing House, 2nd Edition, 1985.

Learning Outcomes: (4-5)

LO 1: To understand the behaviour of inter change property of limits.

LO 2: Approximation of continuous function and Stone-Weierstrass theorem, convergence of power series.

LO 3: Identification of exponential and logarithmic functions, Trigonometric functions and Fourier series and their properties.

LO 4: To understand Linear operator properties, existence of derivative of functions of several variables and solutions of nonhomogeneous equations.

LO 5: Able to understand the method of solving implicit equations, rank theorem, derivatives of higher order and differentiation of integrals.

ANDHRA UNIVERSITY
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 Objectives/ outcomes : (5-8)

CO 1: To study Separation properties of Topological spaces , Urysohn's lemma, Tietze's extension theorem
CO 2: To understand the concept of metrizability of a topological space ,Urysohn's imbedding theorem and one point compactification of a topological space
CO 3: To understand the concept of connected spaces, locally connected spaces, and totally disconnected spaces and their properties
CO 5: To Prove Weirstrass approximation theorem and Stone - Weirstrass theorems
CO 6: To study locally compact spaces and generalise Stone - Weirstrass theorems

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	*	*		*	*	*
CO 2	*	*		*	*	*
CO 3	*	*		*	*	*
CO 4	*	*	*	*	*	*
CO 5	*	*	*	*	*	*

Course Specific Outcomes:(3-5)

CSO 1: This will enable the students to Charactrise the metrizability of a topological space
CSO 2: To study approximation of continuous functions through polynomials
CSO 3: To understand one point compactication of a topological space

Course Syllabus

UNIT-I
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).
12 hours

UNIT-II:
Separation (continued): The Urysohn imbedding theorem – The Stone – Chech compactification. (Chapter 5: Sections 29 to 30 Prescribed text book).
Connectedness: Connected spaces– connectedness of R^n and C^n. (Chapter 6: Section 31 Prescribed text book). 12 hours

UNIT-III

Connectednedness (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

Approximation: The Weierstrass approximation theorem - The Stone-Weierstrass theorems (Chapter 7: Section 35 to 36 Prescribed text book). 12 hours

UNIT-V

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.

Learning Outcomes: (4-5)

LO 1: will be able to understand various toplogical spaces like T_1 spaces, Hausdorff spaces, Completely regular spaces, normal spaces

LO 2: will be able to prove the existence of continuous functions on normal spaces

LO 3: To characterize connected subsets of Real number system , understand local connectedness and totally disconnected spaces

LO 4: The student will be able to prove various approximation theorems for continuous functions

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 Objectives/Outcomes: (5-8)

CO 1: To learn basic properties of power series and utilise this knowledge to construct analytic functions. To understand the relation between the Cauchy - Riemann equations and analytic functions. Study the nature and properties of Mobious transformation

CO 2: To know about Power series expansion of analytic functions, significant properties analytic functions, zeros of analytic functions - gain knowledge pertaining to Liouville theorem, fundamental theorem of algebra, maximum modulus theorem and to know about index of a closed curve

CO 3: To understand the three versions of Cauchy integral formula, Cauchy's theorem and Study Morera's theorem and its significance

CO 4: Be aware of some applications of Cauchy theorem to count zeros of an analytic function and the open mapping theorem as a property of analytic function

CO 5: Recognise and classify singularities of an analytic function - learn about residue theorem

CO 6: Be aware of three versions of maximum modulus theorem and also the Swartz's lemma

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	*	*	*			*
CO2	*	*			*	*
CO3	*	*	*		*	*
CO4	*	*				*
CO5	*	*			*	*
CO 6	*	*			*	*

Course Specific Outcomes: (3-5)

CSO 1: Identify analytic functions, explain about branches of logarithm, be aware of vital properties of analytic functions

CSO 2: Identify types of singularities, compute residues, learn about application of maximum principles

CSO 3: Analyse and Interpret the theory and theoretical structure of Complex Analysis as a prerequisite for the future study subjects such as Operator Theory and Analytic Number Theory.

Course syllabus

UNIT-I
Power series- Analytic functions - Analytic functions as mappings, Mobius transformations – 12 hours
($1, $2,$3 of chapter-III of the prescribed text book)

UNIT-II
Power series representation of analytic functions- zeros of an analytic function - The index of a closed curve – 12 hours
($2, $3, $4 of chapter-IV of the prescribed text book)

Unit - III
Cauchy's theorem and integral formula- Counting zeros, the Open mapping theorem – 12 hours
($5, $7 of chapter-IV of the prescribed text book)

UNIT-IV
Classification of singularities – residues and related results – 12 hours
($1, $2 of chapter-V of the prescribed text book)

UNIT V
The maximum principle – Schwarz's lemma and related results. – 12 hours
($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

Learning outcomes: (4-5)

LO 1: To be able to solve problems using the properties of analytic functions like power series expansion, Cauchy-Riemann equations etc.
LO 2: To be able to analyze the properties of power series and apply them to understand properties of analytic functions.
LO 3: To be able to apply the Cauchy integral formula to solve problems.
LO 4: To be able to analyze the zeros of analytic functions.
LO 5: To identify and analyze the nature of singularities and behavior of functions near the singularities.
LO 6: To be able to apply maximum principle and Schwartz lemma etc to solve problems.

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 Objective/Outcomes:(5-8)

CO-1: To understand The Four Colour Theorem and applications in chemistry and physics.
CO-2: To familiarize the basic concepts of graphs and different types of graphs.
CO-3: To learn the modelling of Konigsberg Bridge Problem and Hamilton's Game by graphs.
CO-4: To characterize graphs which are both Eulerain and Hamiltonian.
CO-5: To understand specific difference between modular and distributive lattices.
CO-6: To learn the importance of diamond and pentagon lattices.

Mappings of COs with POs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	*	*	-	-	*	*
CO-2	*	*	-	-	*	*
CO-3	*	*	-	*	*	*
CO-4	-	*	*	*	-	*
CO-5	*	*	-	-	*	*
CO-6	*	*	*	*	*	*

Course Specific Outcomes:(3-5)

CSO-1: To enable the students to understand the applications of graphs in solving many problems in physics, chemistry too.
CSO-2: To learn the concept of a tree and learn enumerating methods for counting various classes of graphs.
CSO-3: Characterizations of modular lattices which are not distributive and distributive lattices using Pentagon and Diamond lattices.

