ANDHRA KESARI UNIVERSITY
UNIVERSITY COLLEGE
DEPARTMENT OF MATHEMATICS

PROGRAMME OBJECTIVES:

The main objective of this academic program 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.

PROGRAMOUTCOMES:

PO 1:To provide comprehensive curriculum to groom the students into qualitative mathematicians.

PO2: Students will be able to read and identify mathematical and computational methods in order to solve comprehensive problems.

PO3: Ability to think, acquire knowledge and skills through logical reasoning and in culture the habit of self- learning throughout life.

PO4:To provide qualitative education through effective teaching learning processes by introducing projects and participative learning.

PO 5: Students to learn and apply mathematics in real life situations aiming at service to the society.

PO 6: Students are well prepared to take jobs in schools and colleges as Mathematic teachers and Professors, Software Industries, Research and Development Organizations.

PO 7: Investigate and apply mathematical problems and solutions in a variety of contexts related to science, technology, business and industry.

PO8: Students to purse higher studies in Mathematics and computing Sciences and to clear competitive exams like GATE, CSIR NET, APSET and all such others.

PROGRAM SPECIFIC OUTCOMES:

PSO1: Provide Strong foundation and inculcate ample knowledge on topics in Mathematics, empowering the students to pursue higher degrees at reputed academic institutions.

PSO 2: Pursue research in challenging areas of mathematics.

PSO3:To assimilate complex mathematical ideas and argument.

PSO4: Develop abstract mathematical thinking and mathematical reasoning.

PSO5:Provide knowledge of a wide range of mathematical techniques and application of mathematical methods/tools in other scientific and engineering domains.

PSO6:Model the real-world problems into mathematical equations and draw the inferences by finding appropriate solutions.

STRUCTURE

UNIVERSITY COLLEGE , AKU
DEPARTMENT OF MATHEMATICS
M.Sc. MATHEMATICS

COURSE STRUCTURE

SEMESTER-I

S.No	Course category	Course Code	Course Title	Course Type	Credit	Hours/ Week	Marks	
							Int	Ext
1	Core	M101(24)	Algebra	Theory	4	6	30	70
2	Core	M102(24)	Analysis-I	Theory	4	6	30	70
3	Compulsory Foundation	M103(24)	Differential equations	Theory	4	6	30	70
4	Core	M104(24)	Numerical Analysis	Theory	4	6	30	70
5	Elective foundation	M105(A)(24)	Advanced discrete Mathematics	Theory	4	6	30	70
		M105(B)(24)	Mathematical Methods					
		M105(C)(24)	Tensor algebra					
6	Practical	M106(24)	Numerical Analysis by Python		4	6	30	70
TOTAL					**24**	**36**		

SEMESTER-II

S.No	Course category	Course Code	Course Title	Course Type	Credit	Hours/ Week	Marks	
							Int	Ext
1	Core	M201(24)	Galois theory	Theory	4	6	30	70
2	Core	M202(24)	Complex analysis	Theory	4	6	30	70
3	Compulsory Foundation	M203(24)	Measure and Integration	Theory	4	6	30	70
4	Elective foundation	M204(A)(24)	Numerical Methods	Theory	4	6	30	70
		M204(B)(24)	Topology					
		M204(C)(24)	Mathematical statistics					
5	Core	M205(24)	Partial differential equations	Theory	4	6	30	70
6	Practical	M206(24)	Papers from M201 to M205		4	6	30	70
7	Skill development course		MOOCS Course		4			
TOTAL					**28**	**36**		

SEMESTER-III

S.No	Course category	Course Code	Course Title	Course Type	Credit	Hours/ Week	Marks	
							Int	Ext
1	Core	M301(24)	Rings and modules	Theory	4	6	30	70
2	Core	M302(24)	Analysis-II	Theory	4	6	30	70
3	Core	M303(24)	Functional analysis	Theory	4	6	30	70
4	Elective-I	M304(A)(24)	Fuzzy sets and their applications	Theory	4	6	30	70
		M304(B)(24)	Semi groups					
		M304(C)(24)	Number theory					
5	Elective-II	M305(A)(24)	Mathematical biology	Theory	4	6	30	70
		M305(B)(24)	Linear Programming					
		M305(C)(24)	Calculus of variations					
6	Skill enhancement course		MOOCS Course		4			
TOTAL					**24**	**30**		

SEMESTER-IV

S.No	Course category	Course Code	Course Title	Course Type	Credit	Hours/ Week	Marks	
							Int	Ext
1	Core	M401(24)	Non-commutative rings	Theory	4	6	30	70
2	Core	M402(24)	Graph theory	Theory	4	6	30	70
3	Core	M403(24)	Near-rings	Theory	4	6	30	70
4	Elective-I	M404(A)(24)	Algebraic coding Theory	Theory	4	6	30	70
		M404(B)(24)	Lattice theory					
		M404(C)(24)	Operator theory					
5	Elective-II	M405(A)(24)	Classical Mechanics	Theory	4	6	30	70
		M405(B)(24)	Banach algebras					
		M405(C)(24)	Operations Research					
6	Project work	M4PRO			4			100
7	Comprehensive Viva Voice	M4PRV			4			100
TOTAL					**28**	**30**		

***Total Credits in all semesters:-104**

M.Sc. DEGREE EXAMINATION, Month ----------, Year -------Paper Code:
Semester ----------, Mathematics
Paper No. ---------- Name of the Subject ----------
(with effect from 2024-2025 admitted batch)

Time: 3 hrs **Maximum marks: 70 Marks**

(No additional sheet will be supplied)
Answer ONE Question from each Unit (5 ×14 = 70)

Unit -I

1. (a)
(b)

(OR)

2. (a)
(b)

Unit -II

3. (a)
(b)

(OR)

4. (a)
(b)

Unit -III

5. (a)
(b)

(OR)

6. (a)
(b)

Unit -IV

7. (a)
(b)

(OR)

8. (a)
(b)

Unit -V

9. (a)
(b)

(OR)

10. (a)
(b)

First Semester

ANDHRA KESARI UNIVERSITY

UNIVERSITYCOLLEGE

DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS

SEMESTER-I

M101(24):ALGEBRA

Course type: Theory **Course category: Core** **Credits:4**

Course objectives/outcomes:

At the end of the course, the students will be able

CO 1:To introduce the basic concepts of group, Normal groups and Quotient groups and Automorphisms.

CO 2: To analyze Cayley's theorem, permutation groups, counting principle, Sylow's theorems and apply them for describing structures of finite groups.

CO 3: To describe direct products, structures of finite abelian groups and demonstrate the knowledge of Rings, ideals of Rings and Quotient rings.

CO 4: To describe Field of Quotients of an integral domain, Euclidean rings, Polynomial Rings and polynomial rings over the field of rational numbers.

CO5:To describe some other forms of polynomial rings and also base and dimension of a Vector Space and dual spaces.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	M	S	M	W	S	M	M
CO2	S	M	S	M	W	S	M	M
CO3	S	M	S	M	W	S	M	M
CO4	S	M	S	M	W	S	M	M
CO5	S	M	S	M	W	S	M	M

S-Strong, M-Medium, W-Weak.

Unit-I:

Group theory: Definition of a Group - Some Examples of Groups - Some Preliminary Lemmas - Subgroups - A Counting Principle - Normal Subgroups and Quotient Groups -Homomorphisms– Automorphisms. (2.1 to 2.8 of the prescribed book [1]).

Learning outcomes: Upon completion of this unit, the student will be able to Understand the concept of Groups, Normal groups and Quotients groups and automorphisms.

Unit-II:

Group Theory Continued: Cayley's theorem - Permutation groups-Another counting principle - Sylow's theorem. (2.9 to 2.12 of the prescribed book [1])

Learning outcomes: Upon completion of this unit, the student will be able to Analyse Cayley's theorem, permutation groups, counting principle, Sylow's theorems and apply them for describing structures of finite groups.

Unit-III:

Direct products - finite abelian groups; Ring Theory: Definitions and Examples of Rings - some special classes of rings-Homomorphisms - Ideals and quotient Rings

(2.13 to 2.14 and 3.1 to 3.4of the prescribed book[l])

Learning outcomes: Upon completion of this unit, the student will be able to describe direct products, structures of finite abelian groups and demonstrate the knowledge of Rings, ideals of Rings and Quotient rings.

Unit-IV:

Ring Theory Continued: More Ideals and quotient Rings - The field of quotients of an Integral domain -Euclidean rings- A particular Euclidean ring-Polynomial Rings - Polynomials over the rational field. (3.5 to 3.10 of the Prescribed book [l]).

Learning outcomes: Upon completion of this unit, the student will be able to Describe Field of Quotients of an integral domain, Euclidean rings, Polynomial Rings and polynomial rings over the field of rational numbers.

Unit-V:

Polynomial Rings over Commutative Rings;

VectorSpaces: ElementaryBasic Concepts-Linear Independence and Bases - Dual spaces.

(3.11and 4.1to 4.3of the prescribed book [1]).

Learning outcomes: Upon completion of this unit, the student will be able to describe some other forms of polynomial rings and also base and dimension of a Vector Space and dual spaces.

PRESCRIBEDBOOK:

I. N. Herstein, 'Topics in Algebra', Second Edition,JohnWiley&Sons,1999.

REFERENCEBOOKS:

1) P.B. Bhattacharya, S.K.Jain, S.R.Nagpaul."Basic Abstract Algebra", Second Edition, Cambridge Press, 1995.
2) Thomas W. Hungerford, 'Algebra', Springer-Verlag,NewYork,1974.
3) Serge Lang, 'Algebra' ,Revised Third Edition, Springer-Verlag, NewYork, 2002.

Course Outcome: Acquaintance with the fundamental algebraic structures, namely Groups, Rings, Fields and Vector spaces, essential for further study of Algebra.

M 102 (24): ANALYSIS-I

Course type: Theory **Course category: Core** **Credits:4**

Course objectives/outcomes:

At the end of the course, the students will be able

CO 1: To understand the concepts of numerical sequences, series, and limits. Compute the limits of some sequences with great accuracy. Become familiar with a number of series of non negative terms whose convergence or divergence is known.

CO 2: To understand the concepts of limit and continuity of functions and discuss types of discontinuities.

CO 3: To study another equally important concept namely differentiation that is essential in the study of velocity and acceleration of continuous paths.

CO 4: To determine the Riemann- Stieltjes integrability of a bounded function and prove a selection of theorems concerning integration.

CO 5: To prove integration and differentiation are (in a certain sense) inverse operations and prove a selection of theorems concerning integration.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	M	M	W	M	M	S
CO2	S	S	M	M	W	S	S	S
CO3	S	S	S	S	W	S	M	S
CO4	S	S	M	M	W	S	S	M
CO5	M	S	M	S	W	S	S	M

S-Strong, M-Medium, W-Weak.

Unit-I:

Numerical Sequences and Series: Convergent sequences, Sub sequences, Cauchy Sequences. (3.1 to 3.14 of Chapter 3 of the Text book) **(Questions not to be given in 3.1 to 3.14)**

Upper and Lower limits, Some special sequences, Series, Series of non-negative terms, Number Series, The Root and Ratio tests, Power series, Summation by parts, Absolute convergence, Addition and Multiplication of series. (3.15 to 3.51 of Chapter 3 of the Text book)

Learning Outcomes: Upon completion of this unit, the student will be able to Understand the concepts of numerical sequences, series, and limits. Compute the limits of some sequences with great accuracy. Become familiar with a number of series of nonnegative terms whose convergence or divergence is known.

Unit-II:

Continuity: Limits of functions, Continuous functions, Continuity and Compactness, Continuity and Connectedness. Discontinuities, Monotonic functions, Infinite limits and limits at infinity. (Chapter 4 of the Text book)

Learning Out comes: Upon completion of this unit, the student will be able to Understand the concepts of limit and continuity of functions and discuss types of discontinuities.

Unit-III:

Differentiation: Derivative of a real function, Mean value theorems, The continuity of derivatives,

L' -Hospital's rule, Derivatives of higher order, Taylor's theorem. (5.1 to 5.15of Chapter 5 of the Text book).

Learning Outcomes: Upon completion of this unit, the student will be able to Study another equally important concept namely differentiation that is essential in the study of velocity and acceleration of continuous paths.

Unit-IV:

Differentiation of vector -valued functions. Riemann-Stieltjes Integral:Definition and Existence of the Integral. (5.16 to 5.19 of Chapter 5 and 6.1to 6.11 of Chapter 6 of the Text book)

Learning Outcomes: Upon completion of this unit, the student will be able to Determine the Riemann-Stieltjes integrability of a bounded function and prove a selection of theorems concerning integration.

Unit-V:

Properties of the Integral, Integration and Differentiation, Integration of vector-valued functions, Rectifiable curves. (6.12 to 6.27 of Chapter 6 of the Text book)

Learning Outcomes: Upon completion of this unit, the student will be able to Prove integration and differentiation are (in a certain sense) inverse operations and prove a selection of theorems concerning integration

TEXTBOOK:

Principles of Mathematical analysis by Walter Rudin ,3rd Edition.

REFERENCE BOOK:

Mathematical Analysis by TomM.Apostal, NarosaPublishing House,2nd Edition,1985.

Course Outcomes: After completing this course, the student gets adequate knowledge on numerical sequences and series and also about the behaviour of a function in the vicinity of a point, learns about discontinuities at a point, analytical study of the moment of particle in the plane as well as the areas of the region bounded by a curve and the axes.

M 103(24): DIFFERENTIALEQUATIONS

Course type: Theory **Course category: Compulsory Foundation** **Credits:4**

Course Objectives /outcomes:

At the end of the course, the students will be able

CO 1: To obtain the solutions of first order linear differential equations, second order homogeneous equations and initial value problems for the second order equations.

CO 2: To obtain the solutions of non-homogeneous linear differential equations with constant coefficients and understand the utility of Wronskian, linear independence and independence of solutions.

CO 3: To learn how to solve homogeneous and non-homogeneous differential equations with variable coefficients and homogeneous equation with analytic co-efficient.

CO4:To understand the concepts regular singular points and solve the Euler equation and the Bessel equation.

