M.Sc. Mathematics

Syllabus [w.e.f. 2020-2021 Admitted Batch]

COURSE STRUCTURE

Sl.No.	Subject code	Name of the Subject	Number of Periods per Week	Credits
		I-SEMESTER		
1	20 MAT101	Real Analysis	4	4
2	20 MAT 102	Ordinary Differential Equations	4	4
3	20 MAT 103	C-Programming	4	4
4	20 MAT 104	Algebra	4	4
5	20 MAT 105	Practical(of Four Theory Papers)	8	4
6	20 MAT 106	C-Programming Lab	8	4
		Total:	32	24
		II-SEMESTER		
7	20 MAT 201	Complex Analysis	4	4
8	20 MAT 202	Numerical Methods	4	4
9	20 MAT 203	Partial Differential Equations	4	4
10	20 MAT 204	Lattice Theory	4	4
11	20 MAT 205	Practical(of Four Theory Papers)	8	4
12	20 MAT 206	Numerical Methods Lab	8	4
13	20 OEMAT 207	Open Elective-I	4	4
		Total:	36	28
		III-SEMESTER		
14	20 MAT301	Topology	4	4
15	20 MAT 302	Probability and Statistics	4	4
16	20 MAT 303	Galois Theory	4	4
17	20 MAT 304	Mathematical Methods	4	4
18	20 MAT 305	Practical(of Four Theory Papers)	8	4
19	20 MAT 306	User Friendly Software Development / MATLAB/ Python Lab	8	4
20	20 OEMAT 307	Open Elective-II	4	4

		Total:	36	28
		IV- SEMESTER		
21	20 MAT401	MOOCS	4	4
22	20 MAT 402	Elective-I	4	4
23	20 MAT 403	Elective-II	4	4
24	20 MAT 404	Functional Analysis	4	4
25	20 MAT 405	Practical(of Four Theory Papers)	8	4
26	20 MAT 406	Seminar	8	4
		Total:	32	24

Elective-I	Elective-II
20 MAT402A: Measure and Integration	20 MAT 403A: Algebraic Coding Theory
20 MAT402B: Graph Theory	20 MAT 403B: Linear Programming
20 MAT402C: Real Analysis-II	20 MAT 403C: Analytical Number Theory
20 MAT402D:Rings & Modules	20 MAT403D:Discrete Mathematical Structures
20 MAT402E: Any other relevant subject approved by BOS	20 MAT 403E: Any other relevant subject approved by BOS

Instructions for evaluation

1. Each theory subject is evaluated for 100 Marks out of which 70 Marks through end examination and internal assessment would be for 30 Marks. The minimum marks for qualifying in theory subject shall be 40%.
2. End Examination Question Paper Pattern is as follows:

Sl. No.	Questions	Units of the Syllabus	Marks
1	Question1 (Ten short answer Questions, TWO from each unit)	Form UNIT-I to UNIT-V	10x2=20
2	Question2 (a) Or (b)	Form UNIT-I	10
3	Question3 (a) Or (b)	From UNIT-II	10
4	Question4 (a) Or (b)	From UNIT-III	10
5	Question5 (a) Or (b)	From UNIT-IV	10
6	Question6 (a) Or (b)	From UNIT-V	10
		Total:	70

Procedure to evaluate midterm examinations:

Theory:

Midterm Examinations –I & II	30 marks

The pattern for the mid examination: 30 marks will be divided into 10 marks of the objective (Short questions/MCQ & 30 minutes duration) and 20 marks descriptive (four questions each carries 5 marks' with internal choice for each question & 60 minutes duration)

***Note 1: If the final marks are in fraction, it shall be rounded off to the next number**

- If the student is absent for the mid-term examination, no re-exam shall be conducted

If the student failed to attend both the mid- term examinations, his/her aggregate marks shall be considered zero.

Note: Final mid semester marks shall be awarded as average of two mid examinations.

Example:

Marks obtained in first mid: 30
Marks obtained in second mid: 20
Final mid semester Marks: (30+20) = 50/2= 25

Practical/Lab:

*Continuous assessment/ Day to day work	End examination	Total
30 marks	70M	100M

***Continuous assessment format given below.**

Note: For practical courses, there shall be a continuous evaluation during the semester for 30 sessional marks and end examination shall be for 70 marks. Day-to-day work in the laboratory shall be evaluated for 30 marks by the concerned laboratory teacher based on the regularity/record/viva. Both day to day evaluation and two midterm should be finalized by 30 marks. The end examination shall be conducted by the concerned laboratory teacher and external examiner in the subject nominated by the university.

- Internal marks will be awarded by internal examiner only.

Template

Day to day evaluation sheet / Continuous Evaluation of Practicals

Course:**PG** Program:
Academic Year:
Subject with Code: Semester:
Subject Title:

		Experiment & Marks										**Total Marks (100)**	**Final Marks (30M)**
Student Roll. No	**Student Name**	**1 (10 M)**	**2 (10 M)**	3 (10 M)	4 (10 M)	**5 (10 M)**	**6 (10 M)**	**7 (10 M)**	**8 (10 M)**	**9 (10 M)**	**10 (10 M)**		

*Number of experiments varies from subject to subject. Each experiment carries 10M

Seminar:

The student will be given seminar topics at the beginning of the IV semester by faculty In-charge and the student has to present the topics, submit the hard copy of seminar topic report at the end of the IV semester. Out of a total of 100 marks, for the Seminar Evaluation, 50 marks shall be for Seminar report/record and 50 marks for the End Semester Examination (Viva-voce). The Viva- Voce shall be conducted by a committee consisting of HOD, faculty in charge and a senior faculty member/external examiner nominated by the university.

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REAL ANALYSIS-20MAT101

No. of Hours: 04 | Total credits: 04
Total Marks: 100 | (Internal: 30 M & External: 70 M)

Course Learning Objectives:
This Course is intended to expose the ideas of Real Analysis by Learning Continuity, Differentiation, Riemann Integral, Improper Integral of functions.

UNIT-I

Continuity & Differentiation: Limits of functions, continuous functions, Continuity and Compactness, Continuity and Connectedness, Discontinuities, Derivative of a Real Function, Mean value theorems, The Continuity of Derivatives, L' Hospital's rule, Derivatives of higher Order, Taylor's theorem.
[4.1 to 4.34 of chapter4 & 5.1 to 5.19 of chapter5 of Text Book1]

UNIT-II

The Riemann - Stieltjes Integral: Definition and Existence of Integral-Properties of the integral -Integration and Differentiation –Integration of vector-valued function - Rectifiable Curves.[Chapter-6 of Text Book-1]

UNIT-III

Sequences and series of functions: Discussion of main problem - Uniform convergence – Uniform convergence and continuity – Uniform Convergence and Integration – Uniform Convergence and Differentiation – Equicontinuous Families of functions – The Stone - Weierstrass Theorem.[7.1 to 7.26 of Text Book 1]

UNIT-IV

Improper Integrals: Introduction – Integration of unbounded Functions with Finite limits of Integrations – Comparison Tests for Convergence at ‘a’ of Infinite Range of $\int_a^b f dx$ Integration – Integrand as a Product of Functions. [Chapter-11 of Text Book-2]

UNIT-V

Functions of several variables: Explicit and Implicit Functions - Continuity - Partial Derivatives – Differentiability – Partial Derivatives of Higher Order - Functions of Functions – Change of variables – Taylor’s Theorem – Extreme Values - Maxima and Minima – Functions of Several Variables.[Chapter-15 of Text Book-2]

Course Learning Outcome(s):
This Course able to helps the student how to apply the concepts of Real Analysis and understand the Improper Integrals concept and to construct the Mathematical proofs of basic results in Real Analysis.

Prescribed Text books:

1. **Principles of Mathematical Analysis**, Walter Rudin, Student Edition 1976, McGraw-Hill International.
2. **Mathematical Analysis** by S.C. Malik and Savita Aurora, Fourth edition, New Age International Publishers,.

Reference Book:

1. **Mathematical Analysis** by Tom. M. Apostol, second Edition, Addison Weslay Publishing Company.

ORDINARY DIFFERENTIAL EQUATIONS-20MAT102

No. of Hours: 04 Total credits: 04
Total Marks: 100 (Internal: 30 M & External: 70 M)

Course Learning Objectives:
The goal of this course is to provide the students with an understanding of the solutions of first order and second order linear ordinary differential equations and applications of ordinary differential equations.

UNIT-I:
Linear Equation of the first order: Linear equations of the first order, The equation y' + ay = 0, The equation y' + ay = b(x), The general equations of the first order. Linear Equations with constant coefficients: The homogeneous equation of order n, Initial value problems for nth order equations.
[Chapter 1 of Text Book(1) and Section 7, 8 of Chapter 2 of Text book.(1)]
UNIT-II:
Linear Equations with Constant Coefficients: The non - homogeneous equation of order n, A special method for solving the non homogeneous equation. Linear equations with variable coefficients: Initial value problems for the homogeneous equations, Solution of the homogeneous equations, The Wronskian and linear independence.
[Sections 10,11 of Chapter 2 and Sections 1,2,3,4 of Chapter 3 of Text book(1)]

UNIT-III:
Solutions of Differential Equations in Power series: Preliminaries – Second order Linear Equations with Ordinary points – Legendre equations with Legendre Polynomials – Second Order equations with regular singular points – Properties of Bessel functions.
[Topics from Chapter 3 of Text Book(2)]

UNIT-IV:
Systems of Linear Differential Equations: Preliminaries - Systems of first order equations - Model of arms competitions between two nations - Existence and uniqueness theorem - Fundamental Matrix - Non homogeneous linear systems - Linear systems with constant coefficients.[Topics from Chapter 4 of Text Book(2)]

UNIT-V:
Existence and Uniqueness of solutions: Preliminaries – Successive approximations – Picard's theorem
[Chapter 5.1 to 5.4 of Text Book(2)]

Course Learning Outcome(s):

From this course students will be able to learn the study of differential focuses on the existence and uniqueness of solutions and the theory of differential equations is widely used in formulating many fundamental laws of physics and chemistry.