Course Syllabus

UNIT- I

Basic Ideas, History, Initial Concepts, Summary, Connectivity , Elementary Results, Structure Based on Connectivity . 12 hours
(Chapters – 1 & 2 of Text Book 1)

Unit –II

Trees, Characterizations, Theorems on Trees, Tree Distances, Binary trees, Tree Enumeration, Spanning trees, Fundamental Cycles, Summary. 12 hours

(Chapter – 3 of Text Book 1)

Unit –III

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

Poset Definition, Properties of Posets, Lattice Definition, Properties of Lattices. 12 hours

(Chapter 1-A of Text Book 3)

Unit –V

Definitions of Modular and Distributive Lattices and its Properties. 12 hours

(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, 3rd Edition

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

Learning Outcomes:(4-5)

LO-1: To learn the applications of graph theory in other subjects.

LO-2: To understand representations of different problems by means of graphs.

LO-3: To learn the relation between bipartite graphs and odd cycles.

LO-4: To learn the concepts of forest, binary trees, eccentricity of a vertex and radius of connected graphs. To learn the importance of multi graphs in other subjects like physics and chemistry.

LO-5: To learn different characterizations of modular and distributive lattices.

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 Objectives/Outcomes: (5-8)

CO 1: The concept of Banach space through which it helps to consider the combination of algebraic and metric structures opens up the possibility of studying linear transformations of one Banach space into another with the additional property of being continuous.

CO 2: To understand the algebraic and topological aspects of the continuous linear functionals.

CO 3: To study elementary theory of Hilbert spaces and their operators to provide an adequate foundation for the higher studies.

CO 4: To understand a natural correspondence between H and its conjugate space H^*, and the adjoint of an operator on a Hilbert space.

CO 5: To study the spectral resolution of an operator T on a Hilbert space H.

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	*	*				*
CO 2	*	*	*			*
CO 3	*	*			*	*
CO 4	*	*				*
CO 5	*	*		*		

Course Specific Outcomes: (3-5)

CSO 1: This will enable the students to understand about the continuous linear transformations and the description of the projections on a Banach space and its consequences.

CSO 2: Elementary theory of Hilbert spaces and their operators to provide an adequate foundation for further studies.

CSO 3: The students will enable to study the spectral resolution of a normal operator on finite dimensional Hilbert spaces.

Course syllabus

UNIT–I

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

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

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

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

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.

Learning Outcomes: (4-5)

LO 1: Understand that a Banach space is richly supplied with continuous linear functions, and makes possible an adequate theory of conjugate spaces.

LO 2: The open mapping theorem enables us to give a satisfactory description of the projections on a Banach space, and has the important closed graph theorem as one of its consequences.

LO 3: Enable to understand that a Hilbert space is a special type of a Banach space and it is concerned solely with the geometric implications, when two vectors are orthogonal vectors.

LO 4: Understand the natural correspondence between the vectors in H and the functions in H^*, and the adjoint of an operator on a Hilbert space and its properties.

LO 5: Enable to understand about the spectral resolution of a normal operator on finite dimensional Hilbert spaces.

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 Objectives/Outcomes: (5-8)

CO 1: To learn about method of variations with fixed boundaries
CO 2: To learn about method of variations with moving boundaries
CO 3: To gain knowledge on some specific variational problems such as those involving extremals with corners and one sided variations
CO 4: To understand about sufficient conditions for an extremum for variational problems.
CO 5: To learn about variational problems involving a conditional extremum

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	*	*	*	*	*	*
CO2	*	*	*	*	*	*
CO3	*	*	*	*	*	*
CO4	*	*	*	*	*	*
CO5	*	*	*	*	*	*

Course Specific Outcomes: (3-5)

CSO 1: To appreciate the theory behind Calculus of variations
CSO 2: To understand the significance of calculus of variations in the field of applicable mathematics
CSO 3: To be able to apply the skills gained in this course to problems pertaining real world and provide solutions

Course syllabus

UNIT I

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 - 12 hours
(Sections 1-5 of Chapter 6 of the prescribed textbook)

UNIT II

Variational problems in parametric form – some applications – An elementary problem with moving boundaries-Moving boundary problem for a functional of the form $\int_{x_2}^{x_1} F(x, Y, Y')dx$

- 12 hours

(Sections 6,7 of Chapter 6 and sections 1,2 of chapter 7 of the prescribed text book)

UNIT III

Extremals with corners –one sided variations and related problems -12 hours

(Sections 3,4 of Chapter 7 of the prescribed text book)

UNIT IV

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

Constraints of the form $\Phi(x,Y) = 0$ – Constraints of the form $\Phi(x,Y,Y') = 0$ – Isoperimetric problems – 12 hours

(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

Learning outcomes:(4-5)

LO 1: To appreciate the transition between functions and functionals in terms of calculus.
LO 2: To comprehend the theory behind Calculus of variations
LO 3: To realise the potential applications to real world problems
LO 4: To be able to apply the knowledge to optimal control problems pertaining to fields such as Mathematical biology, Mathematical Economics and Mathematical Bio Economic etc.

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 Objectives /Outcomes (5-8)

CO 1: To introduce arithmetical functions and explore their role in the study of distribution of primes.
CO 2: To study the averages of arithmetical functions and some related asymptotic formulas.
CO 3: To introduce the foundations of congruences and study the polynomial congruences.
CO 4: To understand the prime number theorem on distribution of primes and develop some equivalent forms.
CO 5: To introduce the characters of a group and apply to the Dirichlet Theorem on primes in a progression.

Mapping of COs with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	*	*	*			*
CO 2	*	*	*		*	*
CO 3	*		*	*	*	*
CO 4	*		*		*	
CO 5	*		*	*	*	*

Course Specific Outcomes (3-5)

CSO 1: To study the properties of arithmetical functions and understand the inter relations between arithmetical functions using Dirichlet product
CSO 2: To study the properties of congruences and understand the well versed theorems like Euler Fermat theorem, Chinese remainder theorems etc.
CSO 3: To study the properties of group characters and Dirichlet characters and understand the prime number theorem and Dirichlet theorem on primes in progression.