CO5:To understand the concepts of successive approximations, The Lipschitz condition and prove Local and Non- local existence theorems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	W	M	M	M	M	S
CO2	S	S	W	M	S	S	S	S
CO3	S	S	S	S	S	S	W	S
CO4	S	S	M	W	M	S	S	S
CO5	M	S	M	W	S	S	S	W

S-Strong, M-Medium, W-Weak.

Unit-I:

Linear equations of the first order: Linear equations of the first order- The equation $y^1 + ay = 0$

- The equation $y^1 + ay = b(x)$ – The general linear equation of the first order. (Sections 4-7 Chapter 1 of Prescribed Text book).

Linear Equations with constant co-efficients: Introduction **-** The second order Homogeneous equation- Initial value problems for the second order equations. (Sections 1 to 3 in Chapter 2 Prescribed Book).

Learning outcomes: Upon completion of this unit, the student will be able to Obtain the solutions of first order linear differential equations, second order homogeneous equations and initial value problems for the second order equations.

Unit-II:

Linear Equations with constant co-efficients: Linear dependence and independence- A formula for the Wronskian- The non-homogeneous equation of order two- The homogeneous equation of order n- Initial value problems for n-th order equations. (Sections 4 to 8 in Chapter 2 Prescribed Text Book).

Learning outcomes: Upon completion of this unit, the student will be able to Obtain the solutions of non-homogeneous linear differential equations with constant coefficients and understand the utility of

Wronskian, linear independence and independence of solutions.

Unit-III:

Linear Equations with Variable Co-efficients: Introduction- Initial value problems for the homogeneous equation- Solutions of the homogeneous equation- The Wronskian and linear independence- Reduction of the order of a homogeneous equation- The non-homogeneous equation- Homogeneous equations with analytic coefficients. (Sections 1 to 7 in Chapter 3 Prescribed Text Book).

Learning outcomes: Upon completion of this unit, the student will be able to: learn how to solve homogeneous and non-homogeneous differential equations with variable coefficients and homogeneous equation with analytic co-efficient.

Unit-IV:

Linear Equations with Regular Singular Points: Introduction- The Euler equation- Second order equations with regular singular points- A convergence proof - The exceptional cases- The Bessel equation. (Sections 1 to 7 in Chapter 4 Prescribed Text Book).

Learning outcomes: Upon completion of this unit, the student will be able to Understand the concepts regular singular points and solve the Euler equation and the Bessel equation.

Unit-V:

Existence and Uniqueness of Solutions to First Order Equations: Introduction- Equation with variables separated- Exact equations- The method of successive approximations- The Lipschitz condition- Convergence of the successive approximations- Non-local existence of solutions.

(Sections1to7 in Chapter 5 Prescribed Text Book).

Learning out comes: Upon completion of this unit, the student will be able to Understand

the concepts of successive approximations, The Lipschitz condition and prove local and Non- local existence theorems.

Prescribed Text Book:‘An introduction to Ordinary Differential Equations’ by Earl A. Coddington, Prentice- hall of Indian Private Limited, NEW DELHI, 1974.

Course out comes: The students shall receive good introduction to the study of solutions of equations in higher order derivatives of a variable function with variable coefficients in general and constant coefficients as well as the student also learns technique of finding solutions of some special types of equations. Finally the student learns how to establish existence and uniqueness of $y^1 = f(x, y)$ when f satisfies the Lipschitz condition.

M 104(24): NUMERICAL ANALYSIS

Course type: Theory **Course category: Core** **Credits:4**

UNIT-I:

Solutions of Algebraic and Transcendental Equations: Introduction - Bisection method – Method of False position - Newton Raphson –method solutions of nonlinear equations –Method of iteration.

UNIT-II:

Interpolation: Introduction - Lagrange Interpolation - Newton Divided Differences - Finite Difference Operators - Interpolating Polynomials using finite differences- Gregory- Newton forward difference interpolation- Backward difference interpolation - Stirling and Bessel interpolation –

UNIT-III:

Finite differences- newton's formulae for interpolation- central interpolation formulae –gauss central difference formulae- stilling formula- Bessel's formula – Lagrange's interpolation formula.

UNIT-IV:

Numerical Solution of ODE's: Introduction-Solution by Taylor's Method- Picard's Method of successive approximation-Euler Method-Runge-Kutta Methods-Predictor and Corrector Methods.

UNIT-V: Numerical Solution of PDE's: Introduction-Laplace Equation-Finite Difference Approximations to derivatives-Solution of Laplace Equations

Text Book: "Introductory methods for Numerical Analysis by S.S. Sastry fourth edition".

Reference Book:

1. An Introduction to Numerical Analysis by Kendall E. Atkinson.
2. Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S. R. K. Iyengar, R. K. Jain, NewAge International (p) Limited, Publishers, 5th Edition

M105(A)(24): ADVANCED DISCRETE MATHEMATICS

Course type: Theory **Course category: Elective Foundation** **Credits:4**

Course Objectives/outcomes:

At the end of the course, the students will be able

CO1:To formulate statements from common language to formal logic, apply truth tables and Normal Forms.

CO2: To understand the rules of propositional and predicate calculus.

CO 3: To understand the concept of finite machines and study their applications like minimization, and realization.

CO 4: To be familiar with the notions of ordered algebraic structures, including lattices and Boolean algebras.

CO5:To understand the concept of Boolean polynomials, ideals, filters and calculate the minimal forms of Boolean polynomials. Demonstrate switching circuits and applications of switching circuits.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S		M	S	S		S
CO2	S	M	S	S	S	S	S	S
CO3	S	S	S	S	S	M		M
CO4	M	S			M	S		S
CO5				S	S	S	S	

S-Strong, M-Medium, W-Weak.

Unit-I:

Propositional Calculus: Statements and Notations- Connectives and Truth Tables- Tautology and Contradiction- Equivalence of Statement / Formulas- Duality Law and Tautological Implication- Normal Forms. (Chapter- I of the reference [3]).

Learning outcomes: Upon completion of this unit, the student will be able to: Formulate statements from common language to formal logic, apply truth tables and Normal Forms.

Unit-II:

The theory of Inference for Statement Calculus-Consistency of Premises and Indirect Method of Proof. (Chapter- I of the reference [3]).

Predicate Calculus: Predicate Logic-Statement Functions, Variables and Quantifiers-Free and Bound Variable- Inference Theory for the Predicate Calculus (Chapter- 2 of the reference [3]).

Learning outcomes: Upon completion of this unit, the student will be able to Understand the rules of propositional and predicate calculus.

Unit-III:

Finite Machines: Introduction, state tables and state diagrams, simple properties, Dynamics and Behavior. (Chapter 5 of the reference book [1]).

Learning outcomes: Upon completion of this unit, the student will be able to Understand the concept of finite machines and study their applications like minimization, and realization.

Unit-IV:

Properties and Examples of Lattices, Distributive Lattices, Boolean polynomials. (Sections 1 to 4 of Chapter 1 of [2]).

Learning outcomes: Upon completion of this unit, the student will be able to be familiar with the notions of ordered algebraic structures, including lattices and Boolean algebras.

Unit-V:

Ideals, filters and equations, Minimal forms of Boolean polynomials, Application of Lattices Application of switching circuits, (Sections 5,6 of Chapter-1 and sections 7 and 8 of Chapter 2of[2]).

Learning outcomes: Upon completion of this unit, the student will be able to Understand the concept of Boolean polynomials, ideals, filters and calculate the minimal forms of Boolean polynomials. Demonstrate switching circuits and applications of switching circuits.

Note: For units- III and IV the material of pages1to 66 of [2] is to be covered.

REFERENCEBOOKS:

1) "Application oriented Algebra"JAMES L - FISHER, IEP,Dun-Downplaypub.1977.
2) "Applied abstract algebra", Second Edition, R.LIDLANDG.PILZ,Springer,1998.
3) "Bhavanari Satyanarayana, Tumurukota Venkata Pradeep Kumar and Shaik Mohnddin Shaw, "Mathematical Foundation of Computer Science" BS Publications (A unit of BSP Book Pvt Ltd), Hyderabad, India 2016. (ISBN. 978-93-83635-81-8).
4) Rm. Soma sundaram "Discrete Mathematical Structures" Prentice Hall of India, 2003.
5) Bhavanari Satyanarayana & Kuncham Syam Prasad, "Discrete Mathematics and Graph theory" (For B.Tech/B.Sc./M.Sc (Maths)), Printice Hall of India, New Delhi, April 2014.

Course Outcomes: After competing this course, the student will be able to Receive meaningful introduction to discrete mathematics and its applications.

M 105(B) (24): MATHEMATICAL METHODS

Course type: Theory **Course category: Elective Foundation** **Credits:4**

Course objectives:

At the end of the course, the students will be able

CO1:ToAcquire knowledge of various Successful application of mathematics in physics and related sciences.

CO2: To Apply various transforms to solve multi disciplinary application problems.

CO 3: To Recognize and solve the initial and boundary value problems.

CO4:To Demonstrate the ability to present the results.

CO5:To Develop strategies using mathematical methods to solve real world problems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	W	S	S	S	W	S
CO2	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	W	S
CO4	S	S	W	M	S	S	S	S
CO5	S	M	W	S	S	S	S	M

S-Strong, M-Medium, W-Weak.

Unit-I:

Laplace Transform- Properties of Laplace Transforms- Change of Scale property- Heaviside's Shifting theorem- Laplace transform of the derivative of $f(t)$– Laplace transform of Derivative of order n- Laplace transform of Integral of $f(t)$- Initial and Final Value theorems- Laplace transform of$f(t)/t$ – Convolution theorem – Properties of Laplace transform – Inverse Laplace Transforms- Multiplication by$s$-Division by s-First Shifting Property – Second Shifting Property- Heaviside Inverse formula $\frac{F(s)}{G(s)}$ – Solution of Differential Equations by Laplace Transforms.(42.2,42.4, 42.5,42.6,42.8,42.9,42.10,42.12,42.14,42.23,42.27,43.1,43.3,43.4,43.5,43.6,43.11and 43.12 Of Chapter-IX of Reference book[1])

Learning outcomes: Upon completion of this unit, the student will be able to solve initial value problems by using Laplace Transform.

Unit-II:

Fourier Transforms- Fourier sine and Cosine Transforms- Properties of Fourier Transforms- Convolution-Parseval's Identity for Fourier Transform-Parseval's Identity for Cosine Transform-Parseval's Identity for sine Transform - Fourier Transform of Derivatives- Relationship between Fourier and Laplace Transforms. (Sections 41.6 to 41.14 of Chapter- IX of Reference book [1]).

Learning outcomes: Upon completion of this unit the student will be able to understand and apply

The definition of Fourier transforms, Fourier Sine and Cosine Transforms and Relationship between Fourier and Laplace Transforms.

Unit-III:

Solution of Boundary Value Problems by Using Integral Transform - Fourier Transforms of Partial Derivative of a Function- Applications to Simple Heat Transfer Equations- Finite Fourier Transforms-Finite Fourier Sine and Cosine Transforms of Derivatives.(Sections41.15 to 41.19 of Chapter- IX of Reference book [1]).

Learning outcomes: Upon completion of this unit the student will be able to solve Boundary value problems by using Integral Transform.

UNIT-IV

Hankel Transform-Inversion Formula for the Hankel transform-Linear Property-Examples-Hankel transform of the Derivatives of a function- Hankel Transform of

$\frac{d^2f}{dx^2}+\frac{1}{x}\frac{df}{dx}-\frac{n^2}{x^2}f$ -Parseval's Theorem- Examples.(Sections 9.1, 9.2 and 9.4to 9.7 of Chapter-IX Of Reference book [2]).

Learning outcomes: After completion of this unit, the student will be able to define Hanket transform and understand Parsevals theorem.

Unit-V:

Finite Hankel Transform –Another form of Hankel Transform-Hankel Transform of $\frac{df}{dx}$-Hankel Transform of $\frac{d^2f}{dx^2}+\frac{1}{x}\frac{df}{dx}$ where p is the root of the equation $J_n(ap)=0$.
– Hankel Transform of $\frac{d^2f}{dx^2}+\frac{1}{x}\frac{df}{dx}-\frac{n^2}{x^2}f(x)$ where p is the root of the equation $J_n(ap)=0$ - Examples- Applications of Hankel Transform in Initial and Boundary Value Problems.(Sections10.1 to 10.6 of Chapter- X and Chapter- XI of Reference book [2]).

Learning outcomes: After completion of this unit, the students will be able to define Finite Hankel Transform and understand the application of Hankel Transform in initial and boundary value problems.

References:

1) Higher Engineering Mathematics by H.K. Dass and Er. Rajnish Verma, S. CHAND Publications.
2) Integral Transforms by A.R. Vasishtha, R. K. Gupta, Krishna's Educational Publishers.

M105 (C)(24):TENSOR ALGEBRA

Course type: Theory **Course category: Elective Foundation** **Credits:4**

Course Objectives/ Outcomes:

At the end of the course, the students will be able

CO1: To Understand concept of tensor variables and difference from scalar or vector variables.

CO 2: To Derive Second-order and Fourth order Tensors in coordinate system.

CO3: To Investigate the Christoffel symbols and representation of the covariant derivative.

CO 4: To Understand the relations between the principal invariants and eigen values.

CO5: To Establish a linear relationship between the Cauchy stress tensor and Cauchy strain tensor.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	W	S	S	S	W	S
CO2	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	W	S
CO4	S	S	W	M	S	S	S	S
CO5	S	M	W	S	S	S	S	M

S-Strong, M-Medium, W-Weak.

Unit-I:

Vector and Tensor in a Finite-Dimensional Space: Notation of the Vector Space-Basis and Dimension of the Vector Space- Components of a Vector, Summation Convention-Scalar Product, Euclidean Space, Orthonormal Basis-Dual Bases-Second order Tensors a Linear mapping-Tensor product, Representation of a Tensor with Respect to a basis-Change of the Basis, Transformation rules-Special operation with second order Tensor-Scalar Product of second order tensors-De composition of Second order Tensors-Tensors of Higher orders. (Sections 1.1 to 1.12 of Chapter -I of Text Book)

Unit-II:

Vector and Tensor Analysis in Euclidean Space: Vector and Tensor valued functions, Mixed Varia Calculus -Coordinate Transformation, Co-, Contra- and Variant Components -Gradient, Coveriant and Contravariant Derivatives-Christoffel symbols, Representation of the Covariant Derivative-Application in Three-Dimensional Space-Divergence and Curl. (Sections 2.1 to 2.6 of Chapter 2 of Text Book).