Text Book:

1. An introduction to Ordinary Differential Equations by E.A. Coddington
2. S.G. Deo, V. Lakshmi kantham and V. Raghavendra: Text Book of Ordinary Differential Equations, second edition, Tata McGraw – Hill Publishing company Limited, New Delhi, 1997.

Reference Books :

1. Differential Equations with applications and Historical notes by George F.Simmons.
2. Theory of Ordinary Differential Equations by Samsundaram – Narosa Publications.

C - PROGRAMMING -20MAT103

No. of Hours: 04 Total credits: 04
Total Marks: 100 (Internal: 30 M & External: 70 M)

Course Learning Objectives:
This course is designed to provide complete knowledge of C-language and able to develop the logics which will help them to create programs, applications in C.

UNIT-I
Over view of C - Constants - variables - Data types - operators and expressions.
[Chapters 2, 3&4 of the Text Book]
UNIT-II
Managing Input and output operations - Decision making – branching - decision making and looping.
[Chapters 5, 6& 7 of the Text Book]
UNIT-III
Arrays–one dimensional, two dimensional and multi dimensional- Handling of character strings
[Chapters 8 & 9 of the Text Book]
UNIT-IV
Functions- user defined functions-. Pointers-Pointers and arrays –Pointers and functions
[Chapters 10&11 of the Text Book]
UNIT-V
Structures and Unions-file management in C
[Chapter 12 and 13 of the Text Book]

Course Learning Outcome(s):
From this course students will be learn to implement the algorithms and draw flow charts for solving mathematical problems and understanding the concepts of computer programming language.

Prescribed Text Book:

1. **C Programming and Data Structures** – E. Balaguruswamy, Second Edition, Tata McGraw- Hill Publishing Company (We should verify 4th edition).

Reference Books:
1. **Fundamental of C Programming** by E.Balaguruswamy
2. **Programming in C** by D. Ravichandran, 1998, New Age International.
3. **C and Data Structures** by Ashok N. Karthane, Pearson Education.

ALGEBRA – 20 MAT 104

No. of Hours: 04 Total credits: 04
Total Marks: 100 (Internal: 30 M & External: 70 M)

Course Learning Objectives:
The objective of the course is to introduce the basic structures of algebra like groups, rings, fields, and vector spaces which are the main pillars of modern mathematics.

UNIT-I
Group Theory: Definition of a Group, Some Examples of Groups, Some Preliminary Lemmas, Subgroups, A counting Principles, Normal Subgroups and Quotient groups, Homomorphism,Automorphisms.
(2.1 to 2.8 of the prescribed book [1]).
UNIT-II
Group Theory Continued: Cayley's theorem, Permutation groups. Another counting principle.
(2.9 to 2.11 of the prescribed book [1]).
UNIT-III
Group Theory Continued: Sylow's theorem, Direct products, Finite abelian groups.
(2.12 to 2.14 of the prescribed book [1]).
UNIT-IV
Ring Theory: Definition and Examples of Rings, Some special classes of Rings, Homomorphism's, Ideals and quotient Rings, More Ideals and quotient Rings, The field of quotients of an Integral domain.
(3.1 to 3.6 of the prescribed book [1]).
UNIT-V
Ring Theory Continued: Euclidean rings, A Particular Euclidean ring, Polynomial Rings, Polynomials over the rational field, Polynomial Rings over Commutative Rings.
(3.7 to 3.11 of the Prescribed books [1]).

Course Learning Outcome(s):
From this course students will be able to learn the fundamental concept of algebra and their role in mathematics and applied contexts.

PRESCRIBED TEXT BOOK:

1. **Topics in Algebra** by I. N. HERSTEIN, Second Edition 1988, Wiley Eastern Limited. New Delhi.

REFERENCE BOOK:

1. **Basic Abstract Algebra** by BHATTACHARYA P. B., JAIN S. K., NAGPAUL S.R. Cambridge Press, Second Edition.
2. **Abstract Algebra** by David S Dummit and Richard M Foote , Wiley Publication, Third Edition.
3. **Introduction to rings and modules**, by C Musili, Narosa Publications

20MAT105-Practial(of Four Theory Papers)

No. of Hours: 08 | Total credits: 04

Total Marks: 100 | (Internal: 30M & External: 70M)

LIST OF PROBLEMS:

1. **Concepts on Continuity and Differentiation.**
2. **Problems on Improper Integrals.**
3. **Concepts on functions of several variables.**
4. **Concepts on uniform convergence.**
5. **Solve Linear Equation of First Order.**
6. **Solve Homogeneous and Non-homogeneous differential equations.**
7. **Solving differential equations in power series.**
8. **Finding Fundamental matrix of Non-homogeneous linear systems.**
9. **Write a program using Arrays.**
10. **Write a program using Structures & Unions.**
11. **Write a program using pointers.**
12. **Write a program using conditional loop.**
13. **Concepts of Normal subgroups and coefficient groups.**
14. **Concepts on Permutation groups.**
15. **Sylow's theorem concept.**
16. **Concepts of Ring Theory.**

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C- PROGRAMMING LAB-20MAT106-LAB

No. of Hours: 08 | Total credits: 04
Total Marks: 100 | (Internal: 30M & External: 70M)

LIST OF C – PROGRAMES :

1. Factorial of a number
2. Reverse of a number
3. GCD of two numbers using EUCLIDIAN algorithm
4. Fibonacci numbers up to "N"
5. Perfect numbers up to "N"
6. Prime numbers up to "N"
7. Sum of digits of a number
8. Number palindrome
9. Find the squares of first ten natural numbers using function
10. Find biggest of three numbers using function
11. Find biggest element in an array
12. Find Transpose of a Matrix
13. Sum of the matrices
14. Product of the matrices
15. To find String length using user defined function

COMPLEX ANALYSIS – 20 MAT 201

No. of Hours: 04 Total credits: 04
Total Marks: 100 (Internal: 30M & External: 70 M)

Course Learning Objectives:
This course helps to describe basic properties of complex integration and having the ability to compute integrals and decide the analytic function and able toexpand complex function in power series, finding complex integrals, using residues and having the ability of using Linear transformations .

UNIT-I
Analytic Functions: Limits- Continuity- Derivatives- Differentiation Formulas-Cauchy-Riemann Equations-Sufficient conditions for Differentiability-Polar Coordinates- Analytic Functions-Harmonic Functions
[Sec 18 to 26 of Chapter 2 of the Text Book]

UNIT-II
Integrals: Contours- Contour Integrals- Cauchy-Goursat Theorem- Proof of the theorem-Simply Connected Domains- Multiply Connected Domains- Cauchy Integral Formula- An extension of Integral Formula- Some Consequences of the extension-Liouville's Theorem and the Fundamental Theorem of Algebra
[sec 37 to sec 41 and sec 46 to sec 53 of chapter 4 of the Text Book]

UNIT-III
Series: Taylor's series – Proof of Taylor's theorem- Examples- Laurent's series – Proof of Laurent's Series- Examples.
[sec 57 to 62 of Chapter-5 of the Text Book]

UNIT-IV
Residues and Poles: Isolated singular points- Residues – Cauchy's residue theorem-Residue at Infinity- the three types of isolated singular points - Residues at poles, Zeroes of analytic function- Zeroes and Poles- Evaluation of improper integrals- Indented paths, An Indentation around a Branch point.
[sec 68 to 76 of chapter 6 and sec 78, 79,82,83 of chapter 7 of the Text Book]

UNIT-V
Argument principle- Rouche's theorem- Linear Transformations: The transformation $w=1/z$ - mappings by $w=1/z$ - Linear fractional transformations - The transformation $w=\sin z$, Mapping by Z^2.
[86&87 of chapter7, sec 90 to 93, 96 &97 of chapter 8 of the Text Book]

Course Learning Outcomes: This Course helps the student to evaluate complex integrals and expanding complex function in power series,advantage of residues and the application of linear transformation.

Text Book:

1. Complex Variables and Applications by James Ward Brown, RuelV.Churchill, McGraw- Hill InternationalEditions-Eighth Edition.

Reference Books:

1. Complex analysis for Mathematics and Engineering by John H.Mathews and Russel.W, Howell, NarosaPulishinghouse.
2. Complex Variables by H.S.Kasana, Prentice Hall ofIndia.

NUMERICAL METHODS-20MAT202

No. of Hours: 04 Total credits: 04
Total Marks: 100 (Internal: 30M & External: 70M)

Course Learning Objectives:
This Course is introduced a broad range of Numerical methods for solving Mathematical problems that arise in Science and Engineering and helps to choose, develop and apply the appropriate Numerical techniques for the Mathematical problems.