Course Syllabus:

UNIT-I
ARITHMETICAL FUNCTIONS AND DIRICHLET MULTIPLICATION:
Introduction- The Mobius function μ (n) – The Euler totient function φ (n)- A relation connecting φ and μ - A product formula for φ (n)- The Dirichlet product of arithmetical

functions- Dirichlet inverses and the Mobius inversion formula- The Mangoldt function Λ (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. 12 hours
(Sections 2.1 to 2.14 of the Chapter 2 in the Prescribed Text Book.)

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 φ (n)-An application to distribution of lattice points visible from the origin. The average order of μ (n) and Λ (n). The partial sums of a Dirichlet product- Applications to μ (n) and Λ (n).
(Sections 3.1 to 3.12 of Chapter 3 in the Prescribed Text Book.) 12 hours

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 $\sum_{p\le x}(1/p)$ - The partial sums of the Mobius function – The partial sums of the Mobius function.
Brief sketch of an elementary proof of prime number theorem. 12 hours
(Sections 4.1 to 4.10 of the Chapter 4 in the Prescribed Text Book.)

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

UNIT-V
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, χ) for real nonprincipal χ
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 12 hours
(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, Heidalberg-Berlin-1976.

Reference Books:

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

Learning Outcomes (4-5)

LO 1: The study on arithmetical functions enables understanding the study of divisibility of integers and distribution of primes.
LO 2: The study on congruences enables understanding modular arithmetic.
LO 3: The study on properties of congruences helps in the study of Diophantine equations
LO 4: The study on Prime number theorem introduces to fundamental research in Number theory.

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 Objective/Outcomes:(5-8)

CO-1: To learn the two ways of defining a lattice.
CO-2: To learn the concepts of closure operator and complete lattices.
CO-3: To study the concepts of isomorphic algebras, subalgebras and The Irredundant Basis Theorem.
CO-4: To learn two concepts of congruence distributive and congruence permutable lattices.
CO-5: To understand a relation between subdirectly irreducible algebras and directly indecomposable algebras.

Mappings of COs with POs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	-	*	-	*	*	-
CO-2	*	*	*	*	*	-
CO-3	*	*	*	-	*	*
CO-4	*	*	*	-	-	*
CO-5	*	*	-	*	*	*

Course Specific Outcomes:(3-5)

CSO-1: This will enable the students to learn the equivalent conditions for a lattice to become modular and distributive.
CSO-2: This forms a base to learn the applications of The Irredundant Basis Theorem.
CSO-3: This provides a flat form to the students to understand the factor congruences and apply them in different other courses.

Course Syllabus

UNIT-I

Definitions of Lattices, Isomorphic Lattices and Sublattices, Distributive and Modular Lattices. (Sections 1, 2, 3 of Chapter-I of the Prescribed Text Book) 12 hours

UNIT-II

Complete Lattices, Equivalence Relations, Algebraic Lattices, Closure Operators. 12 hours
(Sections 4, 5 of Chapter-I of the Prescribed Text Book)

UNIT-III

Definition and Examples of Algebras, Isomorphic Algebras, Subalgebras, Algebraic Lattices Subuniverses, The Irredundant Basis Theorem. 12 hours
(Sections 1, 2, 3, 4 of Chapter-II of the Prescribed Text Book)

UNIT-IV

Congruences and Quotient Algebras, Homomorphisms, The Homomorphism and Isomorphism Theorems. (Sections 5, 6 of Chapter-II of the Prescribed Text Book) 12 hours

UNIT-V

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.

Learning Outcomes:(4-5)

LO-1: To learn the concepts of complete lattices and a closure operators.
LO-2: To understand the relation between subuniverses and algebraic lattices.
LO-3: To learn the relation between congruences and quotient algebras.
LO-4: To learn the concepts of homomorphism and isomorphism theorems.
LO-5: To study directly indecomposable algebras and simple algebras.

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 Objective/Outcomes:(5-8)

CO-1: To familiarize the concepts of poset, chain conditions.

CO-2: To learn the lattice theoretic duality principle.

CO-3: To study complements, relative complements and semi-complements of elements of a bounded lattices.

CO-4: To learn the properties of compact elements and compactly generated lattices.

CO-5: To study the posets as topological spaces.

Mappings of COs with POs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	-	*	-	*	*	-
CO-2	*	*	*	*	*	*
CO-3	*	*	*	-	*	*
CO-4	*	*	*	-	*	*
CO-5	*	*	-	*	-	*

Course Specific Outcomes:(3-5)

CSO-1: This will enable the students to learn The Jordan –Dedekind chain condition in posets.

CSO-2: This will help the students to understand the concepts of bound elements, atoms and dual atoms in lattices.

CSO-3: To learn the concepts of conditionally complete lattices and σ - lattices

Course Syllabus

UNIT-I

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. 12 hours

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

UNIT-II

Algebras, Lattices, The Lattice Theoretic Duality Pinciple, Semilattices, Lattices as Partly Ordered Sets, Diagrams of Lattices, Sublattices and Ideals. 12 hours

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

UNIT-III

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. 12 hours

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

UNIT-IV

Complete Lattices, Complete Sublattices of a Complete Lattice, Conditionally Complete Lattices, σ-Lattices, Compact Elements, Compactly Generated Lattices. 12 hours

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

UNIT-V

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) 12 hours

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

Learning Outcomes:(4-5)

LO-1: To understand maximum and minimum conditions in posets.
LO-2: To learn irreducible and prime elements of a lattice.
LO-3: To learn the property of homomorphism of a lattices.
LO-4: To study complete sublattices of a complete lattice.
LO-5: To learn Galois Connections, Dedekind Cuts in complete lattices.

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 Objective/Outcomes:(5-8)

CO-1: To familiarize the essential concepts of ideals, quotient rings and homomorphisms.

CO-2: To understand the difference between zero divisors, nilpotent elements and units.

CO-3: To study the properties of finitely generated modulus.

CO-4: To introduce tensor product of modulus and its exactness properties.

CO-5: To learn the concepts of extended and contracted ideals in ring of fractions.

Mappings of COs with POs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	*	*	-	-	*	-
CO-2	*	*	*	-	*	-
CO-3	*	*	*	*	-	*
CO-4	-	*	-	*	*	*
CO-5	*	*	-	*	*	*

Course Specific Outcomes:(3-5)

CSO-1: This will help the students to count the number of zero divisors, nilpotent elements and units in finite rings.