Unit-III:

Curves and Surfaces in Three-Dimensional Euclidean Space: Curves in Three –Dimensional Euclidean Spaces -Surfaces in Three-Dimensional Euclidean Space- Application to Shell Theory. (Sections 3.1, 3.2, 3.3 of Chapter-III of Text Book).

Unit-IV:

Eigen value Problem and Spectral Decomposition of Second Order Tensors: Complexification -Eigen value Problem, Eigen values and Eigenvectors-Characteristic Polynomial-Spectral Decomposition and Eigen projections- Spectral Decomposition of symmetric Second Order Tensors. (Sections4.1 to 4.5 of Chapter-IV of the Text Book)

Unit-V:

Spectral Decomposition of Orthogonal and Skew-symmetric Second order Tensors-Cayley Hamilton Theorem-Fourth order Tensors as a linear mapping-Tensor Products, Representation of Fourth order Tensors with Respect to a Basis-Special Operations with Fourth order Tensors. (Sections 4.6 and 4.7 of Chapter-IV and 5.1, 5.2, 5.3 of Chapter-V of Text Book).

Text Book: Mikhail Itskov, **Tensor Algebra and Tensor Analysis for Engineers** (with Applications to Continuum Mechanics) Fifth Edition, Springer.

Reference Books: "Introduction to vectors and Tensor Analysis " by **ROBERT .C.WREDE.**

M106 (24): Numerical Analysis by Python

Course category: Practical **Credits:4**

- Basics & fundamentals of Python Programming Language.
- Basic Programs using Python Programming Language.
- 10 Programs on Numerical Methods using Python Language.

Second Semester

M.Sc. MATHEMATICS

SEMESTER-II

M201(24):GALOIS THEORY

Course type: Theory **Course category: Core** **Credits:4**

Course Objectives /outcomes:

At the end of the course, the students will be able

CO 1: To derive and apply Gauss Lemma, Eisenstein criterion for irreducibility of Polynomials over the field of rational numbers and algebraic extensions.

CO 2: To demonstrate algebraically closed fields, splitting fields, normal extensions and multiple roots.

CO 3: To learn and apply finite fields, separable extensions and fixed fields of automorphism groups.

CO 4: To understand the fundamental theorem of Galois theory, the fundamental theorem of algebra, roots of unity and cyclotomic polynomials and cyclic extensions.

CO 5: To understand polynomials solvable by radicals, symmetric functions and Ruler & Compass constructions.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	M	S	S	S	S	S
CO2	S	S	S	W	S	S	S	S
CO3	S	M	S	S	S	S	M	W
CO4	S	S	M	W	S	S	S	S
CO5	S	S	S	S	S	S	M	S

S-Strong, M-Medium, W-Weak.

Unit-I:

Algebraic extensions of fields: Irreducible polynomials and Eisenstein criterion- Adjunction of roots-Algebraic extensions. (Sections 15.1 to 15. 3 of Chapter15 of the Prescribed book)

Learning outcomes: Upon completion of this unit, the student will be able to Derive and apply Gauss Lemma, Eisenstein criterion for irreducibility of Polynomials over the field of rational numbers and algebraic extensions.

Unit-II:

Algebraically closed fields; Normal and Separable extensions: Splitting fields - Normal extensions - Multiple roots. (Section 15.4 of Chapter 15 and Sections 16.1 to 16.3 of Chapter16 of the prescribed book)

Learning outcomes: Upon completion of this unit, the student will be able to Demonstrate algebraically closed fields, splitting fields, normal extensions and multiple roots.

Unit-III:

Finite fields-Separable extensions-Automorphism groups and fixed fields.

(Sections16.4to16.5 of Chapter 16 and Section17.1of Chapter17of the prescribed book)

Learning outcome: Upon completion of this unit, the student will be able to Learn and apply finite fields, separable extensions and fixed fields of automorphism groups.

Unit-IV:

Galois Theory: Fundamental theorem of Galois theory - Fundamental theorem of Algebra; Applications of Galois theory to classical problems: Roots of unity and cyclotomic polynomials - Cyclic extensions.

(Sections 17.2 to 17.3 ofChapter 17 and Sections 18.1 to 18.2ofChapter 18 ofthe prescribed book).

Learning outcomes: Upon completion of this unit, the student will be able to Understand the fundamental theorem of Galois theory, the fundamental theorem of algebra, roots of unity and cyclotomic polynomials and cyclic extensions.

Unit-V:

Polynomials solvable by radicals-Symmetric functions-Ruler and Compass constructions

(Sections 18.3 to 18.5 of Chapter 18 of the prescribed text book)

Learning outcomes: Upon completion of this unit, the student will be able to Understand polynomials solvable by radicals, symmetric functions and Ruler & Compass constructions.

PRISCRIBED BOOK:

P. B. Bhattacharya, S. K. Jain, S. R. Nagpaul. "Basic Abstract Algebra", Second Edition, Cambridge Press, 1995.

REFERENCE BOOKS:

1) I.N.Herstein, ‘Topics in Algebra’,Second Edition, John Wiley&Sons,1999.
2) Thomas W. Hungerford, ‘Algebra’,Springer-Verlag, NewYork, 1974.
3) SergeLang, ‘Algebra’,Revised Third Edition, Springer-Verlag, NewYork,2002.

M 202(24): COMPLEX ANALYSIS

Course type: Theory **Course category :Core** **Credits: 4**

Course Objectives:

CO1:To represent complex numbers algebraically and geometrically and understand Analytic functions,

CO2:To introduce and develop the fundamental concepts of complex analysis such as analytic functions, Cauchy-Riemann equations and harmonic functions etc.

CO 3: To understand Harmonic functions and Cauchy- Goursat theorem to simply connected domains and Cauchy-Goursat theorem to multiply connected domains.

CO4:To represent functions as Laurent series theorem.

CO5: To compute integralsusingresiduesandtounderstandArgumentprincipleandRouche's theorem.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	M	S	S	S	W	M
CO2	S	S	M	W	S	S	S	M
CO3	S	S	M	M	M	S	W	S
CO4	S	S	S	M	W	S	S	S
CO5	S	S	S	M	W	S	S	S

S-Strong, M-Medium, W-Weak.

Unit-I:

Sums and products, basic algebraic properties, further properties, vectors and moduli, complex conjugates, exponential form, products and powers in exponential form, arguments of products and quotients, Root s of complex numbers- examples- Regions in the complex plane.

(Sections 1 to 11 of Text Book) (Questions not to be given in Sections 1 to 11).

Functions of a complex variable, mappings, mappings by the exponential function, limits, Theorems on limits, limits involving the point at infinity, continuity, derivatives, Differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability, polar co-ordinates, Analytic functions, Examples. **(Sections 12 to 25 of Text Book).**

Learning outcomes: Upon completion of this unit, the student will be able to represent complex numbers algebraically and geometrically and understand Analytic functions, Cauchy-Riemann equations and verify Complex functions for analycity.

Unit-II:

Harmonic functions, Uniquely determined Analytic functions, Reflection principle. The exponential function, the logarithmic function, branches and derivatives of logarithms,

contours, contour integrals, Some examples - Examples with branch cuts, upper bounds for moduli of contour integrals, anti-derivatives, Proof of the Theorem (45), Cauchy-Goursat theorem,

ProofoftheTheorem (47), simply connected domains, multiply connected domains.

(Sections 26 to 31 & 39 to 49 of Text Book).

Learning outcomes: Upon completion of this unit, the student will be able to understand Harmonic functions and Cauchy-Goursat theorem to simply connected domains and Cauchy- Goursat theorem to multiply connected domains.

Unit-III:

Cauchy integral formula, An extension of the Cauchy integral formula- Some consequences ofthe extension. Liouvelli's theorem and the fundamental theorem of Algebra, maximum modulus principle. Convergence of sequences, Convergence of series, Taylor series, proof of Taylor's theorem, Examples.

(Sections 50 to 59 of Text Book)

Learning outcomes: Upon completion of this unit, the student will be able to evaluate Complex integrals by applying Cauchy integral formula and to understand Liouvelli's theorem and the fundamental theorem of Algebra and maximum modulus principle.

Unit-IV:

Laurent series, proof of Laurents theorem, Examples absolute and uniform convergence of power series, continuity of sums of power series, integration and differentiation of power series, uniqueness of series representations, Isolated singular points, Residues, Cauchy residue theorem, Residue at infinity- The three types of isolated singular points. **(Sections 60 to 72 of Text Book)**

Learning outcomes: Upon completion of this unit, the student will be able to represent functions as Laurent series and to understand residues and Cauchy residue theorem.

Unit-V:

Residues at poles, Examples, zeros of analytic functions, zeros and poles, behavior of a function near isolated singular points. Evaluation of improper integrals, Examples - Improper integrals from Fourier analysis, Jordan's Lemma, definite integrals involving Sines and Cosines, Argument Principle, Rouche's Theorem. **(Sections 73 to 81 & 85 to 87 of Text Book)**

Learning outcomes: Upon completion of this unit, the student will be able to compute integrals using residues and to understand Argument principle and Rouche's theorem.

Text Book: Complex variables and Applications, James Ward Brown, Ruel V.Churchill, McGraw Hill, Eighth Edition, 2009.

Reference Books:

1) Complex Variables, H. Silvermen
2) Complex Variables by H.S.Kasana, Prentice Hall of India Complex Variables by Murrey Rspiegel, Scheam's Outline series.

Course outcomes: Upon completion of this course, the student will be able to define and analyze limits and continuity for functions of complex variables, Cauchy-Riemann equations, analytic functions and entire functions. Evaluate complex contour integrals, the Cauchy integral formula and represent functions as Taylor and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.

M203(24): MEASURE AND INTEGRATION

Course type: Theory **Course Category: Compulsory Foundation** **Credits:4**

Course Objectives/Outcomes:

At the end of the course, the students will be able

CO1:To understand the concept of measure and properties of Lebesgue measure.

CO2:To study the properties of Lebesgue integral and compare it with Riemann integral.

CO3:To establish the equivalent condition an indefinite integral is absolutely continuous. Jenson inequality becomes a generalization of the inequality between the arithmetic and geometric mean.

CO4:To establishes several inequalities involving the $\|.\|_p$ in the L^p spaces.

CO5:To establishes convergence and completeness, approximation in L^P-space. To find a representation for bounded linear functions.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	W	S	M	M	S	S	S
CO2	M	S	S	S	S	M	S	S
CO3	S	M	S	S	W	S	S	S
CO4	S	M	S	M	S	S	S	S
CO5	S	S	S	M	W	S	S	S

S-Strong, M-Medium, W-Weak.

Unit-I:

Lebesgue Measure: Introduction, outer measure, Measurable sets and Lebesgue measure, A non measurable sets, Measurable functions, Littlewoods's three principles **(Chapter 3)**

Learning outcomes: Upon completion of this unit, the student will be able to Understand the concept of measure and properties of Lebesgue measure.

Unit-II:

The Lebesgue integral: The Riemann Integral, The Lebesgue integral of a Bounded function over a set of finite measure, the integral of a non- negative function. The general Lebesgue Integral, Convergence in measure. **(Chapter 4)**

Learning outcomes: Upon completion of this unit, the student will be able to Study the properties of Lebesgue integral and compare it with Riemann integral.

Unit-III:

Differentiation and Integration: Differentiation of monotone functions, functions of bounded variation, differentiation of an integral, absolute continuity**. (Sections 1 to 4** of **Chapter 5)**

Learning outcomes: Upon completion of this unit, the student will be able to: To establish the derivative of the indefinite integral of an integrable function is equal to the integral a.e. To establish the equivalent condition an indefinite integral is absolutely continuous. Jenson inequality becomes a generalization of the inequality between the arithmetic and geometric mean.

Unit-IV:

Convex functions, The Classical BanachSpaces**:** The L^P spaces,The Minkowski and Holder inequalities. (Section **5** of **chapter 5** & **sections 1 to 2 of Chapter 6**)

Learning outcomes: Upon completion of this unit, the student will be able to establishes several inequalities involving the $\|.\|_p$in the L^p spaces.

Unit-V:

Convergence and completeness, Approximation in L^P, Bounded linear functionals on the L^P spaces. **(Sections 3 to 5 of Chapter6)**

Learning outcomes: Upon completion of this unit, the student will be able to establishes convergence and completeness, approximation in L^P-space. To find a representation for bounded linear functions.

TEXT BOOK: Real Analysis **by H.L. Royden, Third Edition, Pearson Publication.**

REFERENCE:

1) Mathematical Analysis by " S. C. Malik 1994" Wiley Eastern Limited.

2) Real Analysis – Golden Math Series by N. P. Bali.

M204(A)(24):NUMERICAL METHODS

Course type: Theory **Course Category: Elective Foundation** **Credits:4**

Course Objectives/Outcomes:

At the end of the course, the students will be able

CO1:To apply various Mathematical operations and tasks, such as Inter polation of Polynomials.

CO 2:To ability to solve the Problems based on Numerical Integration.

CO3:To find Numerical solution of ordinary differential equations such as Runga- Kutta methods.

CO4: To find Numerical solution of ordinary differential equations boundary value problems.

CO5:To find numerical solution of Laplace's equation by using Jacobi's method, Gauss-Seidel Method, Successive Over-Relaxation method.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	W	S	S	S	S	S
CO2	S	S	W	S	S	S	S	S
CO3	S	S	W	S	S	S	W	M
CO4	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	W	S

S-Strong, M-Medium, W-Weak.

Unit-I:

Interpolation and Approximation: Introduction, Lagrange and Newton Interpolations, Finite difference Operators, Interpolating polynomials using finite differences, Hermite Interpolations. (Section 4.1 to 4.5 of chapter 4 of [1]).

Learning outcomes: Upon completion of this unit, the student will be able to Apply various Mathematical operations and tasks, such as Interpolation of Polynomials.