UNIT-I:

Transcendental and Polynomial Equations: Introduction - Bisection method - Iteration methods based on first degree equation - Secant method - Regulafalsi method - Newton Raphson method - Iteration method based on second degree equation - Rate of convergence of secant method - Newton Raphson method.
[Above topics are from Chapter-2 of the Text Book]

UNIT-II:

System Of Linear Algebraic Equation And Eigen Value Problems: Direct methods - Introduction - Gauss Elimination Method- Gauss – Jordan Method - Triangularisation method - Iteration Methods- Jacobi iteration Method - Gauss-Seidel Iteration Method - Eigen values and Eigen vectors.
[Above topics are from Chapter-3 of the Text Book]

UNIT-III:

Interpolation And Approximation: 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 - Hermite interpolation - Spline interpolation - Approximation:Least Square approximation.
[Above topics are from Chapter-4 of the Text Book]

UNIT-IV:

Numerical Differentiation and Integration: Introduction – Numerical differentiation: Methods based on finite differences.
[Above topics are from Chapter-5 of the Text Book]

UNIT-V:

Numerical integration: Composite integration methods-Trapezoidal rule- Simpsons rules – numerical solution of ODEs by picard – Euler - Modified Euler – RungeKutta methods.
[Above topics are from Chapter- 6 of the Text Book]

Course Learning Outcome(s):

From this Course Students are able to learn how to apply the Numerical method for various Mathematical operations and tasks such as Interpolation,Differentiation,Integration,the solution of Differential Equations analyses and evaluate the accuracy of common Numerical methods.

Text Book:

Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S. R. K. Iyengar, R. K. Jain, New Age International (p) Limited, Publishers, 5 th Edition.

Reference Book:

An Introduction to Numerical Analysis by Kendall E. Atkinson.

PARTIAL DIFFERENTIAL EQUATIONS -20MAT203

No. of Hours: 04 Total credits: 04
Total Marks: 100 (Internal: 30M & External: 70M)

Course Learning Objectives:
The goal of this course is provide the students with an understanding of the solutions of First and Second order Partial Differential Equations and applications of Partial Differential Equations.

UNIT-I

First Order PDE's: Introduction – Methods of solution of $\frac{dX}{P} = \frac{dy}{Q} = \frac{dz}{R}$ orthogonal trajectories of a system of curves on a surface- Pfaffian Differential forms and equations – Solutions of Pfaffian Differential Equations in three variables – Cauchy's problem for first order PDE. [Sections 3 to 6 of Chapter 1, Sections 1 to 3 of Chapter 2]

UNIT-II

Linear Equations of the first order – Integral Surfaces – Orthogonal Surfaces – Non-Linear PDE of the first order – Cauchy's method of characteristics – compatible systems of first order equations – Charpit's method – special types of first order equations – Jacobi's method [Sections 4 to 13 of Chapter 2]

UNIT-III

Partial differential equations of the second order, their origin, linear partial differential equations with constant and variable coefficients – solutions of linear Hyperbolic equations – Method of separation of variables – Monger's method.[Sections 1 to 5 and sections 8, 9, 11 of Chapter 3]

UNIT-IV

Laplace Equation – elementary solutions of families of equipotential surfaces, boundary value problems, method of separation of a variables of solving Laplace equation, problems with axial symmetry, Kelvin's inversion theorem.[Section 1 to 7 of Chapter 4]

UNIT-V

The wave equation, elementary solution in one dimensional form, Riemann – Volterra solution of one dimensional wave equation.[Sections 1 to 3 of Chapter 5]

[Problematic approach is Preferred]

Course Learning Outcome(s):
From this course Student will be able to learn the study of Partial derivatives on the Existence and Uniqueness of Solutions and theory of Differential Equations widely used in formulating wave equations and Laplace equations.

Prescribed Text Book:

1. **Elements of partial differential equations** by I. N. Sneddon, McGraw-Hill, international edition, Mathematics series.

Reference Book:

1. **An Elementary Course in Partial differential equations** byT. Amaranth, Second Edition, Narosa Publishing House.

LATTICE THEORY – 20 MAT204

No. of Hours: 04 | Total credits: 04
Total Marks: 100 | (Internal: 30 M & External: 70 M)

Course Learning Objectives:
The course mainly designs with the aim of introducing the Lattice theory and Boolean algebra, the portion of lattice theory discuss modular, distributive lattice.

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 Minimum and Maximum Conditions, The Jordan–Dedekind Chain Condition, Dimension Functions.
(Sections 1 to 9 of Chapter 1)

UNIT-II

Lattices in General: 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 and Prime Elements of a Lattice, The Homomorphism of a Lattice, Axiom Systems of Lattices.
(Sections 10 to 21 of Chapter 2)

UNIT-III

Complete Lattices: 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 to 29 of Chapter 3)

UNIT-IV

Distributive and Modular Lattices: 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, The Isomorphism Theorem of Modular Lattices, Covering Conditions, Meet Representation in Modular and Distributive Lattices.
(Sections 30 to 36 of Chapter 4)

UNIT-V

Boolean Algebras: Boolean Algebras, De Morgan Formulae, Complete Boolean Algebras, Boolean Algebras and Boolean Rings, The Algebra of Relations, The Lattice of Propositions, Valuations of Boolean Algebras.
(Sections 42 to 47 of Chapter 6)

Course Learning Outcome(s): From this course students are able to understand Lattices as Algebraic structures, Homomorphism between Lattices and Boolean algebra.

PRESCRIBED BOOK:

1. **Introduction to Lattice Theory,** Gabor Szasz, Academic press.

REFERENCE BOOK:

1. **Lattice Theory,** G. Birkhoff, Amer, Math. Soc.

20MAT205-Practial(of Four Theory Papers)

No. of Hours: 08 Total credits: 04
Total Marks: 100 (Internal: 30M & External: 70M)

LIST OF PROBLEMS:

1. **Cauchy – Riemann Equations.**
2. **Problems on Analytic Function.**
3. **Problem on Contour Integrals.**
4. **Problem on Cauchy's Integral Formula.**
5. **Solving algebraic and transcendental equations using numerical methods.**
6. **Solving system Linear Algebraic Equations using numerical methods.**
7. **Concepts of Interpolations.**
8. **Concepts on Numerical differentiation and Integration.**
9. **Solving Pfaffian Differential Equation.**
10. **Solving Linear Equations of First Order using Charpit's Method.**
11. **Concepts of Second Order Partial Equations - Laplace Equation.**
12. **Concepts of Second Order Partial Equations - Wave Equation.**
13. **Concepts on Partially Ordered Sets.**
14. **Concepts on Lattices.**
15. **Concepts of Distributive and Modular Lattices.**
16. **Concepts on Boolean algebra.**

NUMERICAL METHODS LAB-20MAT206

No. of Hours: 08 Total credits: 04
Total Marks: 100 (Internal: 30M & External: 70M)

LIST OF PROGRAMS:

1. Bisection method
2. False position method
3. Newton Raphson method
4. Secant method
5. Gauss elimination method
6. Gauss seidal method
7. Difference table method
8. Trapezoidal method
9. Simpson 1/3 rule
10. Simpson 2/3 rule2
11. Euler's method
12. Thomas method
13. Lagranges method
14. Taylor's method
15. Runge-kutta method
16. Modified Euler's method

20OEMAT207 OPEN ELECTIVE-I

No. of Hours: 04 Total credits: 04
Total Marks: 100 (Internal: 30M & External: 70M)

TOPOLOGY – 20MAT301

No. of Hours: 04 Total credits: 04
Total Marks: 100 (Internal: 30M & External: 70M)

Course Learning Objectives:
In this course we shall come across important notions and various definitions, theorems and their proofs to understand the concepts of metric spaces and topological spaces.

UNIT-I
Metric Spaces: The definition and some examples – Open sets – Closed sets – Convergence, Completeness and Baire's Theorem [Section 12 of Chapter-2]

UNIT-II
Topological Spaces: Topological Spaces - the definition and some examples – Elementary concepts – Open bases and Open sub bases. [Sections 16, 17 and 18 of Chapter-3 of Text Book]

UNIT-III
Compactness: Compact spaces – Product spaces – Tychonoff's theorem and locally compact spaces – Compactness for Metric spaces – Ascoli's Theorem.[Sections 21-24 and 25 of Chapter-4 of Text Book]

UNIT-IV
Separation: T1-Spaces and Hausdorff spaces – Completely regular spaces and normal spaces–Urysohn's lemma and the Tietze extension theorem – The Urysohn imbedding theorem. [Sections 26-29 of Chapter-5 of Text Book]

UNIT-V
Connectedness**:** connected spaces – The components of a space – Totally disconnected spaces–Locally connected spaces. [Chapter-6 of Text Book]

Course Learning Outcome(s):
From this course students are able to know how the topology on a space is determine by the collection of open sets and basic properties of connectedness and compactness.

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

Reference Book:
1. **Topology** by James R. Munkres, Second Edition, Pearson Education Asia.

PROBABILITY& STATISTICS- 20MAT302

No. of Hours: 04 Total credits: 04
Total Marks: 100 (Internal: 30 M & External: 70 M)

Course Learning Objectives:
The objective of this course is to introduce the basic concepts of statistics like probability theory, distributions, correlation and regression techniques and sampling distributions.