CSO-2: The student learns the importance of Nilradical and Jacobson radical in ring theory.

CSO-3: This will help the student to study the direct sum, product and tensor product of modulus

Course Syllabus

UNIT-I

Rings and ring homomorphisms, Ideals, Quotient rings, Zero divisors, Nilpotent Elements, Units, Prime Ideals and Maximal Ideals, Nilradical and Jacobson Radical. 12 hours

UNIT-II

Operations on Ideals, Extension and Contraction. 12 hours

UNIT-III

Modules and Module Homomorphism, Submodules and Quotient Modules, Operations on Submodules, Direct Sum and Product, Finitely Generated Modules. 12 hours

UNIT-IV

Exact Sequences, Tensor Poduct of Modules, Restriction and Extension of Scalars, Exactness Properties of the Tensor Product, Algebras, Tensor Product of Algebras. 12 hours

UNIT-V

Rings and Modules of Fractions, Local Properties, Extended and Contracted Ideals in Rings of fractions. 12 hours

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

Learning Outcomes:(4-5)

LO-1: To understand the relation between ideals and quotient rings.
LO-2: To learn the difference between prime ideals and maximal ideals by means of examples.
LO-3: To learn the properties of finitely generated modules.
LO-4: To figure out the exactness properties of tensor products.
LO-5: To realize local properties of rings and modules of fractions.

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 Objectives/ outcomes : (5-8)

CO 1: To understand basic ideas of semigroups , monogenic semigroups,ordered sets, semilattices and lattices. Further Binary and Equivalence relations and some results are established
CO 2: To introduce some special class of congruence relations , correspondence between ideals and congruences, lattice of equivalences and congruences etc
CO 3: To study Green' equivalences and structure of these classes
CO 4: To understand some special semigroups like Regular semigrops,0- simple semigroups,
CO 5: To learn Congruences on completely 0-simple semigroups. The lattice of congruences on a completely 0-simple semigroup, Finite congruence free semigroups

Mappings of Pos with COs:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	*	*	*	*	*	*
CO-2	*	*	*	*	*	
CO-3	*	*		*	*	
CO-4	*	*		*	*	
CO-5	*	*		*	*	

Course Specific Outcomes: (3-5)

CSO 1: To understand properties of semi groups
CSO 2: To develop explicit description on congruences
CSO 3: To classify finite congruence –free semigroups without zero

Course Syllabus

UNIT-I

Basic definitions, monogenic semigroups, ordered sets, semilatttices and lattices, binary relations, equivalences. 12 hours

UNIT-II

Congruences - Free semigroups, Ideals and Rees' congruences, Lattices of equivalences and congruences. 12 hours

UNIT-III

Green's equivalences. The structure of D-classes, regular semigroups. 12 hours

UNIT-IV

Simple and 0-simple semigroups, Principal factors. Rees' theorem, Primitive idempotents.. 10 hours

UNIT-V

Congruences on completely 0-simple semigroups. The lattice of congruences on a completely 0-simple semigroup, Finite congruence free semigroups. 14 hours

(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.

Learning Outcomes : (4-5)

LO 1: To explain different semigroups,and various relations on semigroups
LO 2: To study Green's equivalances and their properties
LO 3: To understand lattice theoretic properties of congruences on completely o- simple semigroups
LO 4: To classify finite congruence free semigroups without zero

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 Objectives/ outcomes : (5-8)

CO 1: To study the theoretical aspects of fuzzy sets , fuzzy logic and its applications
CO 2: To study set theoretic operations on fuzzy sets and their properties
CO 3: To study Fuzzy numbers and arithmetic operations on fuzzy numbers and lattice of Fuzzy numbers
CO 4: To introduce basic concepts of fuzzy relations , particularly binary fuzzy relations and fuzzy equivalence relations
CO 5: To perform operations on fuzzy compatibility relations and fuzzy ordering relations

Mappings of POs with COs:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	*	*	*	*	*	*
CO-2	*	*		*	*	
CO-3	*	*		*	*	
CO-4	*	*		*	*	
CO-5	*	*		*	*	*

Course Specific Outcomes: (3-5)

CSO 1: Will be able to understand different types of fuzzy sets and their properties
CSO 2: The students can understand various operations on fuzzy sets and fuzzy arithmetic
CSO 3: To study the fuzzy relations, linguistic variables and fuzzy equations

Course Syllabus

UNIT-I

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

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)). 12 hours

UNIT-III

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)). 14 hours

UNIT-IV

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

Fuzzy Compatibility Relations - Fuzzy Ordering Relations - Fuzzy Morphisms - Sup – *i* Compositions of Fuzzy Relations - Inf -w_i Compositions of fuzzy Relations. (Sections 6 to 10, CH-5 of (I)). 10 hours

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.

Learning Outcomes : (4-5)

LO 1: To explain difference between randomness and fuzziness and also provide examples of fuzzy variables in daily life
LO 2: To understand different decomposition theorems for fuzzy sets
LO 3: To find image and inverse images of fuzzy sets with membership functions under mappings
LO 4: The students will be able to perform combination of operations on fuzzy sets using t-norms and t- co-norms
LO 5: To do arithmetic on fuzzy numbers and solve fuzzy equations

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 Objectives/Outcomes (5-8)

CO 1: To introduce simplex method an iterative procedure of finite steps to solve a Linear Programming Problem.
CO 2: To introduce primal problem & dual problem and understand the duality in LPP. To Solve LPP using duality and theorems on duality.
CO 3: To study the post optimal analysis.
CO 4: To introduce Transportation problem and Assignment method. To study methods to solve Transportation problem and Assignment problem.
CO 5: To study the problems with decision making in a competitive situation.

Mapping of COs with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	*		*	*		*
CO 2	*		*	*		*
CO 3	*			*	*	*
CO 4	*		*	*	*	*
CO 5	*	*		*	*	*

Course Specific Outcomes (3-5)

CSO 1: To understand simplex procedure and to introduce Two- phase method and Big-M method in the presence of artificial variables. To understand the duality.
CSO 2: To understand some variations and structural changes.
CSO 3: To solve Two-person zero sum games. To introduce some strategies to solve games with and without saddle points and study some graphical solutions.