Unit-II:

Numerical Differentiation and Integration: Introduction, Numerical integration, Methods based on Interpolation, Methods based on Undetermined Coefficients, Composite Integration Methods. (Sections 5.1, 5.6, 5.7, 5.8, 5.9 of chapter 5 of [1]).

Learning outcomes: Upon completion of this unit, the student will be able to Ability to solve the Problems based on Numerical Integration.

Unit-III:

Ordinary Differential Equations: Introduction, Numerical methods, Single step methods, Multistep methods(sections 6.1 to 6.4 of [1]).

Learning outcomes: Upon completion of this unit, the student will be able to: find Numerical solution of ordinary differential equations such as Runga-Kutta methods.

Unit-IV:

Ordinary Differential Equations: Boundary Value Problems Introduction, Initial Value Problem Method (Shooting Method), Finite Difference Methods.

(Sections 7.1, 7.2 and 7.3 of Chapter 7 of [1]).

Learning outcomes: Upon completion of this unit, the student will be able to find Numerical solution of ordinary differential equations boundary value problems.

Unit-V:

Numerical Solution of Partial Differential Equations: Introduction, Finite-difference Approximations to Derivatives, Laplace's Equation Jacobi's Method, Gauss-Seidel Method, Successive Over-Relaxation, Parabolic Equations. (Sections 8.1 to 8.4 of Chapter 8 of [2]).

Learning outcomes: upon completion of this unit, the student able to find numerical solution of Laplace's equation by using Jacobi's method, Gauss-Seidel Method, Successive Over-Relaxation method.

TEXT BOOKS:

1) "**Numerical Methods for Scientific and Engineering Computation**", M.K.JAIN, S.R.K. IYANGAR AND R.K. JAIN Third edition, New Age International (p) Limited, New Delhi, 1997.
2) "**Introductory Methods of Numerical Analysis**", S. S. Sastry, Published by Prentice Hall of India Pvt. Ltd., Fourth Edition, New Delhi.

Course outcomes: Apply numerical methods to obtain approximate solutions to mathematical problems. Derive numerical methods for various mathematical operations and tasks such as interpolation, differentiation, integration, the solution of linear and non linear equations, and the solution of differential equations.

M 204(B) (24):TOPOLOGY

Course type: Theory **Course category: Elective Foundation** **Credits:4**

Course Objectives/outcomes:

At the end of the course, the students will be able

CO1:To understand the basic concepts of metric spaces, open sets, closed sets and continuous functions on metric spaces.

CO 2: To define and illustrate the concept of topology and prove a selection of theorems concerning Topological spaces, continuous functions and product topologies.

CO3:To characterize compact spaces using the Heiene-Borel theorem.

CO 4: To define and illustrate the concepts of the separation axioms and appreciate the beauty of deep mathematical results like Tietze Extension theorem.

CO 5: To define and illustrate the concepts of the mathematical results like Urysohn's lemma, Urysohn imbedding theorem and understand the dynamics of the proof techniques. Characterize connected spaces, components of a space.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	W	S	S	S	M	S
CO2	S	M	S	S	M	S	S	S
CO3	M	M	S	M	S	S	S	M
CO4	S	M	S	S	S	S	S	S
CO5	S	M	M	S	S	S	S	S

S-Strong, M-Medium, W-Weak.

Unit-I:

Metric Spaces: Definition and some examples, Open sets, Closed sets, Convergence, completeness and Baire's theorem, Continuous mappings. (Sections 9 to 13 of chapter 2)

Learning out comes: Upon completion of this unit, the student will be able to Understand the basic concepts of metric spaces, open sets, closed sets and continuous functions on metric spaces.

Unit-II:

Topological spaces: The Definition and some examples, Elementary Concepts, Open bases and open sub bases, Weak topologies. (Sections 16 to 19 of chapter 3)

Learning out comes: Upon completion of this unit, the student will be able to Define and illustrate the concept of topology and prove a selection of theorems concerning Topological spaces, continuous functions and product topologies.

Unit-III:

Compactness: Compact spaces, Products of spaces, Tychonoff's theorem and locally compact spaces, Compactness for metric spaces, Ascoli's theorem. (Sections 21 to 25 of chapter 4)

Learning out comes: Upon completion of this unit, the student will be able to Characterize compact spaces using the Heiene-Borel theorem.

Unit-IV:

Separation: T_1-spaces and Hausdorff spaces, completely regular spaces and normal spaces, Urysohn's Lemma and the Tietze extension theorem. (Sections 26 to 28 of chapter 5).

Learning outcomes: Upon completion of this unit, the student will be able to: Define and illustrate the concepts of the separation axioms and appreciate the beauty of deep mathematical results like Tietze Extension theorem.

Unit-V:

The Urysohnimbedding theorem, Connected spaces, The components of a space (Section 29 of chapter 5 and sections 31 to 32 of chapter 6).

Learning outcomes: Upon completion of this unit, the student will be able to Define and illustrate the concepts of the mathematical results like Urysohn's lemma, Urysohn imbedding theorem and understand the dynamics of the proof techniques. Characterize connected spaces, components of a space.

TEXT BOOK:

Introduction to Topology and Modern Analysis by **G.F. Simmons**, McGraw-Hill Book Company, New York International student edition.

REFERENCE BOOKS:

1) **Topology by K. Chandra Sekhara Rao, Narosa Publications.**
2) **Topology by J. P. Chauhan, J. N. Sharma, Krishna Publications.**

M204(C)(24): MATHEMATICAL STATISTICS

Course type: Theory **Course Category: Elective Foundation** **Credits:4**

Course objectives/Outcomes:-

At the end of the course, the students will be able

CO1:To introduce basic concepts of statistics, various distribution functions

CO2:To help in acquiring kills in handling situations involving more than one variable.

CO3:To explain the objective of Centrallimit Theorem and theorems on limiting distributions.

CO 4:To understand the Binomial, Poisson, Gamma Chi-square normal distribution theory.

CO5: To analyze the data of practical problems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	W	S	S	S	S	S
CO2	S	S	W	S	S	S	S	S
CO3	S	S	W	S	S	S	M	W
CO4	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	M	S

S-Strong, M-Medium, W-Weak.

Unit-I:

The probability set function-Random variables-The probability density function-The distribution function-Mathematical expectations-Some special mathematical expectations- Chebyshev inequality.
(1.4 to1.7 of Chapter-1, and 1.9 to1.11of Chapter-1of Reference book[2]).

Unit-II:

Conditional probability-Marginal and conditional distributions-The Correlation coefficient-Stochastic Independence.(2.1 to 2.4 of Chapter-2, of Reference book[2]).

Unit-III:

The Binomial, Poisson, Gamma, chi-square normal distribution. Distributions of functions of Random variables -Sampling theory- Transformation of Variables of Discrete type-Transformation of Variables of the continuous type.

(3.1 to 3.4 of Chapter-3 and 4.1 to 4.3 of Chapter-4 of Reference book[2]).

Unit-IV:

The t and F Distributions- Distribution of order statistics-The moment-generating function Technique-The Distribution of X and Limiting distribution-Stochastic convergence-Limiting moment generating function-The central limit theorem-Some theorems on Limiting Distribution.

(4.4,4.6to4.8ofChapter-4and5.1to5.5ofChapter-5ofReferencebook[2]).

Unit-V:

Point estimation-Measures of quality of estimations-confidence intervals for means-confidence intervals for difference of Means-confidence intervals for variances.

A Sufficient statistics for a parameters-The Rao-Blackwell theorem.

(6.1to6.5ofChapter-6,10.1and10.2ofChapter-10ofReferencebook[2].)

References:

1) Mathematical Statistics by J.N. Kapur, H.C.Saxena -S.Chand Publications.
2) Introduction to Mathematical Statistics Robert V Hogg, Allencraig, Joseph W Mekean, Pearson Publishers.
3) Fundamentals of mathematical Statistics by S.C.Gupta and V.K.Kapoor,11thedition S. Chand and sons, New Delhi
4) Probability and Statistics for engineers and scientists by Walpole Myers and Keyingye, ninth edition, Pearson Publications.

Course outcomes:

1) To learn the fundamental concepts of statistics and techniques required for data analysis.
2) To explains to chastic convergence,
3) To discuss measures of quantity of estimations,
4) Study confidence intervals of variances.
5) Understand Rao-Blackwell theorem and Rao Cramer's inequality and
6) Able to analyze the data of practical problems.

M205 (24): PARTIAL DIFFERENTIAL EQUATIONS

Course type: Theory **Course Category: Core** **Credits:4**

Course Objectives/Out comes:

At the end of the course, the students will be able

CO1:To classify first order partial differential equations and their solutions and solve them using some methods.

CO 2: To apply Charpit's and Jocobi's methods to solve first order partial differential equations and Classify and solve second order partial differential equations.

CO 3: To solve one dimensional wave equations using different analytic methods and understand Laplace equations and Maximum and minimum principles.

CO4:To solve Laplace equations using various analytical methods demonstrate uniqueness of solutions of certain kinds of these equations.

CO5:To compute solutions of heat equations using certain an alytic methods and verify uniqueness of solutions of some types of these equations.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	W	M	M	M	S	S
CO2	S	S	S	W	S	S	S	W
CO3	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	W	S

S-Strong,M-Medium,W-Weak.

Unit-I:

First Order Partial Differential equations: Curves and Surfaces - Genesis of first order partial differential equations - Classification of integrals - linear equations of the first order Partial Differential equations - Compatible systems. (Sections 1.1 to 1.6 of Chapter 1 of [1])

Learning outcomes: Upon completion of this unit, the student will be able to: Classify first order partial differential equations and their solutions and solve them using some methods.

Unit-II:

Charpit's method- Jacobi's method - Integral surfaces through a given curve- **Second order Partial differential Equations**: Genesis of Second Order Partial Differential Equations - Classification of Second Order Partial differential equations.

(Sections1.7 to 1.9 of Chapter1 and Sections 2.1to2.2 of Chapter 2 of [1]).

Learning outcomes: Upon completion of this unit, the student will be able to: apply Charpit's and Jocobi's methods to solve first order partial differential equations and Classify and solve second order partial differential equations.

Unit-III:

One Dimensional Waves equations: Vibrations of an infinite string - Vibrations of a semi- infinite string – Vibrations of a string of Finite Length - Riemann's Method –Vibrations of a string of finite length (method of separation of variables) - **Laplaces Equation**: Boundary value problems - Maximum and minimum principles.

(Sections 2.3.1 to 2.3.5 of Chapter 2 and Sections 2.4.1 to 2.4.2 of Chapter 2 of [1]).

Learning outcomes: Upon completion of this unit, the student will be able to: solve one dimensional wave equations using different analytic methods and understand Laplace equations and Maximum and minimum principles.

Unit-IV:

The Cauchy problem - The Dirichlet problem for the upper Half plane - The Neumann problemfor the upper Half plane - the Dirichlet problem for a circle - the Dirichlet Exterior problem for a circle- The Neumann problem for a circle- The Dirichlet problem for a Rectangle- Harnack's Theorem.

(Sections 2.4.3 to2.4.10 of Chapter 2 in [1])

Learning outcomes: Upon completion of this unit, the student will be able to: Solve Laplace equations using various analytical methods demonstrate uniqueness of solutions of certain kinds of these equations

Unit-V:

Laplace's Equation- Green's Function- The Dirichlet problem for a Half plane -The Dirichlet problem for a circle - Heat conduction infinite rod case - Heat conduction Finite rod case - **Duhamel's principle**: Wave equation - Heat conduction equation.

(Sections 2.4.11to 2.4.13 and 2.5.1 to2.5.2 and 2.6.1 to 2.6.2 of Chapter 2 of [1])

Learning outcomes: Upon completion of this unit, the student will be able to: Compute solutions of heat equations using certain analytic methods and verify uniqueness of solutions of some types of these equations.

TEXT BOOK:

An Elementary course in Partial Differential Equations by T.Amaranath, Published by Narosa Publishing House.

REFERENCE: "Ordinary and Partial Differential Equations" by M. D. Raisinghania.

Third Semester

M.Sc. MATHEMATICS

SEMESTER-III

M301(24): RINGS AND MODULES

Course type :Theory **Course category: Core** **Credits:4**

Course Objectives:

At the end of the course, the students will be able

CO1**:**To develop skills and to acquire knowledge on some advanced concepts of Modern Algebra.

CO 2:To understand the different algebraic structures.

CO3: To describe Modules, Prime ideals, primeradical, and Jacobson radical in commutative rings.

CO 4:To analyze complete ring of quotients and Prime ideal spaces.

CO5:To Study the Wedderburn –Artin theorem and its applications and Prime ideal spaces.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	M	S	S	M	S	S	S
CO2	M	S	S	S	W	S	S	S
CO3	S	M	S	S	S	S	S	S
CO4	M	S	S	S	S	M	S	S
CO5	S	S	W	M	S	S	S	S

S-Strong, M-Medium, W-Weak.

Unit-I:

Rings and related Algebraic systems, Sub rings, Homomorphisms, Ideals.

(Sections1.1, 1.2 of chapter 1).

Learning outcomes: Upon completion of this unit, the student will be able to Understand the concepts of commutative ring theory and special structures like Boolean algebras and Boolean rings. Know the relations between ring, Boolean algebra and lattice.

Unit-II:

Modules, Direct products and Direct sums, Classical Isomorphism Theorems.

(Sections 1.3, 1.4 of chapter 1).

Learning outcomes: Upon completion of this unit, the student will be able to study Classical isomorphism theorems and some properties of direct sum, product of rings and modules.

Unit-III:

Prime ideals in Commutative Rings, Prime ideals in Special Commutative Rings.

(Sections2.1, 2.2 of Chapter 2).

Learning outcomes: Upon completion of this unit, the student will be able to Understand the concept of Prime ideals, maximal ideals of commutative rings, Prime radical and Jacobson radical.

Unit-IV:

The Complete Ring of Quotients of a Commutative Ring

(Section 2.3 of Chapter 2).

Learning outcomes: Upon completion of this unit, the student will be able to Two methods Applied to any integral domain to Construct its field of quotients, one method is applied to any commutative ring to construct its classical ring of quotients.

Unit-V:

Ring of quotients of Commutative Semi Prime Rings, prime ideal spaces.