UNIT-I:
Sample Space & Events - Axioms of probability- Some theorems on probability- Boole's Inequality- probability-Multiplicationtheorem on probability- Independent events- Multiplication theorem on probability for independent Events- Extension of Multiplication theorem on Probability to n Events-Baye's theorem.
[3.2 to 3.95 of Chapter3 & 4.2 of Chapter4]

UNIT-II:
Distribution functions: Discrete random variable - Continuous random variable - Two-Dimensional Random variables - Mathematical expectation - Moments of a distribution function - Moment generating functions - Characteristic functions and their properties – Chebychev inequality - Probability generating functions.
[5.2 to 5.5(up to 5.5.5.) of Chapter- 5, Chapter 6 except 6.7 and 7.1, 7.2, 7.3, 7.5 and 7.9 ofChapter 7]

UNIT-III:
Distributions: Discrete Distributions Binomial - Poisson distributions and their properties - Continuous distributions - Normal and Rectangular distributions and their properties.
[8.1 to 8.5 of Chapter 8 and 9.1 to 9.3 of Chapter 9]

UNIT-IV:
Correlation and Regression: Correlation - Karl pearson"s coefficient of correlation - Calculation of correlation coefficient for bivariant frequency distribution - Spearman"s rank correlation coefficient - Linear regression- Regression coefficients and their properties - Angle between regression lines.
[10.1 to 10.5 and 10.7.1 of Chapter 10 and Chapter 11 (upto 11.2.3)]

UNIT-V:
Sampling distribution: Sampling and Large sample tests, Exact sampling distributions - χ^2, t' and F-distributions.
[Chapter-14, Chapter 15 up to 15.6.4 and Chapter 16 up to 16.6 except 16.4]

Course Learning Outcome(s):
From this course students will be able to learn the fundamental concept of statistics and techniques required for data analysis which is widely used in practical analysis of any data.

Text Book:
Fundamentals of Mathematical Statistics by S.C.Gupta and V.K.Kapoor , 11^{th} Edition, Sultan Chand & Sons, NewDelhi.

Reference Book:
Probability and Statistics for Engineers and Scientists, 9^{th} edition, Walpole Myers, Keying Ye Pearson Publications.

GALOIS THEORY - 20 MAT 303

No. of hours: 04 | Total credits: 04
Total marks: 100 | (Internal: 30 M & External: 70 M)

Course learning objectives:
This course is the study of roots of polynomials and their symmetries in terms of Galois groups, modules and extension of fields**.**

UNIT-I
Modules: Definition and examples, sub modules and direct sums, r-homomorphism's and quotient modules, completely reducible modules.
(Sections 1 to 4 of chapter 14 of [1])

UNIT-II
Algebraic extensions of fields: irreducible polynomials and Esenstein's criterion, adjunction of roots, algebraic extensions, algebraically closed fields.
(Sections 1 to 4 of chapter 15 of [1])

UNIT-III
Normal and separable extensions: splitting fields, normal extensions, multiple roots, finite fields, separable extensions.
(Sections 1 to 5 of chapter 16 of [1])

UNIT-IV
Galois Theory: Automorphism groups and fixed fields, fundamental theorem of Galois theory, fundamental theorem of algebra.
(Sections 1 to 3 of chapter 17 of [1])

UNIT-V
Applications of Galois Theory to Classical Problems: roots of unity and cyclotomic polynomials-cyclic extensions-ruler and compass constructions
(Sections 1,2,5 of chapter 18 of [1])

Course learning outcome(s):
This course is able to reach the students by learning modules,fundamental theorem of Galois Theory and applications of Galois Theory to classical problems.

PRESCRIBED TEXT BOOK:

1. **Basic abstract algebra** by Bhattacharya P. B. Jain S. K., Nagpaul s. R, second edition, Cambridge Press.

REFERENCE BOOKS:

1. **Galois theory**by Joseph Rotman, second edition 1998, Springer.
2. **Algebra** by Artinm, 1991, PHI.
3. Abstract Algebra by David S Dummit and Richard M Foote, Wiley Publications, Third Edition

MATHEMATICAL METHODS-20MAT304

No. of Hours: 04 Total credits: 04
Total Marks: 100 (Internal: 30M & External: 70M)

Course Learning Objectives:
The aim of this course is provide the students with the basic knowledge of various mathematical methods we use like Fourier series, calculus of variation. Provide basic idea of difference equations and the Laplace Transformations.

UNIT-I:
Fourier Series: Fourier coefficients- Even and Odd functions- Cosine and Sine series-Fourier Series on arbitrary intervals.
[5.1,5.3 and 5.4 of Text Book-1]

UNIT-II:
The Calculus of variations: Euler's Equation – functions of the form $\int_{x_0}^{x_1} f(x, y_1, y_2, \dots y_n, y_1', y_2', \dots y_n',)dx$ -functional dependence on higher order derivatives-Variational problems in parametric form and applications.
[Text Book-1]

UNIT-III:
Difference Equations: Introduction, Definition, Formation of difference equations, Linear difference equations, Rules for finding complementary function, Rules for finding the Particular Integral.
[From Text Book 2]

UNIT- IV:
Laplace Transforms: Existence of Laplace Transform- Functions of exponential-Shifting Theorems-Scale Property-Laplace Transform of derivatives- Initial and final value theorems- Laplace Transforms of integrals-multiplication by. $t^n$and division by t-Laplace Transform Of periodic and some special function.
[Chapter 1 of the text book3].

UNIT- V:
Inverse Laplace Transforms: Shifting theorems and sScale Property of inverse Laplace transforms-Use of partial fractions-Inverse Laplace transforms to derivativesand integrals-multiplication and division by powers of p-convolution theorem-Heaviside's expansion theorem- complex inversion formulae.
[Chapter 2 of the Text Book3]

Course Learning Outcome(s):

From this course Student will be able to learn the Fourier series and calculus of variation techniques that are very much essential for engineering applications. Also they get exposed to difference equations and Laplace Transforms which are used widely.

Text Books:

1. Differential Equations Theory, Technique and Practice by George F.Simmons and Steven G.Krantz, Tata McGraw-Hill Edition.
2. Higher Engineering Mathematics by B.S.Grewal, Khanna Publishers.
3. Integral Transforms by A.R.Vasihatha and R.K.Gupta, KRISHNA Prakashan Media (P) Ltd.

20MAT305-Practial(of Four Theory Papers)

No. of Hours: 08 | Total credits: 04
Total Marks: 100 | (Internal: 30M & External: 70M)

LIST OF PROBLEMS:

1. **Concepts on Metric Spaces.**
2. **Concepts on Topological Spaces.**
3. **Concepts on Compactness for Metric Spaces.**
4. **Concepts on Connectedness.**
5. **Problem on Sample space and Events.**
6. **Concepts on Distributive functions and Distribution.**
7. **Problems on Correlation and Regression Coefficients.**
8. **Problems on Sampling Distribution.**
9. **Concepts on Modules.**
10. **Concepts on Algebraic Extensions of Fields.**
11. **Concepts on Normal and Separable Extensions.**
12. **Problems on Ruler and Compass Constructions using Galois Theory.**
13. **Problems from Fourier Series.**
14. **Problems on Laplace Transforms.**
15. **Problems on Inverse Laplace Transforms.**
16. **Problems from Difference Equations.**

20MAT306
User friendly software Development/ MATLAB/Python Lab

No. of Hours: 08 Total credits: 04
Total Marks: 100 (Internal: 30M & External: 70M)

(A):MATLAB

1. Solving a first order differential equation analytically
2. Solving a second order differential equation analytically
3. Solving a first order IVP using Euler method
4. Solving a first order IVP using modified Euler method
5. Solving a first order IVP using 4^{th} order RK method
6. Modelling of LR,RC circuits and solving through MATLAB and graphical representations
7. Modelling of free oscillations ,forced oscillations without damping
8. Modelling of free oscillations ,forced oscillations with damping
9. Fourier series expressions of given function, graphical comparison
10. Solving linear system of equations modelling
11. Finding eigen values of a matrix
12. Modelling of electrical circuits formation of linear systems and solving through MATLAB and graphical representation

(OR)

(B):
Develop a User friendly Package for Numerical methods

(OR)

(C):
Develop a User friendly Package for Linear Programming/ Operations Research Problems

(OR)

(D):
Write Programs for Linear Programming/ Operations Research Problems

20OEMAT307 OPEN ELECTIVE-II

No. of Hours: 04 | Total credits: 04
Total Marks: 100 | (Internal: 30M & External: 70M)

MOOCS – 20 MAT 401

No. of Hours: Nil | Total credits: 04
Total Marks: 100 | (Internal: 30M & External: 70M)

Elective-I
MEASURE AND INTEGRATION – 20 MAT 402(A)

No. of Hours: 04 Total credits: 04
Total Marks: 100 (Internal: 30 M & External: 70 M)

Course Learning Objectives:
The objectives of the course are to acquire the basic knowledge of measure theory needed to understand functional analysis.

UNIT-I
Lebesgue Measure: Introduction, Outer measure, Measurable sets and Lebesgue measure, A non-measurable set, Measurable functions, Little wood's three principles.
(Chapter 3)

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.
(Sections 4.1 to 4.4 of Chapter 4).

UNIT-III
Differentiation and Integration: Differentiation of monotone functions, Functions of bounded variation, Differentiation of an Integral, Absolute continuity.
(Sections 5.1 to 5.4 of Chapter 5)

UNIT-IV
Measure and Integration: Measure spaces, Measurable functions, Integration, General Convergence theorems, Signed Measures, The Radon-Nikodym theorem.
(Sections 11.1 to 11.6 of Chapter 11)

UNIT-V
Measure and Outer Measure: Outer Measure and Measurability, The Extension theorem, Product measures.
(Sections 12.1, 12.2 & 12.4 of Chapter 12).

Course Learning Outcome(s):
From this course students are able to learn the concepts of measure theory and differentiation and integration of naonotone functions.

PRESCRIBED BOOK:

1. **Real Analysis** by H.L. Royden, Third Edition, Pearson pub.