Course Syllabus:

UNIT-I

Linear Programming: Simplex Method: Introduction-Fundamental properties of solutions-The computational procedure-Use of artificial variables. 12 hours
(Sections 4.1 to 4.4 of the Chapter 4 in the Prescribed Text Book.)

UNIT-II

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. 12 hours
(Sections 5.1 to 5.7 of the Chapter 5 in the Prescribed Text Book.)

UNIT-III

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. 12 hours
(Sections 5.8, 5.9 and 6.1 to 6.6 of the Chapters 5 and 6 in the Text Prescribed Book.)

UNIT-IV

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.
12 hours
(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

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 2xn and mx2 games. 12 hours
(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.

Learning Outcomes (4-5)

LO 1: Study on LPP enables to arrive at an optimal decision/solutions in difficult decision making.

LO 2: Study on LPP applied to problems pertaining to both profit making and low cost related real world situation.

LO 3: Study on Post optimal analysis enables into manage and control resource allocation.

LO 4: Study of Transportation problem and Assignment problem introduces to implementing simplex procedure for more variables using Modi method stepping stone method and hungary method

LO 5: Study on games and strategies helps in decision making for problems with competitive situations like candidates for elections, marketing campaigns by different companies etc.

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 Objectives/Outcomes: (5-8)

CO 1: To learn about autonomous differential equations and nature of their solutions
CO 2: To construct and analyse various growth and harvest models
CO 3: To gain knowledge on phase plane analysis and study the cyclic nature associated with various real world problems
CO 4: To understand the dynamics that exists between species with distinctive interactions such as prey-predator, competitive and cooperative.
CO 5: To associate economic component to the species dynamics and study the resultant optimal control [problems

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	*	*			*	
CO2	*	*	*	*	*	
CO3	*	*	*	*	*	
CO4	*	*	*	*	*	
CO5	*	*	*	*	*	

Course Specific Outcomes: (3-5)

CSO 1: To appreciate the application of basic mathematics to real world problems
CSO 2: To be able to model some realistic situations and study them to understand the inherent dynamics
CSO 3: To be able to apply the skills gained in this course to problems pertaining real world and provide solutions

Course syllabus

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. - 12 hours

(Sections 1 and 2 of the prescribed 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. - 12 hours

(Sections 7 and 8 of the prescribed 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. - 12 hours

(Section 9 of the prescribed text book)

UNIT-IV

competition models - Mutualism models – various types of mutualisms – cooperative systems - 12 hours

(Sections 12 and 13 of the prescribed Textbook)

UNIT V

Harvest models and optimal control theory – open access fishery – sole owner fishery – Pontryagin's maximum principle – Economic interpretation of Hamiltonian and adjoint variable. - 12 hours

(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

Learning outcomes:(4-5)

LO 1: To appreciate the translation of a real world situation into a mathematical model.

LO 2: To be able to model a real world system apply mathematical techniques to analyze it and interpret the results

LO 3: To be able to examine Bio-economics of a real world problem and offer solutions that optimises the utility of the system concerned.

LO 4: Increase curiosity and scientific temperament in the students and drive them to take up interdisciplinary research.

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 Objectives/Outcomes: (5-8)

CO 1: Introduce a special theory on sets, called outer measure of a set and measurable sets, which are useful to get an idea on real number system.
CO 2: To understand measurable functions through the certain construction of measurable sets and their properties.
CO 3: To introduce and understand the Lebesgue integral of various measurable functions and their properties.
CO 4: To study differentiation of Lebesgue integral and convex functions.
CO 5: To study some spaces of functions of a real variable, the L^p spaces.

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	*	*				*
CO 2	*	*				*
CO 3	*	*	*			*
CO 4	*	*	*		*	*
CO 5	*	*		*	*	*

Course Specific Outcomes: (3-5)

CSO 1: This will enable the students to understand measurable sets, nonmeasurable sets and measurable functions.
CSO 2: The students will be able to know that the Lebesgue integral is a generalization of Riemann integral so that the Lebesgue integral gained more importance.
CSO 3: Able to understand Differentiability, Differentiation of integrals, convex functions and L^p-spaces.

Course syllabus

UNIT–I

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

Chapter 3, Sections 1 to 3, of the Text Book. 12 Hours

UNIT –II

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

Chapter 3, Sections 4 to 6, of the Text Book. 12 Hours

UNIT –III

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 tect book. 12 Hours

UNIT-IV

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. 12 Hours

UNIT-V

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

Chapter 6 of the text book. 12 Hours

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

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

Learning Outcomes: (4-5)

LO 1: To understand the fundamental concepts, namely outer measure, measurable sets and Lebesgue measure.

LO 2: Very interesting fact of the existence of nonmeasursble set and understanding of measurable functions.

LO 3: To recognise the importance of Lebesgue integral as a generalization of Riemann integral.

LO 4: To understand the differentiation of monotone functions, differentiation of an integral and convex functions.

LO 5: To understand the L^p spaces as Banach spaces for $1 \leq p \leq \infty$ and bounded linear functional on the L^p spaces.

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 Objectives/Outcomes: (5-8)

CO 1: To be introduced to categorization of partial differential equations such as linear, quasi linear and nonlinear equations.
CO 2: To learn a few methods of solving linear, semi linear and quasi linear equations and construction of Cauchy problem for first order partial differential equations
CO 3: To understand the classification pertaining to second order equation and learn the p rocedure of reducing equations to their cannonical forms.
CO 4: To understand the structure of hyperbolic equation, know its properties and solve related problems
CO 5: To understand the structure of elliptic equation, know its properties and solve related problems
CO 6: To understand the structure of parabolic equation, know its propeerties and solve related problems

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	*	*				
CO 2	*	*	*		*	*
CO 3	*	*	*	*	*	*
CO 4	*	*	*	*	*	*
CO 5	*	*	*	*	*	*
CO 6	*	*	*	*	*	*

Course Specific Outcomes: (3-5)

CSO 1: To be aware of various problems associated with first order partial differential equations and some methods to solve them explicitly.
CSO 2: Understand the structure of Cauchy problem and know some fundamental theory pertaining to it.
CSO 3: Understand the significance of Heat equation, wave equation and potential equations and be aware of methods to solve problems pertaining to them
CSO 4: Know the significance and applicability of partical differential equations in the real world