(Sections2.4&2.5 of Chapter 2).

Learning outcomes: Upon completion of this unit, the student will be able to Study the Wedderburn-Artin theorem and its applications and Prime ideal spaces.

TEXTBOOK: "Lectures on Rings and Modules", J.Lambek, Blaisdell Publications.

REFERENCE: "Introduction to Rings and Modules" Second Edition by Musili, Narosa Publication.

Course outcome: The student attains more mathematical sophistication extending the concepts of rings introduced in the introductory course 101.

M 302(24): ANALYSIS-II

Course type: Theory **Course category: Core** **Credits:4**

Course Objectives /outcomes:

At the end of the course, the students will be able

Co 1: To recognize the difference between point wise and uniform convergence of sequences of functions and illustrate the effect of uniform convergence on the limit function with respect to continuity, and integrability.

CO 2: To illustrate the effect of uniform convergence on the limit function with respect to differentiability. Study the Stone- Weierstrass theorem and its applications.

CO 3: To understand the properties of power series. Study the Exponential, Logarithmic and Trigonometric functions.

CO 4: To compute derivatives and integrals of real valued and vector-valued functions of several variables. Understand and apply the inverse function theorem.

CO 5: To understand and apply the implicit function theorem. Compute the derivatives of higher order and differentiation of integrals.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	S	M	W	S	S	S
CO2	S	S	M	W	W	S	S	S
CO3	S	S	S	W	M	S	M	W
CO4	S	S	S	W	M	S	S	S
CO5	S	S	M	S	W	S	M	M

S-Strong, M-Medium, W-Weak.

Unit-I:

Sequences and series of functions: Discussion of main problem, Uniform convergence, Uniform convergence and Continuity, Uniform convergence and Integration. (7.1 to 7.16 of Chapter 7 of the Text Book)

Learning Outcomes: Upon completion of this unit, the student will be able to Recognize the difference between point wise and uniform convergence of sequences of functions and illustrate the effect of uniform convergence on the limit function with respect to continuity, and integrability.

Unit-II:

Uniform Convergence and Differentiation, Equicontinuous families of functions, Stone- Weierstrass theorem. (7.17 to 7.27 of Chapter 7 of the Text Book)

Learning Outcomes: Up on completion of this unit, the student will be able to Illustrate the effect of uniform convergence on the limit function with respect to differentiability. Study the Stone- Weierstrass theorem and its applications.

Unit-III:

Algebra of functions, Power series, Exponential and logarithmic functions,Trigonometric functions. (7.28 to 7.33 of Chapter 7 and 8.1 to 8.7 of Chapter 8 of the Text Book)

Learning Outcomes: Upon completion of this unit, the student will be able to:

Understand the properties of power series. Study the Exponential, Logarithmic and Trigonometric functions.

Unit-IV:

Lineartransformations,Differentiation,Contraction principle, Inverse function theorem.

(9.1 to 9.25 of Chapter 9 of the Text Book)

Learning Outcomes: Upon completion of this unit, the student will be able to:

Compute derivatives and integrals of real valued and vector- valued functions of several variables. Understand and apply the inverse function theorem.

Unit-V:

Implicit function theorem, Determinants, Derivatives of higher order, Differentiation of integrals.

(9.26 to 9.29 and 9.33 to 9.43 of Chapter 9 of the Text Book)

Learning Outcomes: Upon completion of this unit, the student will be able to Understand and apply the implicit function theorem. Compute the derivatives of higher order and differentiation of integrals.

TEXT BOOK: Principles of Mathematical Analysis by Walter Rudin, 3rd Edition.

REFERENCE BOOK:

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

Course Outcomes: After completing this course, the student will be able to Learn about the uniform behaviour of sequences of plane curves and learn the Weierstrass approximation theorem provides techniques to approximate a continuous function on a compact interval with a polynomial while stones generalization explains method for extension of this concept in the context of algebras. The student shall be able to appreciate the role of fixed point theorem in the inverse function theorem. The student is further introduced to the way in which the inverse function theorem is involved while proving the famous implicit function theorem.

M303(24): FUNCTIONAL ANALYSIS

Course type: Theory **Course category: Core** **Credits:4**

Course Objectives/Outcomes:

At the end of the course, the students will be able

CO1:To introduce basic concepts of Functional Analysis namely normed spaces, bounded linear functional.

CO 2: To study their applications and also to introduce fundamental results in Functional Analysis.

CO3:To understand the Hahn-Banach Theorem, open mapping theorem and closed graph theorem.

CO 4: To describe strong and weak convergences.

CO5: To describe reflexive spaces, Category theorem and uniform boundedness principle,

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	M	S	S	S	M	S
CO2	M	S	S	S	W	S	S	S
CO3	S	S	S	W	S	S	W	S
CO4	M	S	M	M	S	S	S	S
CO5	S	M	M	S	S	S	S	W

S-Strong, M-Medium, W-Weak.

Unit-I:

Review of properties of Metric spaces (Chapter-1);Vector space - Normed spaces, Banach space - Further properties of normed spaces - Finite dimensional normed spaces- compactness and finite Dimension.

(2.1to 2.5 of Chapter2)

Learning outcomes: Upon completion of this unit, the student will be able to: Understand basic properties of finite dimensional normed spaces.

Unit-II:

Linear operators- Bounded and continuous linear operators- Linear functionals- Linear operators and functionals on Finite dimensional spaces- Normed spaces of operators, Dual Space.(2.6 to 2.10 of Chapter 2)

Learning outcomes: Upon completion of this unit, the student will be able to: Analise boundedlinear operators and functionals of finite dimensional normed spaces.

Unit-III:

Banach fixed point theorem- Applications of Banach fixed point theorem to linear equations and differential equations–Zorn's lemma - Hann Banach theorem- Hann Banach theorem to complex vector spaces and normed spaces.

(5.1to 5.3 of Chapter5 and 4.1to4.3of Chapter4)

Learning outcomes: Upon completion of this unit, the student will be able to: Demonstrate the knowledge of Banach fixed point theorem and apply it to linear and differential equations. Also analyze the Hahn-Banach theorem is different spaces.

Unit-IV:

Applications to bounded linear functionals on C[a, b] - Adjoint Operator- Reflexive spaces-Category theorem and Uniform boundedness theorem.

(Sections 4.4 to 4.7 of Chapter 4)

Learning outcomes:Upon completion of this unit, the student will be able to: Describe reflexive spaces, Category theorem and uniform boundedness principle,

Unit-V:

Strong and weak convergence-Convergence of sequences of operators and functionals-Open mapping theorem- Closed graph theorem

(Sections4.8,4.9,4.12 and 4.13of Chapter 4).

Learning outcomes: Upon completion of this unit, the student will be able to: Describe strong and weak convergences, open mapping theorem and closed graph theorem.

TEXT BOOK:

Introductory Functional analysis with applications by Erwin Kreyszig, John Willy and sons.

Reference Books:

1) Introduction to Topology and Modern Analysis by G.F. Simmons, McGraw Hill Book Company, New York International student edition.
2) Introduction to Functional Analysis, by A. E. Taylor, Wiley, NewYork,1958.

M304(A)(24):FUZZYSETS AND THEIR APPLICATIONS

Course type: Theory **Course category: Elective -I** **Credits:4**

Course Objectives/ outcomes:

At the end of the course, the students will be able

CO1: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.

CO3: To study Fuzzy numbers and arithmetic operations on fuzzy numbers and lattice of Fuzzy numbers.

CO4: To introduce basic concepts of fuzzy relations, particularly binary fuzzy relations and fuzzy equivalence relations.

CO5:To perform operations on fuzzy compatibility relations and fuzzy ordering relations.

Mappings of PO's with CO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S		S	S	S		S
CO2	S	S	S	S	M	S	M	S
CO3	S	S	M	S	S	S		S
CO4	S	S		M	S	S	S	S
CO5	M			S	S	S	S	

S-Strong, M-Medium, W-Weak.

Course Specific Outcomes: (3-5)

CSO1:Will be able to understand different types of fuzzy sets and their properties

CSO2:The students can understand various operations on fuzzy sets and fuzzy arithmetic

CSO 3: To study the fuzzy relations, linguistic variables and fuzzy equations

Unit-1:

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. (Sections 1.1-1.5 of Chapter -1 of text book)

Fuzzy sets versus Crisp sets: Additional Properties of α-cuts, Representations of Fuzzy sets, Extension principle for Fuzzy sets (Sections 2.1-2.3 of Chapters 2 of Text book).

Learning outcomes: Upon completion of this unit, the student will be able to: Understand the basic concepts of fuzzy sets, properties of α-cut sets and extension principle of fuzzy sets.

Unit-II:

Operations on Fuzzy sets: Types of Operations, Fuzzy Compliments, Fuzzy Intersections: t-Norms, Fuzzy unions: t- Conorms, Combinations of operations, Aggregation Operations (Sections 3,1-3.6 of Chapter-3 of Text book).

Learning outcomes: Upon completion of this unit, the student will be able to: Describe fuzzy compliments, fuzzy intersections and fuzzy unions.

Unit-III:

Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals, Arithmetic Operations on Fuzzy numbers, Lattice of fuzzy numbers, Fuzzy equations (Sections 4.1-4.6 of Chapter 4 of Text book).

Learning outcomes: Upon completion of this unit, the student will be able to: Understand the concept of fuzzy arithmetic.

Unit-IV:

Fuzzy Relations: Crisp versus fuzzy relations, Projections and Cylindric Extensions, Binary Fuzzy Relations, Binary Relations on a Single set, Fuzzy Equivalence Relations, Fuzzy Compatibility Relations. **(**Sections 5.1-5.6 of Chapter 5 of Text book).

Learning outcomes: Upon completion of this unit, the student will be able to: Determine the difference between crisp relations, fuzzy relations and understand the concepts of fuzzy compatibility relations and fuzzy ordering relations.

Unit-V:

Fuzzy Ordering Relations, Fuzzy Morphisms, Sup- i Compositions of Fuzzy Relations, Inf- ω_i Compositions of fuzzy Relations.(Sections 5.7-5.10 of Chapter 5 of Text book).

Learning outcomes: Upon completion of this unit, the student will be able to: Fuzzy Ordering Relations, Fuzzy Morphisms, Sup- I Compositions of Fuzzy Relations, Inf- ω_i Compositions of fuzzy Relations.

TEXT BOOK: "Fuzzy sets and Fuzzy Logic, Theory and Applications", G.J.Klir & B.YUAN, Prentice - Hall of India Pvt. Ltd., New Delhi., 2001.

REFERENCE BOOK: "Fuzzy sets and Their Applications" by R. Pundir, S.K. Pundir.

Course outcomes: After completing this course, the student shall be able to: Understand the basic concepts of fuzzy sets, fuzzy arithmetic and fuzzy relations. Construct the appropriate fuzzy numbers corresponding to uncertain and imprecise collected data and also determine the concepts of fuzzy compatibility relations, fuzzy ordering relations and fuzzy morphisms.

M304(B)(24): SEMI GROUPS

Course type: Theory **Course category: Elective -I** **Credits:4**

Course Objectives/ outcomes: (5-8)

At the end of the course, the students will be able

CO1:To understand basic ideas of semi groups, monogenic semi groups, ordered sets, semi lattices and lattices. Further Binary and Equivalence relations and some results are established.

CO2:To introduce some special class of congruence relations, correspondence between ideals and congruences, lattice of equivalences and congruences, etc.

CO3:To study Green' equivalences and structure of these classes.

CO4:To understand some special semi groups like Regular semigrops,0-simple semi groups,

CO5:To learn Congruences on completely 0-simple semi groups. The lattice of congruences on a completely 0-simple semi group, Finite congruence free semi groups.

MappingsofPoswithCOs:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO7	PO8
CO-1	S	S	S	S	S	S	M	S
CO-2	S	S	S	S	S	W	S	S
CO-3	S	S	W	S	S	W	S	M
CO-4	S	S	W	S	S	W	M	S
CO-5	S	S	W	S	S	W	S	S

S-Strong, M-Medium, W-Weak.

Course Specific Outcomes: (3-5)

CSO1: To understand properties of semi groups.

CSO2:To develop explicit description on congruences.

CSO3:To classify finite congruence-free semi groups without zero.

Unit-I:

Basic Definitions, Monogenic Semi groups, Ordered Sets, Semi lattices and Lattices, Binary Relations, Equivalences. (Sections 1.1-1.4 of Chapter- I).

Learning outcomes:Upon completion of this unit, the student will be able to: understand basic definitions of Semi groups, Semi lattices and Lattices, and their basic Results.

Unit-II:

Congruences, Free Semi groups and Monoids: Presentations, Ideals and Rees Congruences, Lattices of Equivalences and Congruences equivalences. (Sections 1.5 to1.8 of Ch. 1).

Learning outcomes:Upon completion of this unit, the student will be able to: Understand Free Semi groups, Ideals and Lattice's of equivalences.

Unit-III:

Green's equivalences, The structure of D.Classes –Regular D-Classes, Regular Semi groups. (Sections 2.1-2.4 of Chapter 2).

Learning outcomes: Upon completion of this unit, the student will be able to: Green's equivalences, find Structure of D. Classes and regular semi groups.

Unit-IV:

Simple and Q-Simple Semi groups; Principle Factors, Rees'sTheorem, Completely Simple semi groups, Isomorphism and Normalization. (Sections 3.1-3.4 of Chapter 3).

Learning outcomes: Upon completion of this unit, the student will be able to: Analyze Simple and 0-Simple Semi groups, and Rees's Theorem and Isomorphism.

Unit-V:

Congruences on Completely 0- Simple semi groups, The Lattice of Congruences on a Completely 0-Simple Semi group, Finite Congruence- Free Semi groups. (Sections 3.5-3.7 of Chapter 3).

Learning outcomes:Upon completion of this unit, the student will be able to: Describe Congruences on Completely O-Simple Semi groups and Finite Congruences.

TEXTBOOK: "An Introduction to Semi Group Theory", J.M.Howie , Academic Press.

REFERENCE BOOK: **Theory of Semi Groups and Applications**" by Kalyan B. Sinha, SachiSrivastava, Hindustan book Agency, Springer Edition.

Course out comes: The student realizes the richness of properties enjoyed by Semi groups, an algebraic structure with fewer facilities than Groups.