REFERENCE BOOKS:

1. **Measure Theory** by P. R. Halmos, 1974, Springer-Verlag.
2. **Measure Theory** by V.I. Bogachev, 1997, Springer-Verlag.

Elective-I

GRAPH THEORY-20MAT402(B)

No. of Hours: 04 | Total credits: 04
Total Marks: 100 | (Internal: 30M & External: 70M)

Course Learning Objectives:
The objective of the course is to understand and apply the fundamental concepts in graph theory and apply the tools in solving practical problems.

UNIT-I:
Introduction: Finite and Infinite graphs- Incidence and degree- Isolated Vertex- Pendant Vertex and Null Graph Paths and circuits: Isomorphism- Subgraphs- a puzzle with multi colored cubes- walks- Paths and Circuits- connected graphs- Disconnected graphs- Components- Euler graphs - Operations on graphs- More on Euler graphs- Hamiltonian paths and circuits- Travelling – Salesman Problem
[Chapters 1 and 2 of Text Book]

UNIT-II:
Trees and Fundamental Circuits: Trees , some properties of trees , pendant Vertices in a tree, distances and centers in a tree, rooted and binary trees, on Counting trees, spanning trees, fundamental circuits, finding all spanning trees of a graph , spanning trees in a weighted Graphs. Cut sets and Cut –vertices: Cut sets, Some Properties of a Cut Set, All cut sets in a Graph, Fundamental circuits and cut sets, connectivity and separability, network flows, 1-isomorphism, 2- isomorphism.
[Chapter 3 & 4 of Text Book]

UNIT-III:
Planar graphs: Planar graphs – Kuratowski's two graphs - Different representations of planar graphs- Detection of Planarity - Geometric Dual of a graph.
[Sections 5.1 to 5.6 Chapter 5 of the Text Book]

UNIT-IV:
Matrix representation of graphs: Incidence and circuit matrices of a graph - Fundamental Circuit Matrix - Cut set and Path Matrices - Adjacency matrices - Directed Graphs - Incidence and adjacency matrix of adigraph.
[Chapter 7 and Sections 9.1, 9.2, 9.8 and 9.9 of Chapter 9 of Text Book]

UNIT-V:
Coloring - Covering and Partitioning - Chromatic number- Chromatic Partitioning – Chromatic Polynomial – Matchings –Coverings -The four color problem - Applications of graph theory in Operations Research.
[Chapters 8 and Sections 14.1 to 14.3 of chapter 14 of Text Book]

Course Learning Outcome(s):

From this course studentsare able to define basic concepts of graphs and understand the concept of planer graph.

Text Book:

Graph Theory with applications to Engineering and Computer Science by NarasinghDeo, Prentice – Hall of India.

Reference Books:

1. Discrete Mathematics for Computer Scientists and Mathematicians by J.L.Mott, A.Kandel and T.P. Baker, Prentice-HallIndia.
2. Graph Theory with applications by Bond JA and Murthy USR, North Holland, NewYork

Elective-I

REAL ANALYSIS-II - 20 MAT 402(C)

No. of hours: 04 | Total credits: 04
Total marks: 100 | (Internal: 30 M & External: 70 M)

Course learning objectives:

This course is intended to expose the ideas of real analysis by learning functions of several variables and special functions.

UNIT-I

Some Special Functions: Power Series, The Exponential and Logarithmic Functions, The Trigonometric Functions, The Algebraic Completeness of the Complex Field, Fourier Series.
(Sections 8.1 To 8.15 of Chapter 8)

UNIT-II

Functions of several variables: Linear Transformations, Differentiation, Contraction Principle.
(Sections 9.1 To 9.23 of Chapter 9)

UNIT-III

Functions of several variables (Continued): Inverse function theorem, Implicit function theorem, The Rank theorem, Determinants, Derivatives of higher order and differentiation of Integrals.
(Sections 9.24 To 9.43 of Chapter 9)

UNIT-IV

Integration of Differential Forms: Integration, Primitive Mappings, Partitions of unity, Change of variables, Differential forms.
(Sections 10.1 To 10.25 of Chapter 10).

UNIT-V

Integration of differential forms (Cont.,): Simplexes and chains, Stokes Theorem - Closed forms and Exact forms
(Sections 10.26 To 10.41 Of Chapter 10)

Course Learning Outcome(S):

This Course able to help the students to learn fundamental principles of special Functions, and advanced topics of a differentiation and Integration.

PRESCRIBED TEXT BOOK:

1. **Principles of Mathematical Analysis** byWalter Rudin, Third Edition, Tata McGraw-Hill.

REFERENCE BOOKS:

1. **Mathematical Analysis** by Tom. M. Apostol, Second Edition, 2002, Narosa Publication.
2. **A First Course in Mathematical Analysis by** D. Somasundaram, B. Choudary, Narosa Publishing House.

Elective-I

RINGS AND MODULES – 20 MAT 402(D)

No. of Hours: 04 | Total credits: 04
Total Marks: 100 | (Internal: 30 M & External: 70 M)

Course Learning Objectives:
The objective of this course is to develop the theory of rings and to study about module over ring. Which is a key to many advanced algebra courses.

UNIT-I
Fundamental Concepts of Algebra: Rings and related Algebraic systems, Subrings, Homomorphisms, Ideals.
(Sections 1.1, 1.2 of chapter 1)
UNIT-II
Fundamental Concepts of Algebra: Modules, Direct products and Direct sums, Classical Isomorphism Theorems.
(Sections 1.3, 1.4 of chapter 1)
UNIT-III
Selected Topics on Commutative Rings: Prime ideals in Commutative Rings, Prime ideals in Special Commutative Rings.
(Sections 2.1, 2.2 of Chapter 2)
UNIT-IV
Selected Topics on Commutative Rings: The Complete Ring of Quotients of a Commutative Ring, Ring of quotients of Commutative Semi Prime Rings.
(Sections 2.3, 2.4 of Chapter 2)
UNIT-V
Selected Topics on Commutative Rings: Prime Ideal spaces (Section 2.5 of Chapter 2), Appendices: Functional representation.
(Appendix 1: Proposition 1 to Proposition 9)

Course Learning Outcome(s):
To understand the key concepts of modules and Homomorphism, Commutative rings of modules which are useful in advance algebra.

PRESCRIBED TEXT BOOK:
1. **Lectures on Rings and Modules,** J. Lambek, ABlasidell Book in Pure and Applied Mathematics.

REFERENCE BOOK:
1. **Algebra,** Thomas W. Hungerford, Springer Publications.
2. Introduction to rings and modules, by C Musili, Narosa Publications
3. Abstract Algebra by David S Dummit and Richard M Foote, Wiley Pulications, Third Edition

(Elective-II)
ALGEBRAIC CODING THEORY – 20 MAT 403(A)

No. of Hours: 04 | Total credits: 04
Total Marks: 100 | (Internal: 30 M & External: 70 M)

Course Learning Objectives:
The objective of course is to develop the knowledge among students about the properties & algorithms for coding & decoding of linear block codes cyclic codes and perfect & related codes.

UNIT –I
Introduction to Coding Theory: Introduction, Basic assumptions, Correcting and Detecting error 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. (Section 1.1 to 1.10 of Chapter 1)

UNIT – II
Introduction to Coding Theory: Error- detecting Codes, Error – correcting Codes
Linear Codes: Linear Codes, Two important sub spaces, Independence, Basis, Dimension, Matrices, Bases for $C= \langle S \rangle$ and $C^{\perp}$. (Sections 1.11, 1.12 of Chapter 1 & Sections 2.1 to 2.5 of Chapter 2).

UNIT – III
Linear Codes : Generating Matrices and Encoding , Parity – Check Matrices, Equivalent Codes, Distance of a Linear Code, Cosets, MLD for Linear Codes, Reliability of IMLD for Linear Codes.
(Section 2.6 to 2.12 of Chapter 2)

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). (Chapter 3)

UNIT –V
Cyclic Linear Codes: Polynomials and Words, Introduction to Cyclic Codes, Polynomials encoding and decoding, Finding Cyclic Codes, Dual Cyclic Codes.
(Chapter 4).

Course Learning Outcome(s):
It covers the fundamental concepts of information theory and error control coding.

PRESCRIBED TEXT BOOK:

1. **Coding Theory- The Essentials** by D.G. Hoffman, D.A. Lanonard , C.C. Lindner, K. T. Phelps, C. A. Rodger, J. R. Wall, Marcel Dekker Inc.

REFERENCE BOOK:

1. **Introduction to coding Theory** byJ.H. Van Lint, Springer Verlag.

Elective-II

LINEAR PROGRAMMING-20MAT403(B)

No. of Hours: 04 Total credits: 04
Total Marks: 100 (Internal: 30M & External: 70M)

Course Learning Objectives:
The objective of Linear programming is the linear equation which is representing some quantity which is to be maximized or minimized subject to the given constraints.

UNIT-I:
Overview of operations research: OR models - OR Techniques- Linear Programming- Introduction - Graphical solution - The standard form of linear programming problems- Basic feasible solutions- Unrestricted variables - Simplex Method.

UNIT-II:
Concept of Duality: Artificial variables - Big M and Two phase methods- Degeneracy - Alternative optima- Unbounded solutions - infeasible solutions

UNIT-III:
Duality concept- Dual problems - Relation between primal and dual Problems - - Complementary slackness conditions-Dual simplex method.