Course syllabus

Unit I

First Order Partial Differential Equations – Quasi linear PDEs – Pfaff's Equations – 12 hours
(Sections 2.1, 2.2 of the prescribed text book)

Unit II

Nonlinear first order PDEs-Classification of the second order PDEs in two independent variables – wave, potential and Heat equations – 12 hours
(Sections 2.3, 3.1 and 3.3 of the prescribed text book)

Unit III

Hyperbolic Equations – Cauchy problem for one dimensional wave equation – The Fourier method of Separation of variables – 12 hours
(Sections 4.1, 4.3 of the prescribed text book)

Unit IV

Elliptic equations – Dirichlet problems involving Cartesian coordinates – 12 hours
(Section 5.1 of the prescribed text book)

Unit V

Parabolic Equations – Cauchy problem – Mixed type problems – 12 hours
(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

Learning Outcomes:(4-5)

LO 1: To comprehend the basic structure of partial differential equations and their categorisation
LO 2: To understand the basic methods to compute solutions of simple partial differential equations.
LO 3: To be aware of the theory behind existence of solutions of a few well known problems associated with partial differential equations
LO 4: To recognise the significance classifying second order partial differential equations into cannonical forms
LO 5: To figure out qualitative behaviour of solutions of initial and boundary value problems associated with partial differential equations of various orders.

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 Objectives/Outcomes: (5-8)

CO 1: To introduce the concept of Quadratic residues. To define Legendre symbol and evaluate Quadratic residue. To generalize Legendre symbol to Jacobi symbol and to study applications of Quadratic residues

CO 2: To introduce the concept of primitive roots. To understand the study on existence of primitive roots.

CO 3: To define Dirichlet Series and identify the plane of absolute convergence and convergence of Dirichlet series. To establish Euler products to Dirichlet series.

CO 4: To derive some analytic properties of Dirichlet series. To develop some expressions as exponential and integral form for Dirichlet series.

CO 5: To understand the analytic proof of prime number theorem based on the analytic properties of the particular Dirichlet series, Riemann Zeta function.

Mapping of COs with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	*	*	*	*		*
CO 2	*	*	*	*	*	*
CO 3	*	*	*		*	
CO 4	*	*			*	
CO 5	*	*	*	*	*	

Course Specific Outcomes (3-5)

CSO 1: To introduce the Quadratic residues. To find Quadratic residues through Eulers Criteria, Gauss lemma and Quadratic reciprocity law. To generalize Legendre symbol to Jacobi symbol and to study applications of Quadratic residues to Diophantine equations.

CSO 2: To understand all the properties of the particular Dirichlet series like Riemann Zeta function, L- functions.

CSO 3: To understand the proof of prime number theorem and get introduced to Riemann Hypothesis based on Riemann zeta function

Course Syllabus:

UNIT-I

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. 12 hours

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

UNIT-II

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 and p for odd primes p. Primitive roots and quadratic residues- The existence of primitive roots mod p^{α} - The existence of primitive roots mod 2 p^{α} - The nonexistence of primitive roots in the remaining cases- The number of primitive roots mod m. 12 hours

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

UNIT-III

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 12 hours

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

UNIT-IV

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. 12 hours

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

UNIT-V

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 12 hours

(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, Heidalberg-Berlin-1976.

Reference Books:

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

Learning Outcomes (4-5)

LO 1: The study on Quadratic residues and primitive roots introduces to several new techniques adapted in the proofs.
LO 2: The study on Quadratic residues and primitive roots motivates towards the study of their applications in Number theory and other areas in mathematics
LO 3: The study properties of Dirichlet series introduces to ingenious methods and develops the connection with continuous quantities for set of discrete set of integers.
LO 4: The study on prime number theory introduces to unsolved problem called Riemann hypothesis and motivates towards fundamental research in Number theory

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

Course type: Theory Course category: Elective Credits: 4

Course Objective/Outcomes:(5-8)

CO-1: To introduce the concepts of class operators and varieties.
CO-2: To understand the concepts of free algebras and to learn The Birkhoff's Theorem.
CO-3: To introduce the concept of centre of algebra.
CO-4: To learn the relation between Boolean algebras and Boolean rings.
CO-5: To learn The Stone Duality between Boolean algebras and Boolean spaces.

Mappings of COs with POs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	*	*	-	-	*	-
CO-2	*	*	-	*	*	*
CO-3	*	-	*	*	*	-
CO-4	*	*	*	*	*	*
CO-5	*	*	*	-	*	*

Course Specific Outcomes:(3-5)

CSO-1: This will enable the students to learn the concepts of term-term algebras and free algebras.
CSO-2: This forms a basis to learn Mal'cev Conditions which characterize congruence permutable and congruence distributive algebras.
CSO-3: This helps to understand the properties of congruence distributive varieties .

Course Syllabus

UNIT-I
Class Operators and Varieties, Terms, Term Algebras and Free algebras. 12 hours
(Sections 9, 10 of Chapter-II of the Prescribed Text Book).

UNIT-II

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) 12 hours

UNIT-III

Boolean Algebras, Boolean Rings. 12 hours
(Sections 1, 2 of Chapter-IV of the Prescribed Text Book)

UNIT-IV

Filters and Ideals, Stone Duality. (Sections 3, 4, of Chapter-IV of the Prescribed Text Book) 12 hours

UNIT-V

Boolean Powers, Ultra Products and Congruence-Distributive Varieties, Primal Algebras.
(Sections 5, 6, 7 of Chapter-IV of the Prescribed Text Book) 12 hours

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

Learning Outcomes:(4-5)

LO-1: To learn the relation between direct products and factor congruences.
LO-2: To study The Brikhoff's Theorem and subdirectly irreducible algebras.
LO-3: To learn properties of congruence distributive and congruence permutable varieties.
LO-4: To study the relation between filters and ideals in Boolean algebras.
LO-5: To study the ultra products and congruence distributive varieties.

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 Objective/Outcomes:(5-8)

CO-1: To study equivalent conditions for a lattice to become modular and distributive.
CO-2: To learn meet-representations of modular and distributive lattices.
CO-3: To understand the equivalent conditions for a complete Boolean algebra to become atomic.
CO-4: To study the properties of valuations of Boolean algebras.
CO-5: To learn the properties of rings of sets.