M304(C)(24): NUMBER THEORY

Course type:Theory **Course category: Elective -I** **Credits: 4**

Course Objectives/Outcomes (5-8)

At the end of the course, the students will be able

CO 1:To introduce arithmetical functions and explore their role in the study of distribution of primes.

CO2: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 use the Lagrane theorem, Fermat's theorem, Chinese remainder theorem.

CO5: To solve congruence's of various types and use the theory of congruences in applications..

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	S	M	M	S	W	S
CO2	S	S	S	M	S	S	S	S
CO3	S	W	S	S	S	S	S	S
CO4	S	W	S	M	S	M	S	W
CO5	S	W	S	S	S	S	S	S

S-Strong, M-Medium, W-Weak.

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.

CSO3: To study the properties of group characters and Dirichlet characters and understand the prime number theorem and Dirichlet theorem on primes in progression.

Unit-I:

ARITHMETICAL FUNCTIONS AND DIRICHLET MULTIPLICATION: Introduction,

The Mobius function$\mu(n)$, The Euler Totient function $\varphi(n)$, A relation connecting φ and μ, A product formula for $\varphi(n)$, The Dirichlet product of arithmetical functions, Dirichlet inverses and Mobius inversion formula.(Sections 2.1-2.7 of Ch 1)

Learning outcomes: Upon completion of this unit, the student will be able to: Define and interpret the concepts of divisibility, congruence, Dirichlet product.

Unit-II:

ARITHMETICALFUNCTIONSANDDIRICHLETMULTIPLICATION:

The Mangoldt function $\Lambda(n)$, Multiplicative functions, Multiplicative functions and Dirichlet multiplication,Theinverseofacompletelymultiplicativefunction,Liouville'sfunction$\lambda(n)$,The

divisor function$\sigma_z(n)$. Generalised convolutions.(Sections 2.8-2.14 of Ch1)

Learning outcomes: Upon completion of this unit, the student will be able to: Define and interpret the concept multiplicative functions and Generalised convolutions.

Unit-III:

AVERAGESOF 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 divisor functions $\sigma_z(n)$, The average order of $\varphi(n)$, An application to the distribution of lattice points visible from the origin, The average order of $\mu(n)$ and $\Lambda(n)$, The partial sums of a Dirichlet product, Applications to $\mu(n)$ and $\Lambda(n)$, Another identity for the partial sums of a Dirichlet product.

Learning outcomes: Upon completion of this unit, the student will be able to: Understand the concepts of averages of arithmetical functions, prove and apply properties of multiplicative functions such as the Euler's phi function and of residues modulo n.

Unit-IV:

SOME ELEMENTARY THEOREMS ON THE DISTRIBUTION OF PRIME NUMBERS:

Introduction, Chebyshev's functions $\psi(x)$and **I**(x). Relations connecting $\psi(x)$ and **I**(x), Some equivalentformsoftheprimenumbertheorem,Inequalitiesof$\pi(n)$and$\mathbf{p_n}$,Shapiro's Tauberian theorem, Application of Shapiro's theorem, An asymptotic formulae for the partial sums$\sum(1/p)$.

Learning outcomes: Upon completion of this unit, the student will be able to: Understand Chebyshev's functions $\psi(x)$and I(x) and the Relations connecting I(x) and $\pi(x)$, Some equivalent forms of the prime number theorem, Inequalities of $\pi(n)$ and pn, to study some applications of Shapiro's Tauberian theorem.

Unit-V:

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

Learning outcomes: Upon completion of this unit, the student will be able to: Solve congruences of various types and use the theory of congruences in applications.

PRESCRIBED BOOK: "**Introduction to Analytic Number Theory",** Tom M.Apostol, Narosa Publishing House, New Delhi.

REFERENCE BOOK: "Elementary Number Theory" by David M. Burtron, Mc Graw Hill.

Course outcomes: After completing this course the student able to: Understand the properties of divisibility and prime numbers, compute the greatest common divisor and least common multiples, operations with congruences and use the Lagrane theorem, Fermat's theorem, Chinese remainder theorem.

M305(A)(24): MATHEMATICAL BIOLOGY

Course type: Theory **Course category: Elective-II** **Credits:4**

Course Objectives/Outcomes:

At the end of the course, the students will be able

CO1:To learn about autonomous differential equations and nature of their solutions

CO 2:To construct and analyse various growth and harvest models

CO3:To gain knowledge on phase plane analysis and study the cyclic nature associated with various real world problems

CO4:To understand the dynamics that exists between species with distinctive interactions such as prey-predator, competitive and cooperative.

CO5: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	PO7	PO8
CO1	S	S	W		S	S	S	M
CO2	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	M	S	S

S-Strong,M-Medium,W-Weak.

Course Specific Outcomes: (3-5)

CSO1: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

CSO3:To be able to apply the skills gained in this course to problems pertaining real world and provide solutions

Unit I:

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

Learning out comes: Upon Completing this unit, students will be able to: Understand the concept of single species growth models involving exponential logistic and Gompertz growths. Harvest models, bifurcations and break points, Convert verbal descriptions of biological systems into appropriate mathematical models amenable to quantitative and qualitative analysis, and Develop the ability to explain mathematical results in language understandable by biologists.

Unit II:

LotkaVolterra 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.(Sections7and 8 of the text book).

Learning out comes: Upon completing this unit students will be able to: Understand the concept of Lotka Volterra predator, pry model, phase palne analysis and applications of Bendixson-Dulac's negative criterion, Identify the equilibrium points and study the phase portrait analysis of predator prey model, and Perform elementary mathematical analysis of models introduced and interpret conditions obtained from the analysis, usually taking the form of relationships between model parameters-that correspond to specific model behavior, and express the ramifications for the biological process being considered.

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- (Sections 9 and 10 of the text book).

Learning out comes: Upon completing this unit, students will be able to: Understand the concept of Global bifurcations in predator prey model, Gobal bifurcations using Allee effect in prey-competition models and applications, Understand and apply the concept of stability of a fixed point solution of a system of ordinary differential equations, Analyze the model with graphical representation and give biological interpretation.

Unit IV:

Lotka- Voltrrra Competition model- exploitation competition models. Mutualism models- various types of mutualisms- cooperative systems- Harvest models and optimal control theory (Sections 11 and 12 of the text book).

Learning out comes: Upon competing this unit, students will be able to: Analyze ODE models for the populations of two interacting species, Identify equilibrium points and using information about their linear stability to characterize the long-term behavior of the system, Analyze the model with graphical representation and give biological interpretation.

Unit V:

Open access fishery- sole owner fishery- Pontryagin's maximum principle- Economic interpretation of Hamiltonian and adjoint variable. (Sections 13 and 14 of the text book)

Learning out comes: Upon completing this unit, students will be able to: Understand the concepts of open access fishery, sole owner fishery, Apply Pontryagin's maximum principle to open access fishery, sole owner fishery, Analyze economical interpretation for sole owner fishery.

Text book: MarkKot,2001,ElementsofMathematicalEcology, Cambridge University Press.

Reference:

NisbetandGurney,1982,Modeling Fluctuating Populations, JohnWiley & Sons.

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

Course outcomes: On successful completion of this course the students will be able to:

1) Read, situate, and understand research papers in the area of mathematical biology.
2) Prepare to discuss specific biological systems with life scientists, and in particular communicate efficiently how values of model parameters can impact the qualitative behavior of the system..

3) Solve mathematically and interpret biologically simple problems involving one and two species ecosystems, epidemics and biochemical reactions.
4) Analyze the model with graphical representation and give biological interpretation for competition models, mutualism models.
5) Analyze economical interpretation for open access fishery, solve owner fishery models using pontryagin's maximum principle.

M305(B)(24):LINEAR PROGRAMMING

Course type:Theory **Course category: Elective-II** **Credits:4**

Course Objectives/Outcomes:

At the end of the course, the students will be able

CO1:To formulate and solve a linear programming problem.

CO2:To develop problem solving skills and to acquire knowledge on basic concepts of in linear programming problems,

CO3:To understand the formulate and solve Transportation problems, Assignment problems and Job sequencing.

CO4:To Convert standard business problems into linear programming problems and can solve using simplex algorithm.

CO5:To understand and solve problems by using the Stepping-Stonealgorithm.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	M	S	S	S	S	S
CO2	S	S	S	W	M	S	S	S
CO3	S	M	M	S	S	S	S	S
CO4	S	S	S	M	S	S	S	S
CO5	S	S	S	S	S	S	S	S

S-Strong,M-Medium,W-Weak.

Unit-I:

Mathematical Back ground: Lines and hyper planes: Convex sets, convex sets and Hyper planes, convex cones. (Sections 2.19 to 2.22 of Chapter 2of [1]).

Theory of the simplex method: restatement of the problem, slack and surplus Variables, reduction of any feasible solution to a basic feasible solution, some definitions and notations, improving a basic feasible solution, unbounded solutions, optimality conditions alternative optima, Extreme points and basic feasible solutions. (Sections 3.1, 3.2, 3.4 to 3.10 of Chapter 3 of [1])

Learning outcomes: Upon completion of this unit, the student will be able to: Formulate and solve a linear programming problem.

Unit-II:

Detailed development and Computational aspects of the simplex method, The Simplex method, selection of the vector to enter the basis, degeneracy and breaking ties further development of the transportation formulas, the initial basic feasible solution-artificial variables, Tableau format for simplex computations, use of the tableau format, conversion of a minimization problem to a maximization problem, Review of the simplex method, illustrative examples. (Sections 4.1 to 4.5 & 4.7 to 4.11 of Chapter 4 of [1]).

Learning outcomes: Upon completion of this unit, the student will be able to: Convert standard business problems into linear programming problems and can solve using simplex algorithm.

Unit-III:

Transportation problems: Introduction, properties of the matrix A: the simplex Method and transportation problems, simplifications resulting from all $y_{ij}\alpha\beta = \pm 1$or 0, The Stepping-Stone algorithm.(Sections 9.1 to 9.7 of Chapter 9of [1]).

Learning outcomes: Upon completion of this unit, the student will be able to: Formulate and solve transportation problems.

Unit-IV:

Determination of an initial basic feasible solution, alternative procedure for computing z_{ij}-c_{ij}; duality (Sections 9.10 & 9.11 of chapter 9 of [1])

Learning outcomes: Upon completion of this unit, the student will be able to: Formulate and solve transportation problems by using the Stepping- Stone algorithm.

Unit-V:

The assignment problem: Introduction, description and mathematical statement of the problem, Solution using the Hungarian method, the relationship between transportation and assignment problems, further treatment of the assignment problem, the bottle neck assignment problem.(Sections 6.1 to 6.6 of Chapter-6 of [2])

Learning outcomes: Upon completion of this unit, the student will be able to: Formulate and solve the Assignment problem.

TEXT BOOK:

1) G.Hadley “Linear Programming” Addison-Wesley Publishing Company.
2) Benjamin Levand Howard J.Weiss “Introduction to Mathematical Programming” Edward Arnold Pub, London, 1982.

Course out comes: After completing this course, the student acquaints him(her) self in the mathematical methods for solving transportation problem and assignment problem.

M305(C)(24):CALCULUS OF VARIATIONS

Course type: Theory **Course category: Elective-II** **Credits:4**

Course Objectives/Outcomes:

At the end of the course, the students will be able

CO 1:To learn about method of variations with fixed boundaries

CO2:To learn about method of variations with moving boundaries

CO3:To gain knowledge on some specific variational problems such as those involving extremals with corners and one sided variations

CO4: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	PO7	PO8
CO1	S	S	S	S	M	S	S	W
CO2	S	M	S	S	S	S	S	S
CO3	S	S	S	S	W	W	S	W
CO4	S	S	M	S	S		S	S
CO5	S	S	S	S	S	S	S	S

S-Strong,M-Medium,W-Weak.

Course Specific Outcomes: (3-5)

CSO1:To appreciate the theory behind Calculus of variations

CSO2:To understand the significance of calculus of variations in the field of applicable mathematics

CSO3:To be able to apply the skills gained in this course to problems pertaining real world and provide solutions

Unit-I:

Variation and its properties- Euler's equation-Functionals of the form $\int_{x_0}^{x_1} F(x,y,y,....,yy^1,y^{1,1},...,y^1)dx.$ -Functionals dependent on higher order derivatives-Functionals Dependent on the functions of several independent variables.(Sections1-5 of Chapter6 of the prescribed text book).

Unit-II:

Variational problems in parametric form-some applications-An elementary problem with moving boundaries-Moving boundary problem for a functional of the form $\int_{x_0}^{x_1} F(x, y,z,y^1,z^1)dx.$ (Sections

6, 1,2 of chapter 7of the prescribed text book).

Unit-III:

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

Unit-IV:

Field of extremals-The functionF(x,y,p,y')-Transforming the Euler equations to the Canonical form. (Sections 1-3 of Chapter 8 of the prescribed text book)

Unit-V:

Constraints of the form $\Phi(x, y_1, y_2, \ldots, y_n) = 0$-Constraints of the form $\Phi(x, y_1, y_2, \ldots, y_n, y_1^1, y_2^1, \ldots, y_n^1) = 0$-Isoperimetricproblems.(Sections1-3 of Chapter 9 of the prescribed text book)

PrescribedText 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)

LO1:To appreciate the transition between functions and functional in terms of calculus.

LO 2:To comprehend the theory behind Calculus of variations

LO3:To realize 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.

Fourth Semester

M.Sc. MATHEMATICS

SEMESTER-IV

M401(24):NON-COMMUTATIVE RINGS

Course type:Theory **Course category :Core** **Credits:4**

Course Objectives/Outcomes:

At the end of the course, the students will be able

CO1:To introduce the concepts of primitive rings, and study the radicals completely reducible modules

CO2:To introduce the Artinian and Noetherian rings and study the concepts on lifting idempotents

CO 3: To determine structure of projective modules, injective modules.

CO4: To study the completering of quotients, rings of endomorphism of injective modules

CO5: To introduce the concepts of Tensor products of modules, Hom and functions exact Sequences.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	M	S	S	S	W	S
CO2	S	S	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	S
CO4	S	S	M	S	S	S	S	S
CO5	S	W	M	S	S	S	S	M

S-Strong,M-Medium,W-Weak.