UNIT-IV:
Transportation and Assignment Problems: Transportation model - Basic feasible solutions- North West corner Rule- Lowest cost method- Vogel approximation method- transportation algorithm (MODI -method)

UNIT-V:
Assignments problem – Description and mathematical formulation of the problem- Hungarian method.

Course Learning Outcome(s):
Students are able to learn how to formulate a given real world problem as a linear programming model and solve using simplex method and also learn transportation and assignment problems.
Text Book: Operations Research, Theory and Applications by J.K.SHARMA

Reference Books:

1. Operations Research, An Introduction- Hardy A.Taha, Seventh Edition.
2. Introduction to Operations Research- Hillier Lieberman, Tata McGraw Hill.

Elective-II
ANALYTICAL NUMBER THEORY - 20 MAT 403(C)

No. of Hours: 04 | Total credits: 04
Total Marks: 100 | (Internal: 30 M & External: 70 M)

Course Learning Objectives:
This course is introduced to illustrate how general methods of analysis can be used to obtain results about integers and prime number

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, The Mangoldt function $\Lambda(n)$, Multiplicative functions, Multiplicative functions and Dirichlet multiplication, The inverse of a completely multiplicative function, Liouville's function $\lambda(n)$, The divisor function $\sigma_z(n)$. Generalized convolutions. (Sections 2.1 to 2.14 of Chapter 2)

UNIT-II
Averages of Arithmetical Functions: Introduction, The big oh notation Asymptotic equality of functions, Euler's summation formula, Some elementary asymptotic formulas, The average order of d(n), The average order of 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. (Sections 3.1 to 3.12 of Chapter 3)

UNIT-III
Some Elementary Theorems on the Distribution of Prime Numbers: Introduction, Chebyshev's functions $\psi(x)$ and $\vartheta(x)$.Relations connecting $\vartheta(x)$ and $\pi(x)$, Some equivalent forms of the prime number theorem, Inequalities of $\pi(n)$ and ***pn*,** Shapiro's Tauberian theorem, Application of Shapiro's theorem, An asymptotic formulae for the partial sums $\sum_{psk}(1/p)$, The Partial Sums of the Mobius function. (Sections 4.1 to 4.9 of Chapter 4)

UN1T-1V
Congruence's: 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, Applications of Lagrange's Theorem, (Sections 5.1 to 5.5 of Chapter 5)

UNIT-V

Simultaneous linear congruences, The Chinese remainder theorem, Applications of the Chinese 5.6 to 5.9 of Chapter 5).

Course Learning Outcome(s):

From this students are able to understand better the distribution of prime numbers, and understanding the proof of Dirichilet's Theorem.

PRESCRIBED TEXT BOOK:

1. **Introduction to Analytic Number Theory,** Tom M. Apostol, Narosa Publishing House, New Delhi.

REFERENCE BOOK:

1. **AN INTRODUCTION to the Theory of Numbers,** Hardy G. H. and Wright E. M., Oxford Press.

Elective-II

DISCRETE MATHEMATICAL STRUCTURES - 20 MAT403(D)

No. of Hours: 04 Total credits: 04
Total Marks: 100 (Internal: 30M & External: 70M)

Course Learning Objectives:
The purpose of introducing this course is to develop logical thinking and its application to computer science of proving statements.

UNIT-I:
Logic: Computer Representation of sets, Mathematical Induction,Matrices,Logic,Tautology,Normal forms,Logical Inferences,Predicate Logic,Universal Quantifiers,Rules of Inference
[Chapter 1 of Text Book 2]

UNIT-II:
Relations and ordering: Relations- properties of binary relations in a set - partially ordering - Partially ordered sets - representation and associated terminology.
[2-3.1, 2-3.2, 2-3.8, 2-3.9 of Chapter 2 of the Text Book1]

UNIT-III:
Lattices: Lattices as partially ordered sets - some properties of Lattices - Lattices as algebraic systems - Sub-Lattices - direct product and homomorphism some special Lattices.
[4-1.1 to 4-1.5 of Chapter 4 of the Text Book1]

UNIT-IV:
Boolean Algebra: Sub algebra - direct product and Homomorphism - Boolean forms and free Boolean Algebras - values of Boolean expressions and Boolean function.
[4-2.1, 4-2.2, 4-3.1, 4-3.2 of Chapter 4 of the Text Book1]

UNIT-V:
Representations and minimization of Boolean Function: Representation of Boolean functions - minimization of Boolean functions - Finite State Machines - Introductory Sequential Circuits - Equivalence of Finite - State Machines.
[4-4.1, 4-4.2, 4-6.1, 4-6.2 of Chapter 4 of the Text Book1]

Course Learning Outcome(s):
From this course students are able to acquire ability to learn relations, lattices, boolean algebra and mathematical logic.

Prescribed Text Book:

1. **Discrete Mathematical structures with applications to Computer Science** by J.P. Trembly and R. Manohar, Tata McGraw-Hill Edition.

2. **Discrete Mathematical Structure** by R.M.Somasundaram, Prentice-Hall India-2003.

Reference Book:

1. **Discrete Mathematics for Computer Scientists and Mathematicians** by J. L. Mott, A. Kandel and T. P. Baker, Prentice-Hall India.

FUNCTIONAL ANALYSIS – 20MAT404

No. of Hours: 04 | Total credits: 04
Total Marks: 100 | (Internal: 30M & External: 70M)

Course Learning Objectives:
The Objective of the course is to introduce students to the ideas and some of the fundamental theorems of functional analysis on Banach Spaces, Hilbert Spaces & fixed point Theory.

UNIT-I
Banach Spaces: Normed space – Banach space – properties of normed spaces – Finite dimensional normed spaces and subspaces – Compactness and finite dimension – Linear operators – Bounded and continuous linear operators – Linear functional - Linear operators and functional on finite dimensional spaces – Normed spaces of operators – Dual space.[2.2 – 2.10 of Text Book]

UNIT-II
Hilbert Space: Inner product space – Hilbert space – Properties of inner product spaces – Orthogonal complements and direct sums – Orthonormal sets and Sequences - Series related to orthonormal sequences and sets.[3.1-3.5 of Text Book]

UNIT-III
Proper ties of Hilbert Space: Total orthonormal sets and sequences – Representation of functional on Hilbert spaces – Hilbert-Adjoint operator – Self adjoint, unitary and normal operators.[3.6 and 3.8-3.10 of Text Book]

UNIT-IV
Fundamental Theorems: Hahn Banach theorem for complex vector spaces and normed spaces– Adjoint operator – Reflexive space – Uniform boundedness theorem – Open mapping theorem – Closed graph theorem.[4.3, 4.5-4.7, 4.12 and 4.13 of Text Book]

UNIT-V
Fixed point Theory: The Contraction mapping theorem and its application, Brouwer's fixed point theorem without proof and its applications, Schauder's fixed point theorem without proof and some related results.[5.1 to 5.4 of Text Book]

Course Learning Outcome(s):
From this course students will be able to learn and apply the ideas from the theory of Banach Spaces, Hilbert Spaces & Fixed Point Theory.

Prescribed Text Book:

1. **Introductory Functional Analysis with Applications** by Erwin Kreyszig, John Wiley & Sons, 1989.

Reference Books:

1. **Introduction to Topology and Modern Analysis** by G. F. Simmons, McGraw-Hill Edition.
2. **Introduction to Functional analysis,** by E. Taylor, Wiley International Edition.
3. **First Course in Functional analysis,** by C. Goffman and G.Pedrick, 1991, Prentice Hall of India Private Limited.
4. **Functional Analysis** by BV Limaye, New Age International Publishers, Third Edition.

20MAT405-Practial(of Four Theory Papers)

No. of Hours: 08 | Total credits: 04
Total Marks: 100 | (Internal: 30M & External: 70M)

LIST OF PROBLEMS:

1. **Concepts on Banach Spaces.**
2. **Concepts on Hilbert Spaces.**
3. **Concepts on Adjoint Operator.**
4. **Concepts on Fixed Point Theory.**

5., 6., 7., 8. } **Concepts from MOOCS**

9., 10., 11., 12. } **Concepts from Elective − I**

13., 14., 15., 16. } **Concepts from Elective − II**

SEMINAR-20**MAT40**6

No. of Hours: 08 | Total credits: 04
Total Marks: 100 | (Internal: 50M & External: 50M)

The student will be given seminar topics at the beginning of the IV semester by faculty In-charge and the student has to present the topics, submit the hard copy of seminar topic report at the end of the IV semester. Out of a total of 100 marks, for the Seminar Evaluation, 50 marks shall be for Seminar report/record and 50 marks for the End Semester Examination (Viva-voce). The Viva- Voce shall be conducted by a committee consisting of HOD, faculty in charge and a senior faculty member/external examiner nominated by the university.

KRISHNA UNIVERSITY, MACHILIPATNAM - 521 003
From The Department of Applied Mathematics/Mathematics
SEMESTER-II
[w. e. f 2020 – 21 Admitted batch]
Syllabus

OPEN ELECTIVE -I

MATRIX THEORY

No. of Hours: 04 | Total credits: 04
Total Marks: 100 | (Internal: 30M & External: 70M)

Course learning Objectives : In this course we study a branch of mathematics called Linear algebra and some of its applications related to matrices. Students able to apply the concepts in computer science, engineering, biology and commerce.

Unit-I
Linear system of Equations: Introduction, Fundamentals of Matrices, Rank of Matrix.
(Sections 1.0, 1.1, 1.2 of unit 1 of Text book 1)

Unit-II
Linear system of Equations: Echelon Form, Normal Form of a Matrix, Finding inverse by row operations.
(Sections 1.3,1.4 of unit 1 of Text book 1 and concepts from Text book 2).