Mappings of COs with POs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	-	*	-	*	*	-
CO-2	-	*	*	*	*	-
CO-3	*	-	*	-	*	*
CO-4	*	*	*	*	*	*
CO-5	*	*	-	*	*	*

Course Specific Outcomes:(3-5)

CSO-1: To learn isomorphism theorems of modular lattices and covering conditions.
CSO-2: To study the properties of complete Boolean algebras.
CSO-3: To understand the concept of ideal in lattices.

Course Syllabus

UNIT-I

Distributive Lattices, Infinitely Distributive and Completely Distributive Lattices, Modular Lattices, Characterization of Modular and Distributive Lattices by their Sublattices. 12 hours
(Sections 30 to 33 of Chapter IV of the Prescribed Text Book)

UNIT-II

Ddistributive Sublattices of Modular Lattices, The Isomorphism Theorem of Modular Lattices, Covering Conditions, Meet Representations in Modular and Distributive Lattices. 12 hours

(Sections 34 to 36 of Chapter IV of the Prescribed Text Book)

UNIT-III

Boolean Algebras, De Morgan Formulae, Complete Boolean Algebras, Boolean Algebras and Boolean Rings. 12 hours

(Sections 42 to 44 of Chapter VI of the Prescribed Text Book).

UNIT-IV

The Algebra of Relations, The Lattice of Propositions, Valuations of Boolean Algebras. 12 hours

(Sections 45 to 47 of chapter VI of the Prescribed Text Book)

UNIT-V

Ideals and Dual Ideals, Ideal Chains, Ideal Lattices, Distributive Lattices and Rings of Sets. 12 hours

(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.

Learning Outcomes:(4-5)

LO-1: To comprehend the relation between distributive and modular lattices.

LO-2: To learn the properties of distributive sublattices of modular lattices.

LO-3: To study Boolean algebras and De-Morgan's Laws.

LO-4: To learn algebra of relations.

LO-5: To recognize the significance of ideal lattices.

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

Course type: Theory Course category: Elective Credits: 4

Course Objective/Outcomes:(5-8)

CO-1: To learn the decomposition of ideals into primary ideals.
CO-2: To learn Going-Up and Going-Down theorems concerning prime ideals in an integral extensions.
CO-3: To study valuation rings of a given field of fractions.
CO-4: To characterise Noetherian rings and Artin rings.
CO-5: To study primary decomposition in Noetherian rings and to learn The Structure Theorem for Artin rings.

Mappings of COs with POs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	-	*	-	*	*	-
CO-2	*	*	*	*	*	-
CO-3	*	-	-	-	*	*
CO-4	*	*	*	-	*	*
CO-5	-	*	-	*	-	*

Course Specific Outcomes:(3-5)

CSO-1: To learn the First and Second Uniqueness theorems of primary decomposition in ring theory.
CSO-2: This enables the students to learn the relation between local rings and valuation rings of field of fractions.
CSO-3: This enables the students to understand the difference between Noetherian and Artin rings

Course Syllabus

UNIT-I:
Primary Decomposition, The First Uniqueness Theorem, The Second Uniqueness Theorem.
12 hours

UNIT-II:
Integral Dependence, The Going-Up Theorem, Integrally Closed Integral Domains, The Going-Down Theorem, Valuation Rings. 12 hours

UNIT-III:
Chain Conditions. 12 hours

UNIT-IV:
Noetherian Rings, Hibert's Basis Theorem, Primary decomposition of Noetherian rings. 12 hours

UNIT-V:
Artin Rings. 12 hours

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

Learning Outcomes:(4-5)

LO-1: To understand the importance of primary decomposition in rings.
LO-2: To learn the relation between integral dependent and integrally closed integral domains.
LO-3: To learn the relation between exact sequences and quotient modulus.
LO-4: To learn The Hilbert Basis Theorem.
LO-5: To recognize the importance of The Structure Theorem for Artin rings.

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 Objectives/ outcomes : (5-8)

CO 1: To understand many concepts , Union of Groups, Semi lattices of groups, bands, free bands. varieties of bands etc
CO 2: To study inverse semigroups and congruence relations
CO 3: To introduce Fundamental inverse semi groups, anti-uniform semilattices, Bi-simple inverse semi groups and study some results
CO 4: To study about Simple inverse semigroups, representation of inverse semigroups.
CO 5: To understand Orthodox semigroups, basic properties, the analogue of the Munn semi-group, uniform and anti-uniform bands, the structure of orthodox semi groups

Mappings of POs with COs:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	*	*	*	*	*	*
CO-2	*	*	*	*	*	
CO-3	*	*	*	*	*	
CO-4	*	*	*	*	*	
CO-5	*	*	*	*	*	

Course Specific Outcomes: (3-5)

CSO 1: This will enable to understand the students to deal with many relations on semigroups and establish their equivalences
CSO 2: To obtain inter relationships between different semigroups
CSO 3: To study the structure of orthodox semigroups

Course Syllabus

UNIT-I:
Union of Groups, Semi lattices of groups, bands, free bands. varieties of bands. 14hours

UNIT-II:
Introduction to inverse semi groups, preliminaries, the natural order relation on an inverse semi group, congruences on inverse semigroups 10 hours

UNIT-III:

Fundamental inverse semi groups, anti-uniform semilattices. Bi-simple inverse semi groups 12 hours

UNIT-IV:

Simple inverse semigroups, representation of inverse semigroups. 10 hours

UNIT-V:

Orthodox semigroups, basic properties, the analogue of the Munn semi-group, uniform and anti-uniform bands, the structure of orthodox semi groups. 14 hours

(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.

Learning Outcomes : (4-5)

LO 1: To explain basic theory of semigroups and special classs of semigroups
LO 2: To understand inverse semigroups and related results
LO 3: To study representations of inverse semigroups
LO 4: To study orthodox semigroups and some basic properties

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 Objectives/Outcomes: (5-8)

CO 1: The study of Banach fixed point theorem is important to find the existence and uniqueness of solutions in different branches of analysis.
CO 2: To introduce fundamental ideas and aspects of approximation theory in normal and Hilbert spaces.
CO 3: To study the spectral theory which is concerned with certain inverse operators, their general properties and their relations to the original operators.
CO 4: To study the compact linear operators, which play an important role in the theory of integral equations.
CO 5: To study the solvability of certain equations involving a compact linear operator.