UNIT-I:

Primitive Rings,Radicals,Completely reducible modules,(Sections3.1to3.3 of chapter 3).

Learning outcomes: Upon completion of this unit, the students will be able to understand primitive rings, radicals, completely reducible modules.

UNIT-II:

Completely reducible rings, Artinian and Noetherian rings, onlifting idempotents, (Sections 3.4 to 3.6 of chapter 3).

Learning outcomes: Upon completion of this unit, the students will be able to know the Artinian and Noetherian rings and prove the related concepts.

UNIT- III:

Local and semi perfect rings, projective modules, Injectivemodules,(Sections3.7ofchapter3& Sections 4.1 to 4.2 of chapter 4).

Learning outcomes: Up on completion of this unit, the students will be able to know Local and semi perfect rings and prove the proposition on projective modules, and Injective modules.

UNIT-IV:

The complete ring of quotients, Rings of endomorphism's of injective modules.

(Sections 4.3 to 4.4 of chapter 4)

Learning outcomes: Upon completion of this unit, the students will be able to know concept of complete ring of quotients, Rings of endomorphism's of injective modules.

UNIT-V:

Tensor products of modules, Hom and functors exact sequences(Sections5.1to5.3ofchapter5)

Learning outcomes: Upon completion of this unit, the students will be able to know the definition of tensor products, tensor product of modules, hom exact sequences.

TEXT BOOK:

J.Lambek "Lectures on Rings and Modules" ABlais dell book in pure and Applied Mathematics.

REFERENCE: "Introduction to Rings and Modules" Second Edition by Musili, Narosa Publication.

M 402 (24):GRAPH THEORY

Course type: Theory **Course category: Core** **Credits:4**

Course Objectives/Outcomes:

At the end of the course, the students will be able

CO 1: To understand the basic concepts of graphs and Euler graphs and study the concepts of walks, paths and circuits in a graph.

CO2: To understand the concepts of Hamiltonian graphs and obtain a solution for Travelling salesman problems. Study the properties of trees, pendent vertices, centers in a tree and also study rooted and binary trees.

CO 3: To find a minimal spanning tree for a given weighted graph. Understand the purpose of introduction of concepts like fundamental circuits and cut-sets in a graph.

CO 4: To understand the purpose of introduction of concepts like connectivity and separability. Study about Combinatorial Vs. geometric graphs, Planar graphs and also study about the Kuratowski's two graphs.

CO 5: To understand the detection of planarity and geometrical dual. Study modular arithmetic and Galois fields and also study the vector space associated with a graph.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	S	W	M	S	S	S
CO2	S	S	M	W	S	S	S	S
CO3	S	S	S	M	M	W	W	W
CO4	S	S	M	W	W	S	S	S
CO5	S	M	S	M	S	W	M	S

S-Strong, M-Medium, W-Weak.

Unit-I:

Paths and Circuits: Isomorphism, Sub graphs, A puzzle with multi colored cubes, Walks, Paths and circuits, Connected graphs, Disconnected graphs, Components, Euler graphs, Operations on graphs, More on Euler graphs.

(Sections2.1to 2.8 of chapter 2 of the Text Book.)

Learning Outcomes: Upon completion of this unit, the student will be able to Understand the basic concepts of graphs and Euler graphs and study the concepts of walks, paths and circuits in a graph.

Unit-II:

Hamiltonian Graphs: Hamiltonian paths and circuits, Traveling sales man problem.

Trees: Trees, Some properties of trees, Pendent vertices in a tree, Distance and centers in a tree, Rooted and binary trees, On counting trees.

(Sections 2.9 to 2.10 of Chapter 2 and 3.1to 3.6 of Chapter 3 of the Text Book.)

Learning Outcomes: Upon completion of this unit, the student will be able to Understand the concepts of Hamiltonian graphs and obtain a solution for Travelling salesman problems. Study the properties of trees, pendent vertices, centers in a tree and also study rooted and binary trees.

Unit-III:

Fundamental Circuits: Spanning trees, Fundamental circuits, Finding all spanning trees of a graph, Spanning trees in weighted Graphs.

Cut-sets: Cut-sets, All cut-sets in a graph, Fundamental circuits and cut-sets.

(Sections 3.7to 3.10 of Chapter 3and 4.1to 4.4 of Chapter 4 of the Text Book.)

Learning Outcomes: Upon completion of this unit, the student will be able to Find a minimal spanning tree for a given weighted graph. Understand the purpose of introduction of concepts like fundamental circuits and cut-sets in a graph.

Unit-IV:

Cut-vertices: Connectivity and separability, Network flows, 1- Isomorphism, 2-Isomorphism.

Planar Graphs: Combinatorial Vs. geometric graphs, Planar graphs, Kuratowski's two graphs, Different representations of a planar graph.

(Sections 4.5 to 4.8 of Chapter 4 and 5.1to 5.4 of Chapter 5 of the Text Book.)

Learning Outcomes: Upon completion of this unit, the student will be able to Understand the purpose of introduction of concepts like connectivity and separability. Study about Combinatorial Vs. geometric graphs, Planar graphs and also study about the Kuratowski's two graphs.

Unit-V:

Dual Graphs: Detection of planarity, Geometric dual.

Vector Spaces of a Graph: Sets with one operation, Sets with two operations, Modular Arithmetic and Galois fields, Vectors and Vector Spaces, Vector Space associated with a graph, Basis vectors of a graph.

(Sections 5.5 to 5.6 of Chapter 5 and 6.1to 6.6 of Chapter 6 of the Text Book.)

Learning Outcomes: Upon completion of this unit, the student will be able to Understand the detection of planarity and geometrical dual. Study modular arithmetic and Galois fields and also study the vector space associated with a graph.

TEXT BOOK:

"Graph Theory with Applications to Engineering and Computer Science" by 'NARSINGH DEO', Prentice Hall of India, Pvt Ltd., New Delhi, 1993.

REFERENCE:

"Graph Theory With Applications" by J.A. Bondy and U. S.R Murthy, M.C. Millan Press.

Course Outcomes: After completing this course, the student will be able to Understand the basic concepts of graphs, directed graphs, weighted graphs, trees, minimal spanning trees for a given graphs, Eulerian graphs, Hamiltonian graphs and apply the shortest path algorithm to solve some real life problems.

M403(24):NEAR- RINGS

Course type: Theory **Course Category: Core** **Credits:4**

Course Objectives/Outcomes:

At the end of the course, the students will be able

CO1:To introduce Near-rings and its basic concepts.

CO2:To know and understand direct products and sums of near-rings and also direct sums of ideals and chain conditions on ideals.

CO 3: To understand decomposition theorems in near-rings and prime and semi prime ideals of near-rings.

CO4: To understand and apply types of N-groups, modularity in near-rings.

CO5: To understand quasi regularity in near-rings and structure of primitive near-rings.

Mappings of Pos with COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	S	M	W	S	S	M
CO2	S	S	S	S	S	M	S	S
CO3	S	M	W	W	S	S	W	W
CO4	S	S	S	S	S	S	W	S
CO5	S	S	S	S	S	S	S	S

S-Strong,M-Medium,W-Weak.

Unit I

The Elementary Theory of Near-Rings

Fundamental definitions and properties:

Near-rings, N-groups, Substructures, Homomorphisms and ideal-like concepts, Annihilators and Generated objects. (Section (a) of Chapter- 1)

Learning outcomes: Upon completion of this unit, the student will be able to understand near- rings, sub near-rings, ideals and homomorphisms and the results based on these concepts.

Unit II

(a) Constructions: Products, direct sums and sub direct products

(b) Embeddings: Embeddings in M(Γ)

Ideal Theory

a) Sums:
   1. Sums and direct sums
   2. Distributive sums

b) Chain conditions

(Sections (b)(1)&(c)(1)ofChapter-1and Sections(a)&(b) of Chapter-2)

Learning outcomes: Upon completion of this unit, the student will be able to know and understand direct products and sums of near-rings and also direct sums of ideals and chain conditions on ideals.

Unit III

(c) Decomposition theorems

(d) Prime ideals

1. Products of subsets
2. Prime ideals
3. Semi prime ideals

(Sections(c)&(d)ofChapter-2)

Learning outcomes: Upon completion of this unit, the student will be able to understand decomposition theorems in near-rings and prime and semi prime ideals of near-rings.

Unit IV

(e) Nil and nilpotent

Structure Theory:

Elements of the structure theory

a) Types of N-groups
b) Change of the Near-ring
c) Modularity

(Section (e) of Chapter-2 and Sections (a), (b) & (c) of Chapter-3)

Learning outcomes: Upon completion of this unit, the student will be able to understand and apply types of N-groups, modularity in near-rings.

Unit V

Structure Theory:

d) Quasi regularity

Primitive Near-Rings:

(a) General

1. Definitions and elementary results
2. The centralizer
3. Independence and density

(b) 0-primitivenear-rings

(Section(d) of Chapter-3 and Sections(a)&(b) of Chapter-4)

Learning outcomes: Upon completion of this unit, the student will be able to understand quasi regularity in near-rings and structure of primitive near-rings.

Prescribed Book:

Near-Rings, The Theory and its Applications by Gunter Pilz, North-Holland Publishing Company, AMSTERDAM, Revised Edition, 1983

REFERENCE: "The Theory of Near Rings " by Robert Lockhart, Springer Edition.

M404(A)(24):ALGEBRAIC CODING THEORY

Course type: Theory **Course Category:Elective-I** **Credits:4**

Course Objectives/Outcomes:

At the end of the course, the students will be able

CO1:To understand the Effects of error correction and Detection and the concept of Maximum.

CO 2: To understand Basis, Dimension and Generating Matrices and Encoding.

CO3:To understand Parity-Check Matrices, solving problems On linear codes.

CO4:To understand and implement Hamming Codes, Extended Codes, The extended Golay Code, Decoding the extended Golay Code.

CO5:To understand Cyclic codes.

Mappings of COs with Pos:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO7	PO8
CO-1	M	S	M	S	S	W	S	S
CO-2	M	S	S	S	S	W	S	S
CO-3	S	W	S	W	S	S	M	M
CO-4	S	S	S	S	S	S	S	S
CO-5	S	S	M	S	S	S	S	S

S-Strong, M-Medium, W-Weak.

Unit-I:

Introduction to Coding Theory: Introduction, Basic assumptions, Correcting and Detectingerror patterns, Information Rate, The Effects of error Correction and Detection, Finding the most likely codeword transmitted, Some basic algebra, Weight and Distance, Maximum likelihood decoding, Reliability of MLD, Error- detecting Codes, Error- correcting Codes. (Sections 1.1-1.12 of Chapter 1).

Learning outcomes: Upon completion of this unit, the student will be able to: Understand the Effects of error correction and Detection and the concept of Maximum-Likelihood Decoding and Reliability of MLD.

Unit-II:

Linear Codes: Linear Codes, Two important subspaces, Independence, Basis, Dimension, Matrices, Bases for C= <S> and $C^{\perp}$, Generating Matrices and Encoding. (Sections 2.1-2.6 of Chapter 2).

Learning outcomes: Upon completion of this unit, the student will be able to: Understand Basis, Dimension and Generating Matrices and Encoding.

Unit-III:

Linear Codes: Parity- Check Matrices, Equivalent Codes, Distance of a Linear Code, Cosets, MLD for Linear Codes, Reliability of IMLD for Linear Codes. (Sections 2.7-2.12 of Chapter.2).

Learning outcomes: Upon completion of this unit, the student will be able to: Understand Parity-Check Matrices, solving problems On linear codes.

Unit-IV:

Perfect and Related Codes: Some bounds for Code, Perfect Codes, Hamming Codes, Extended Codes, The extended Golay Code, Decoding the extended Golay Code, The Golay code, Reed-Mullar Codes, Fast decoding for RM (1,m).(Sections 3.1-3.9 of Chapter 3).

Learning outcomes: Upon completion of this unit, the student will be able to: Understand and implement codes and source of information.

Unit-V:

Cyclic Linear Codes: Polynomials and Words, Introduction to Cyclic codes, Polynomials encoding and decoding, Finding Cyclic Codes, Dual Cyclic Codes.(Sections4.1-4.5ofChapter4).

Learning outcomes: Upon completion of this unit, the student will be able to: Understand Cyclic codes.

PRESCRIBED BOOK: "CODING THEORY-THE ESSENTIALS",D.G.Hoffman,D.A. Lanonard, C.C.Lindner, K.T.Phelps, C.A.Rodger, J.R.Wall, MarcelDekker Inc.

REFERENCE BOOK: "**Introduction to coding Theory",** J.H.VanLint**,** Springer Verlag.

Course outcomes: After completing this course, the student will be able to: learn some algebraic properties of certain types of codes that at widely used in Engineering.

M404(B)(24):LATTICE THEORY

Course type: Theory **Course Category: Elective-I** **Credits:4**

Course Objective/Outcomes:

At the end of the course, the students will be able

CO 1: To Understand partially ordered sets and Jordan Dedekind chain conditions.

CO-2:To study equivalent conditions for a lattice to become modular and distributive.

CO-3: To learn meet-representations of modular and distributive lattices.

CO-4:To understand the equivalent conditions for a complete Boolean algebra to become atomic.

CO-5: To study the properties of valuations of Boolean algebras.

Mappings of Cos with POs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO7	PO8
CO-1		S		S	S			
CO-2		S	S	S	M			
CO-3	S		M		S	S		
CO-4	S	S	S	S	S	S		
CO-5	M	S		S	S	S		

S-Strong,M-Medium,W-Weak.

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.

Unit-I:

Partly Ordered Sets:

Set Theoretical Notations, Relations, Partly Ordered Sets, Diagrams, Special Subsets of a Partly Ordered Set, Length, Lower and Upper Bounds, The Jordan–Dedekind Chain Condition, Dimension Functions. (Sections 1-9 of Ch I)

Learning outcomes: Upon completion of this unit, the student will be able to: Understand partially ordered sets and Jordan Dedekind chain conditions.