Unit- III
Linear system of Equations: Solutionof a System of Linear Equations, Gauss-Elimination Method, Inverse Method, Cramer's Rule.
(Sections 1.5, 1.6 of unit 1 of Text book 1 and concepts from Text book 2).

Unit-IV
Eigen Values- Eigen Vectors: Introduction, Basic concepts, Eigen Values and Eigen Vectors.
(Sections 2.0, 2.1, 2.2 of unit 2 of Text book 1).

Unit-V
Eigen Values- Eigen Vectors: Cayley Hamilton Theorem with proof, and its applications.
(Section 2.4 of unit 2 of Text book 1).

Course learning Outcomes: Ater completion of this course students are able to analyse and solve a linear system of equations using the concepts of matrices.

PRESCRIBED TEXT BOOK:

1) "A text book of Engineering Mathematics-III" by N. P. Bali & Dr. K. L. Sai Prasad. First edition 2018, University science Press, New Delhi.

2) "Higher Engineering Mathematics" by Dr. B. S. Grewal, 40th Edition, 2007, Khanna publishers, New Delhi.

KRISHNA UNIVERSITY, MACHILIPATNAM - 521 003

Semester-II

[w. e. f 2020 – 21 Admitted batch]

[QUESTION PAPER PATTERN FOR SEMESTER END (EXTERNAL) EXAMINATION]

MODEL PAPER (OPEN ELECTIVE-I)

MATRIX THEORY

Time: 3 Hours **Max Marks: 70**

Answer All Questions **(10 X 2 = 20 M)**

1. a) Define Row Matrix and Column Matrix.
b) Define Symmetric and Skew Symmetric Matrices.
c) Define transpose and Inverse of a Matrix A.
d) Define Echelon form of a Matrix.
e) Define Normal form of a matrix.
f) Define homogeneous and non-homogeneous linear equations.
g) Define consistent and inconsistent system of equations.
h) Define Eigen value and Eigen vector .
i) Define Linear Transformation with example.
j) Define Cayley- Hamilton's Theorem.

Answer any Five (05) Questions choosing **One** question from **each unit.**

All questions carry equal marks **(5 X 10 = 50)**

<u>Unit-I</u>

2. A) Use Gauss Jordan method to find the inverse of the given Matrix.

$$A = \begin{bmatrix} 1 & 3 & 3 \\ 1 & 4 & 3 \\ 1 & 3 & 4 \end{bmatrix}$$

(OR)

B) Find the rank of the Matrix $\begin{bmatrix} 1 & 2 & 3 \\ 1 & 4 & 2 \\ 2 & 6 & 5 \end{bmatrix}$

<u>Unit-II</u>

3. A) Find the rank of the Matrix by reducing it to Echelon form $\begin{bmatrix} 2 & 3 & 7 \\ 3 & -2 & 4 \\ 1 & -3 & -1 \end{bmatrix}$

OR).

B) Find the rank of the Matrix by reducing it to normal form $\begin{bmatrix} 0 & 1 & 2 & -2 \\ 4 & 0 & 2 & 6 \\ 2 & 1 & 3 & 1 \end{bmatrix}$

<u>Unit-III</u>

4. A) Solve the following equations by Gauss - elimination method:
$3x + 4y + 5z = 18$, $2x – y + 8z = 13$, $5x - 2y + 7z = 20$.

(OR)

B) Solve the following equations by using Cramer's rule:
$3x + y + 2z = 3$; $2x - 3y - z = -3$; $x + 2y + z = 4$.

Unit-IV

5. A) i) Show that the matrices A and A^T have the same Eigen values where A^T is the transpose of A.

ii) Show that if $\lambda_1, \lambda_2, \lambda_3 \ldots \lambda_n$ are the Eigen values of a Matrix A, then A^{-1} has the Eigen values $\frac{1}{\lambda 1}, \frac{1}{\lambda 2}, \frac{1}{\lambda 3}, \ldots \ldots \frac{1}{\lambda n}$.

(OR)

B) Find the Eigen values and Eigen vectors of the matrix $\begin{bmatrix} 1 & 2 & 3 \\ 0 & -4 & 7 \\ 0 & 0 & 7 \end{bmatrix}$

Unit-V

6. A) Find the characteristic equation of the Matrix and verify that it is satisfied by A and hence obtain A^{-1}.

$$A = \begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$$

(OR)

B) Verify Cayley-Hamilton theorem for the Matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & -1 & 3 \\ 1 & 1 & 2 \end{bmatrix}$

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SEMESTER-III
[w. e. f 2020 – 21 Admitted batch]
Syllabus

OPEN ELECTIVE -II

NUMERICAL METHODS

No. of Hours: 04 Total credits: 04
Total Marks: 100 (Internal: 30M & External: 70M)

Course Learning Objectives:
This Course is introduced a broad range of Numerical methods for solving Mathematical problems that arise in Science and Engineering and helps to choose, develop and apply the appropriate Numerical techniques for the Mathematical problems.

UNIT-I
Solution of Algebraic & Transcendental Equations: Introduction - The Bisection method - The method of false position - Newton Raphson method.
[Sections 2.1, 2.2., 2.4, 2.5 from Chapter 2 of Text Book 1].

UNIT-II
Interpolation: Finite differences - Forward differences, Backward difference, Central Differences, Symbolic relations, Differences of a polynomial, Newton's formulas for interpolation, Central Difference interpolation formulae, Gauss' central difference formulae, Stirling's formula, Lagrange's Interpolation formula.
[Sections 3.3, 3.5, 3.6, 3.71, 3.72, 3.9.1 from chapter 3 of Text Book 1].

UNIT-III
Curve fitting: Least-squares curve fitting procedures - fitting a straight line, Non-linear curve fitting, Curve fitting by a sum of exponential.
(Sections 4.2 from chapter 4 of Text Book 1).

UNIT-IV
Numerical integration: Trapezoidal rule- Simpsons 1/3 rules, Simpson's 3/8 rule.
(Sections 5.4.1, 5.4.2, 5.4.3 from chapter 5 of Text Book 1]

UNIT-V
Numerical Solution of Ordinary differential equations: Solution by Taylor's series, Picard's method of successive approximations, Euler's method, modified Euler's method, Runge-kutta method fourth order only. (Sections 7.2, 7.3, 7.4, 7.5 from chapter 7 of Text Book 1)

Course Learning Outcome(s):
From this Course Students are able to learn how to apply the Numerical method for various Mathematical operations and tasks such as Interpolation, Differentiation, Integration, the solution of Differential Equations analyze and evaluate the accuracy of common Numerical methods.

PRESCRIBED TEXT BOOK:

1. **Introductory method of Numerical Analysis by S.S SASTRY, Third Edition, 1993, Prentice Hall of India Pvt. Ltd., New Delhi.**

REFERENCE BOOK:

1. **Numerical Methods for Scientific and Engineering Computation** by M. K. Jain, S. R. K. Iyengar, R. K. Jain,New Age International (P) Limited, Publishers, 5th Edition.

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Semester-III

{w. e. f 2020 – 21 Admitted batch}

[QUESTION PAPER PATTERN FOR SEMESTER END (EXTERNAL) EXAMINATION]

MODEL PAPER (OPEN ELECTIVE-II)

NUMERICAL METHODS

Time: 3 Hours **Max Marks: 70**

Answer All Questions **(10 X 2 = 20 M)**

1. a) Write the first and second approximation formulae of the method of false position.

b) Define Algebraic and Transcendental functions.

c) Define forward differences.

d) Show that $E = 1+\Delta$

e) Write the normal equations of fitting a straight line.

f) Explain briefly the power function.

g) Write the formula of Trapezoidal rule.

h) Write the formula of Simpson's 3/8 rule.

i) Write the Taylor's series expression for any function y(x) .

j) Write the iterative formula of Modified Euler's method.

Answer any Five (05) Questions choosing **One** question from **each unit.**

All questions carry equal marks **(5 X 10 = 50)**

Unit-I

2. A) Find the real root of the equation $x^3 - 3x - 5 = 0$ using Newton's Raphson method.

(OR)

B) Find a real root of the equation $f(x) = x^3 – x – 1 = 0$ using Bisection method.

Unit-II

3. A) The population of a town in the decimal census was as given below.

Years	1891	1901	1911	1921	1931
Population of Y (in Thousands)	46	66	81	93	101

Estimate the population for the year 1895 using Newton's backward difference interpolation formula.

(OR).

B) If y (1) = -3, y (3) = 9, y (4) = 30 and y (6) = 132, find the four point Lagrange's Interpolation polynomial that takes the same values as the function y at the given points.

Unit-III

4. A) Fit a straight line of the form $y = a_0 + a_1x$ to the data.

x	1	2	3	4	6	8
y	2.4	3.1	3.5	4.2	5.0	6.0

(OR)

B) Fit a polynomial of the second degree to the data points given in the following table.

.

x	0	1.0	2.0
y	1.0	6.0	17.0

Unit-IV

5. A) Evaluate I = $\int_0^1 \frac{1}{1+x}$. Correct to the three decimal places using trapezoidal rule.

(OR)

B) Apply Simpson's 1/3 rule to the integral $\int_0^1 \sqrt{1-x^2}\,dx$.

Unit-V

6. A) Solve y' = -y, y(0) =1, using Euler's method.

(OR)

B) $\frac{dy}{dx} = y - x$, y(0) = 2, find y(0.1) and y(0.2). Correct to four decimal places using Runge-Kutta forth order formula.