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	*	*		*	*	*
CO 2	*	*				*
CO 3	*	*	*	*		*
CO 4	*	*	*	*	*	
CO 5	*	*	*		*	

Course Specific Outcomes: (3-5)

CSO 1: Banach fixed point theorem helps us to get the existence of solutions of linear algebraic equations, ordinary differential equations and integral equations.
CSO 2: Conditions to guarantee uniqueness of best approximations.
CSO 3: Discuss general properties of compact linear operators and spectral properties and the results about operator equations.

Course syllabus

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. 12 Hours

UNIT –II

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. 12 Hours

UNIT –III

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. 12 Hours

UNIT-IV

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. 12 Hours

UNIT-V

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

Chapter 8, Sections 8.5 to 8.7, of the Text Book. 12 Hours

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

Learning Outcomes: (4-5)

LO 1: To understand the Banach fixed point theorem and its applications to ordinary differential equations and integral equations.

LO 2: To obtain the existence of best approximations and the uniqueness. Further, depending on the choice of a norm, the student will study uniform approximation in $C[a, b]$ and approximation in Hilbert space.

LO 3: To understand eigenvalues, eigenvectors, eigenspaces, spectrum and spectral theory in finite dimensional spaces and spectral properties of bounded linear operators.

LO 4: To study compact linear operators and their properties and spectral properties of compact linear operators.

LO 5: To investigate the solvability of certain equations involving a compact linear operator.

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 Objectives/ outcomes : (5-8)

CO 1: To understand the concept of Banach algebra and regular, singular elements, topological divisors of zero and spectrum of an element in a Banach algebra
CO 2: To define spectral radius and have formula for spectral radius and its applications,semi simple Banach algebras
CO 3: To understand the structure of a commutative Banach algebra and Gelfand mapping
CO 4: To study the Gelfand mapping theorem and some of its consequences. Stone Banach theorem
CO 5: To study Picard's theorem for the existence and uniqueness of solution of a differential equation using Banach contraction theorem, Stones representation theorem.

Mappings of Pos with COs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	*	*	*	*	*	*
CO 2	*	*	*	*	*	
CO 3	*				*	
CO 4	*	*	*	*	*	
CO 5	*	*	*	*	*	

Course Specific Outcomes: (3-5)

CSO 1: To classify Banach algebras in Function algebras, operator algebras and group algebras
CSO 2: To study self adjoint algebras, Banach * algebras and B * algebras
CSO 3: To study fixed point spaces fixed point theorems and continuous curves

Course Syllabus

UNIT-I:
General preliminaries on Banach Algebras – The definition and examples – Regular and singular elements – Topological divisors of Zero – The spectrum (12 hours)

UNIT-II:
The formula for the spectral radius -The radical and the semi – simplicity.

The structure of commutative Banach Algebras – The Gelfand mapping (12 hours)

UNIT III:

Applications of the formula $r(x) = \lim (\| x^n \|/n)$-- Involutions in Banach Algebras – The Gelfand – Neumark theorem. (12 hours)

UNIT-IV:

Some special commutative Banach Algebras - Ideals in C(x) and the Banach – Stone theorem - The stone – Chech compactification – commutaticve C* - algebras. (12 hours)

UNIT-V:

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. (12 hours)

(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

Learning Outcomes : (4-5)

LO 1: To define Banach algebras, sub algebras and characterize f regular and singular elements
LO 2: Able define spectrum and spectral radius, resolvent set of an elment in a Banach algebra.
LO 3: To derive formula for spectral radius, study semi simple algebra
LO 4: To state and prove Gelfand –Neumark theorem, Stone –Banach theorem
LO 5: To understand the proofs of Picard's theorem and Stone's representation theorem

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 Objectives/Outcomes: (5-8)

CO 1: To describe various forms of continuity and Geometry in Normed spaces to understand the theory of Nonlinear Functional Analysis.
CO 2: To introduce and develop the calculus in real Banach spaces.
CO 3: To study Banach contraction mapping theorem and its consequences.
CO 4: To study nonexpansive mappings and discuss approximations of fixed points of nonexpansive mappings.
CO 5: To study Brouwer's fixed point theorem and Schauder's fixed point theorem.

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	*	*	*			*
CO 2	*	*		*		*
CO 3	*	*	*	*	*	*
CO 4	*	*	*		*	*
CO 5	*	*	*	*	*	

Course Specific Outcomes: (3-5)

CSO 1: The student will be able to understand various forms of continuity, Geometry in normed spaces and duality mapping which are needed for further study.
CSO 2: It deals with Gateaux and Fréchet derivatives with illustrative examples and their properties. Also, the student will learn the concept of subdifferential of convex functionals.
CSO 3: The student will learn the techniques to prove the existence of fixed points of contraction maps, contractive maps and nonexpansive maps, which will be useful to do research in the field of Nonlinear Functional Analysis.

Course Syllabus

UNIT–I

Various Forms of Continuity, Geometry in Normed Spaces and Duality Mapping.Chapter 1, Sections 1.1 to 1.2 of the Text Book. 12 Hours

UNIT –II

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

Chapter 2 of the Text Book. 12 Hours

UNIT –III

Banach's contraction principle and its generalization.

Chapter 4, Section 4.1 of the Text Book. 12 Hours

UNIT-IV

Nonexpansive mappings.

Chapter 4, Section 4.2 of the Text Book. 12 Hours

UNIT-V

Fixed Point Theorems of Brouwer and Schauder.

Chapter 4, Section 4.3 of the Text Book. 12 Hours

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

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

Learning Outcomes: (4-5)

LO 1: To understand the various forms of continuity, Geometry in normed linear spaces and duality mapping.

LO 2: To study Gateaux and Fréchet derivatives and their relation, and subdifferential of convex functionals.

LO 3: To discuss the Banach's contraction mapping theorem and its consequences, and some other fixed point theorems due to Edelstein, Boyd and Wong, and Caristi's fixed point theorem.

LO 4: To study the existence of fixed points of nonexpansive mapping and discuss approximation of fixed points of nonexpansive mappings.

LO 5: To study Brouwer's fixed point theorem and Schauder's fixed point theorem and several important consequences of Schauder's fixed point theorem.