Unit-II:

Algebras, Lattices, The Lattice Theoretical Duality Principle, Semi Lattices, Lattices as Partly Ordered Sets, Diagrams of Lattices, Sub Lattices, Ideals, Bound Elements of a Lattice, Atoms and Dual Atoms, Complements, Relative Complements, Semi Complements, Irreducible Prime Elements of a Lattice, The Homomorphism of a Lattice, Axiom Systems of Lattices.(Sections 10-21 of Ch II)

Learning outcomes: Upon completion of this unit, the student will be able to: Analyze the relationship between posets and lattices, acquire knowledge of fundamental notions from lattice theory.

Unit-III:

Complete Lattices, Complete Sub Lattices of a Complete Lattice, Conditionally Complete Lattices, Compact Elements and Compactly Generated Lattices, Sub Algebra Lattice of an Algebra, Closure Operations, Galois Connections, Dedekind Cuts, Partly Ordered Sets as Topological Spaces.(Sections 22-29 of Ch III)

Learning outcomes: Upon completion of this unit, the student will be able to: Define and understand basic properties of complete lattices and conditionally complete lattices, closure operations and their applications.

Unit-IV:

Distributive Lattices, Infinitely Distributive and Completely Distributive Lattices, Modular Lattices, Characterization of Modular and Distributive Lattices by their Sub lattices, Distributive Sub lattices of Modular Lattices.(Sections 30-34 of Ch IV)

Learning outcomes: Upon completion of this unit, the student will be able to: Characterize modular and distributive lattices using the Dedekind criterions.

Unit-V:

The Isomorphism Theorem of Modular Lattices, Covering Conditions, Meet Representation in Modular and Distributive Lattices.(Sections 35-36 of Ch IV)

Boolean Algebras, De Morgan Formulae, Complete Boolean Algebras, Boolean Algebras and Boolean Rings. (Sections 42-46 of Ch VI)

Learning outcomes: Upon completion of this unit, the student will be able to: Characterize modular and distributive lattices using the Birkhoff and Understand Boolean algebras, Boolean rings.

PRESCRIBED BOOK: "IntroductiontoLatticeTheory",GaborSzasz,Acadamicpress.

REFERENCE BOOK: "LatticeTheory", G.Birkhoff, Amer.Math.Soc**.**

Course outcomes: After completing this course, the student shall be able to: attain some knowledge of basic concepts of structures with order relation, importance's of lattice and the relationship between Boolean algebras and Boolean Rings with unity.

M404(C)(24):OPERATOR THEORY

Course type: Theory **Course Category: Elective-I** **Credits:4**

Course Objectives / Outcomes:

At the end of the course, the students will be able

CO 1: To define Inner product spaces, Hilbert spaces, Orthogonal sets and sequences and prove related properties.

CO2:To discuss Legendre, Hermite and Laguerre polynomials, representation functions on Hilbert spaces.

CO3:Discuss general properties of compact linear operators and spectral properties and the results about operator equations.

CO4: To define and discuss Banach Algebras, Properties of Banach Algebras, Spectral Properties of Compact Linear Operators on Normed Spaces.

CO5: To investigate the solvability of certain equations involving a compact linear operator.

Mapping of Cos with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	M	S	S	S	S	S
CO2	S	S	M	M	M	S	S	W
CO3	S	S	S	S	M	S	S	S
CO4	S	S	S	S	S	M	S	S
CO5	S	S	S	W	S	M	S	S

S-Strong, M-Medium, W-Weak.

Unit-I:

Inner Product Space. Hilbert Space, Further Properties of Inner product Spaces, Orthogonal Complements and Direct Sums, Orthonormal sets and sequences, Series Related to Orthonormal sequences and sets. (Sections: 3.1 to 3.5 of Chapter 3)

Unit-II:

Total Orthonormal sets and sequences, Legendre, Hermite and Laguerre Polynomials, Representation of functionals on Hilbert Spaces, Hilbert-Adjoint Operator. (Sections: 3.6 to 3.9 of chapter 3)

unit-III:

Spectral theory in Finite Dimensional Normed Spaces, Basic Concepts, Spectral Properties of Bounded Linear Operators, Further Properties of Resolvent and Spectrum. (Sections: 7.1 to 7.4 of Chapter -7)

Unit-IV:

Banach Algebras, Further Properties of Banach Algebras, Compact Linear Operators on Normed spaces, Further Properties of Compact Linear Operators, Spectral Properties of Compact Linear

Operators on Normed Spaces.

(Sections:7.6 to7.7 of Chapter7 and Sections 8.1 to 8.3 of Chapter-8)

Unit-V:

Further Spectral properties of Compact Linear Operators, Operator Equations Involving Compact Linear Operators, Further Theorems of Fredholm type, Fredholm alternative. (Sections: 8.4 to 8.7 of Chapter -8)

TEXT BOOK:

INTRODUCTORY FUNCTIONAL ANALYSIS WITH APPLICATIONS: **Erwin Kreyszig**, John Wiley& Sons.

REFERENCE BOOKS:

1) Introduction to Topology and Modern Analysis by G.F. Simmons, McGraw Hill Book Company, New York International student edition.
2) Introduction to Functional Analysis, by A. E. Taylor, Wiley, NewYork,1958.

M405(A)(24):CLASSICAL MECHANICS

Course type: Theory **Course category: Elective-II** **Credits:4**

Course Learning Objectives:

This course helps to describe basic definitions of conservative and non-conservative systems. Students able to learn the Lagranges equations of motion, Hamiltons Principle and various Canonical transformations.

Course Objectives/Outcomes:

At the end of the course, the students will be able

CO 1: To understand Lagrange's equations of motion, holonomic and conservative system.

CO 2: To apply relation between Lagrange's and Hamilton's equation of motion.

CO3:To understand types of canonical transformation equations and exact differential conditions.

CO4: To understand and apply the relation between Lagrange's and poisson brackets.

CO5:To understand Jacobi's identity and poisson theorem and the harmonic oscillator problem.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	S	S	S	M	S	M
CO2	S	S	S	W	S	S	S	W
CO3	S	S	M	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S
CO5	S	S	S	W	S	S	S	S

S-Strong,M-Medium,W-Weak.

UNIT-I

Generalizedcoordinates,Velocities,Forces,Holonomicandnon-holonomicsystems,conservativeand non-conservative systems. Lagrange's equations of motion of holonomic (non- holonomic) and conservative (non-conservative) systems. (Sections 10.2 to10.10 of Ref.(1) and for problems Ref.(2))

UNIT-II

Hamilton's principle for holonomic (non-holonomic) and conservative (non-conservative) systems from Lagrange's equations of motion, Cyclic coordinates, Conservation theorems, Routh's procedure and Hamilton's equation of motion from variational principle and from modified Hamilton's Principle, Principle of least action for holonomic and non-holonomic systems.

(Sections 2.1,2.3,2.4,2.6,8.1to8.3,8.5 and 8.6 of Ref.(3))

UNIT-III

Canonical Transformations, Jacobi's theorem, Types of canonicaltransformation equations, Examples of C.T. Solution of Harmonic oscillator problem using canonical transformation, Symplectic approach to a canonical transformation, Infinitesimal canonical transformation, canonical transformations forma group, Exact differential condition.

UNIT-IV

Bilinear invariant condition. Poisson and Lagrange brackets and invariance of them under C.T, Relation between Lagrange and Poisson brackets. Conditions for C.T. in terms of Lagrange and Poisson brackets. (Sections 9.1 to9.4 of Chapter 9 of Ref.(3), relevant articles in Ref.(4) for UNIT-III & IV)

UNIT-V

Generalized equation of motion, Jacobi's identity and Poisson theorem, Infinitesimal canonical transformation in terms of Poisson Brackets, Poincare's theorem, Hamilton-Jacobi equation for Hamilton's Principal function. The Harmonic oscillator problem as an example of the Hamilton Jacobi method. (Section 9.4(Pages 399, 400, 402, 403), section 9.5(Pages 405, 406,407) of Ref.(2), sections 10.1,10.2 of Ref.(3)) Course Learning Outcomes:

This course helps the students to evaluate the relation between Lagranges and Hamiltons equations of motion And the relation between lagrange and Poisson brackets

Text Book:

1) "Text Book of Dynamics"byF.Chorlton, CBS Publishing and distributions, Seconed edition.
2) "An Elementary Treatise on the Dynamics of a Particle and of rigid bodies" by S.L.Loney, MacMillan Co., of India Ltd., Metric Edition(1975).
3) "Classical Mechanics" by H.Goldstein, Narosa Publishing House, Second Edition(1985). 4. "A Treatise on the analytical dynamics of particles and rigid bodies" by E.T.Whittaker, Fourth edition, Cambridge University Press, 1964.

M405(B)(24):BANACH ALGEBRA

Course type:Theory **Course category: Elective-II** **Credits:4**

Course Objectives/Outcomes:

At the end of the course, the students will be able

CO1:To understand the concept of Banach algebra and regular, singular elements topological divisors of zero and spectrum of an element in a Banach algebra.

CO2:To define spectral radius and have formula for spectral radius and its applications, semi simple Banach algebras.

CO3:To understand the structure of a commutative Banach algebra and Gelfand mapping.

CO4:To study the Gelfand mapping theorem and some of its consequences, Stone Banach Theorem.

CO5:To know and understand some special commutative Banach algebras.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	S	S	S	S	M	M
CO2	S	S	S	S	S	M	M	M
CO3	S	M	M	W	S	S	W	W
CO4	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	W	S	S

S-Strong,M-Medium,W-Weak.

UNIT-I

General preliminaries on Banach Algebras: The definition and examples - Regular and singular elements - Topological divisors of Zero.

Learning outcomes: Upon completion of this unit, the student will be able to: know basic notions in Banach algebras and examples of Banach algebras and understand regular and singular elements and topological divisors of zero in Banach algebras.

UNIT-II

The spectrum-The formula for the spectral radius.

Learning outcomes: Upon completion of this unit, the student will be able to: understand the spectrum spectral formula in Banach spaces.

UNIT-III

The radical and the semi-simplicity - The structure of commutative Banach Algebras: The Gelfand mapping.

Learning outcomes: Upon completion of this unit, the student will be able to: understand the radical

And semi-simplicity of Banach algebras and the structure of the commutative Banach algebras.

UNIT-IV

Applications of the formula r (x)=limllx^{n}ll$^{1/n}$-Involutions in Banach Algebras :The Gelfand-Neumark theorem.

Learning out comes: Upon completion of this unit, the student will be able to: apply spectral formula and understand involutions in Banach algebras.

UNIT-V

Some special commutative Banach Algebras: Ideals in C(x) and the Banach- Stone theorem The stone- Cech compactification - commutative C* - algebras.

Learning outcomes: Upon completion of this unit, the student will be able to: know and understand some special commutative Banach algebras.

Text Book: Introduction to Topology and Modern Analysis-By G.F.Simmons-Tata McGraw - Hill Edition, 2004.

Reference Books:

1) E.Kaniuth, A Course in Commutative Banach Algebras, Springer, NewYork,2009.
2) R.Larsen, Banach Algebras,Marcell-Dekker,1973.
3) Banach Algebras and Automatic Continuity, London Mathematical Society, Monographs, 2001.

M405(C)(24): OPERATIONS RESEARCH

Course type: Theory **Course Category: Elective-II** **Credits:4**

Course Objectives / Objectives:

At the end of the course, the students will be able

CO1:To develop problem solving skills of linear programming problems using Two-Phase method artificial variables.

CO2:To find the dual of an LPP and solve the Problem.

CO3:To solve a linear programming problem using Revised Simplex Method.

CO 4: To solve Linear programming problems and game theory problems.

CO5:To understand and Solve Goal programming problems and integer programming problems.

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	M	S	S	W	S	S	M
CO2	S	M	S	S	M	S	S	S
CO3	S	W	M	S	S	S	S	S
CO4	S	M	S	S	S	S	S	S
CO5	S	S	M	S	S	S	M	S

S-Strong,M-Medium,W-Weak.

UNIT-I

Further Discussion of the simplex method: Further discussion; the two phase Method for artificial variables; phase-I; Phase-II; Numerical examples of the two phase method.

[Sections 5.1to5.4ofChapter-5of [1]]

Learning outcome: Upon completion of this unit, the student will be able to: Solve the LPP using the two phase method.

UNIT-II

Duality theory and its Ramifications: Alternative formulations of linear programming problems; Dual linear programming problems; Fundamental properties of dual problems; other formulations of dual problems; unbounded solution in the primal; the dual simplex algorithm-an example. Post optimality problems, changing the price vector, changing the requirements vector, adding variables or constraints

(Sections8.1to8.7; 8.10 of Chapter 8 and 11.2 to 11.5 Chapter11of [1]).

Learning outcome: Upon completion of this unit, the student will be able to: Find the dual of an LPP and solve the Problem.

UNIT-III

The Revised simplex method: Introduction; Revised simplex method-standard form I; computational procedure for standard form I; Revised simplex method-

Standard form II; computational procedure for standard form II; Initial identity

Matrix for phase-I; comparison of the simplex method and Revised simplex method.

(Sections 7.1 to 7.6 & 7.8 of Chapter 7 of [1]).

Learning outcome: Upon completion of this unit, the student will be able to: Solve a linear programming problem using Revised Simplex Method.

UNIT-IV

Game theory: Game theory and Linear programming; Introduction; reduction of a game to a linear programming problem; conversion of a linear programming problem to a game problem.(Sections 11.2 to 11.14 of Chapter 11 of [1])

Learning outcome: Upon completion of this unit, the student will be able to: Solve Linear programming problems and game theory problems.

UNIT-V

Goal programming, Integer programming: Introduction; Gomory'scut, Balas Implicit Enumeration Technique, Goal programming.

(Sections7.1,7.2 and 7.4 of Chapter 7 and Section10.3 of Chapter10 of [2])

Learning outcome: Upon completion of this unit, the student will be able to: Understand and Solve Goal programming problems and integer programming problems.

TEXTBOOKS:

1) **G.Hadley** "Linear programming"Addison Wesley Publishing Company.
2) **Benjamin Lev and Howard J. Weiss** "Introduction to Mathematical Programming" Edward Arnold Pub, London, 1982.

Course outcomes: After completing this course, the student shall learn in detail, about the Simplex method, Revised simplex method and the relation between Game theory and linear programming.

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