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REAL ANALYSIS - 20 MAT 101

Time: 3 Hours **Max. Marks : 70 M**

Answer All questions **10 X 2=20 M**

1. a) Define $f(x) = sin\frac{1}{x}, x \neq 0$
   $= 0, x = 0$ Discuss the continuity of this function on R.
   b) Let f be a differentiable function on (a, b) Then prove that ‘f is continuous on (a, b).
   c) If ‘f is continuous on [a, b] then show that f $\in$R(α) on [a, b].
   d) State Fundamental theorem of calculus.
   e) Define Uniform convergence.
   f) Discuss the uniform convergence of the series $f(x) = \sum_{n=1}^{\infty} \frac{1}{1+n^2 x}$
   g) Define Beta function.
   h) Examine the convergence of $\int_0^1 \frac{dx}{\sqrt{1-x}}$
   i) Define Explicit and Implicit functions.
   j) Define Maxima and Minima value of extreme values.

Answer Five Questions. Choose one Question from each Unit.
ALL Questions carry equal Marks. **(5X10=50 M)**

UNIT-I

2. a) If f is a continuous mapping of a compact metric space X into a metric space Y, then show that f is uniformly continuous on X.

(OR)

b) State and Prove Taylors theorem

UNIT-II

3. a) If f is monotonic on [a, b] and if α is continuous on [a, b] then show that f$\in$ R(α). (Assume that α is monotonic).

(OR)

b) If γ^1 is continuous on [a, b] then show that 'γ' is rectifiable and $\wedge(\gamma) = \int_a^b |\gamma^1(t)|$ dt.

UNIT-III

4. a) If {fn} is sequence of continuous functions on E and if fn -> f uniformly on E, then show that f is continuous on E

(OR)

b) State and prove Stone – weierstrass theorm.

UNIT – IV

5. a) State and prove Abel's test.

(OR)

b) Show that $\int_0^{\infty} \frac{sinx}{x}\,dx$ is convergent but not absolutely.

UNIT-V

6. a) State and prove Taylor's theorem.

(OR)

b) Show that $f(x,y,z)= (x+y+z)^3-3(x+y+z)-24xyz+a^3$ has a minima at (1,1,1) and a maxima at (-1,-1,-1) .

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ORDINARY DIFFERENTIAL EQUATIONS 20 MAT 102

Time: 3 Hours **Max Marks: 70M**

Answer All Questions **(10 X 2 = 20 M)**

1. a) Solve $y' - 2y = 1$
   b) Solve $y' + e^x y = 3e^x$
   c) Write Characteristic polynomials of e^{ax}, sinax, x^k cosax, $x^k e^{ax}$.
   d) Define homogeneous and non-homogeneous equations with example.
   e) Express $f(t) = 1 + t + t^2$ interms of Legendre series.
   f) Show that $P_n(1) = 1$ and $P_n(-1) = (-1)^n$.
   g) Define fundamental matrix of the system of Linear Differential Equations.
   h) State Existence of Uniqueness theorem.
   i) Define Contraction Principle.
   j) Compute first two successive approximations of the equation $x' = e^x$.

Answer any Five questions choosing **One** question from **each unit.**

All questions carry equal marks **(5 X 10 = 50)**

UNIT-I

2. a) State and prove Existence theorem.

(OR)

b) Consider the equation $y''' - 4y' = 0$. Compute three Linearly Independent solutions and Wronskian of the solutions, find Φ satisfying $\Phi(0) = 0$, $\Phi'(0) = 1$, $\Phi''(0) = 0$.

UNIT-II

3. a) Compute the solution of non-homogeneous equation $y''' + y'' + y' + y = 1$, Satisfying $\psi(0) = 0$, $\psi'(0) = 1$, $\psi''(0) = 0$.

(OR)

b) Find two linearly independent solutions for $x>0$, and prove that they are linearly Independent of the equation $y'' + \frac{1}{x} y' - \frac{1}{x^2} y = 0$

UNIT-III

4. a) Show that the Legendre polynomials are given by $P_n(t) = \frac{1}{2^n\, n!} \frac{d^n}{dt^n}(n^2 - 1)^n$.

(OR)

b) Show that $\frac{d}{dt}[t^P J_P(t)] = t^P J_{P-1}(t)$ and $\frac{d}{dt}[t^{-P} J_P(t)] = -t^{-P} J_{P+1}(t)$

UNIT-IV

5. a) Find the fundamental matrix for x' = Ax where A = $\begin{bmatrix} 3 & -2 \\ -2 & 3 \end{bmatrix}$

(OR)

b) Determine exponential e^{At} for the system x' = Ax where A = $\begin{bmatrix} 1 & 1 & 1 \\ 0 & -2 & 3 \\ 0 & 1 & 0 \end{bmatrix}$

UNIT-V

6. a) State and prove Picard's theorem.

(OR)

b) State and Prove Fixed point theorem.

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C PROGRAMMING 20 MAT 103

Time: 3 Hours **Max.Marks:70M**

Answer All questions **10 X 2=20m**

1. a) Explain history of C programming language.
   b) Write the Advantages of C programming languages.
   c) Explain increment and decrement operators with examples.
   d) What is algorithm and explain key features of algorithm.
   e) What is array explain types of arrays with syntax.
   f) What is string? Explain any two string functions with examples.
   g) What is function? Uses of functions.
   h) What is pointer? Uses of pointer.
   i) Write a program to print 1 to n numbers using for loop.
   j) Explain data types.

Answer Five Questions. Choose one Question from each Unit.
ALL Questions carry equal Marks **(5X10=50M)**

UNIT-I

2. a) Briefly explain structure of C program with example.

(OR)

b) Explain C Tokens.

UNIT-II

3. a) Write a program for calculator operations using switch case.

(OR)

b) Explain simple if, if-else, nested if, if else ladder with example programs.

UNIT-III

4. a) Write a program addition of two matrices using arrays.

(OR)

b) Explain the following with example programs

i. strupr ii. Strlen iii. Strlwr

UNIT-IV

5. a) Explain types of functions and its features?

(OR)

b) Explain call by reference.

UNIT-V

6. a) Difference between structure and union.

(OR)

b) What is file and write file operations.

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ALGEBRA 20 MAT 104

Time: 3 Hours **Max Marks: 70**

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Answer All Questions **(10 X 2 = 20 M)**

1. a) If G is a finite group and a ϵ G then $a^{O(G)} = e$.
   b) If $\emptyset$ is a homomorphism from G $\rightarrow$ G ', then $\emptyset(x^{-1}) = [\emptyset(x)]^{-1}$
   c) State Sylow's theorem.
   d) Define direct product of groups.
   e) Define an ideal and maximal ideal of ring R.
   f) Define integral domain with an example.
   g) Define Euclidean Ring.
   h) Define irreducible polynomial over a field F.
   i) Write a short notes about vector space.
   j) Define finite dimensional vector space.

Answer any Five Questions choosing **One** question from **each unit.**

All questions carry equal marks **(5 X 10 = 50)**

UNIT-I

2. A) If H and K are finite subgroups of G of orders O(H) and O(K) respectively then $O(HK) = \frac{O(H)O(K)}{O(H \cap K)}$

(OR)

B) Prove that if G is a group then A(G), the set of automorphisms of a group G is also a group;.

UNIT-II

3. A) State and Prove Cauchy's Theorem.

(OR)

B) State and Prove fundamental theorem on finitely generated abelian groups.

UNIT-III

4 A) If R is a commutative ring with unity and M is an ideal of R, then prove that M is maximal iff $\frac{R}{M}$ is a field.

(OR)

B) Prove that every integral domain can be embedded in a field.

UNIT-IV

5 A) Prove that J[i], the ring of Gaussian integers is a Euclidean ring.

(OR)

B) State and prove Gauss Lemma.

UNIT-V

6 A) Prove that L(S), the linear span of S, is a subspace of the vector space V.

(OR)

B) If V is a finite dimensional vector space and W is a subspace of V, then prove that W is a finite dimensional, dimW ≤ dimV and dim $\frac{V}{W}$ = dimV – dimW

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COMPLEX ANALYSIS 20 MAT 201

Time: 3 Hours **Max Marks: 70M**

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Answer All Questions **(10 X 2 = 20 M)**

1. a) Check the differentiability of f (z) = $\bar{z}$
   b) Determine the singular points of f (z) = $z^2 + 1/(z^2 + 2z + 2)$.
   c) Write the polar form of C-R equations.
   d) Expand the function in a series, f (z) = $1 / z^2 (1 + z)$.
   e) State Liouville’s theorem and fundamental theorem of algebra.
   f) Find the value of the integral of g (z) around the circle $| z – i | = 2$, if g (z) = $1 / (z^2 + 4)$
   g) Find the residue of the function f (z) = $2z / (z + 4) (z – 1)^2$ at z = 1.
   h) Define Three types of Isolated singular points.
   i) Define Argument principle.
   j) Define Mobius transformation and Inverse transformation.

Answer any Five (05) Questions choosing **One** question from **each unit.**

All questions carry equal marks **(5 X 10 = 50M)**

UNIT - I

2 a) The complex function w = f (z) = u + iv is differentiable if and if ‘u’ and ‘v’ are differentiable and satisfies C – R equations. $u_x = v_y$, $u_y = -v_x$.

(OR)

b) Find an analytic function f (z) and its harmonic function v (x, y) when u (x, y) = e^x (xcosy – ysiny).

UNIT – II

3 a) State and Prove Cauchy-Goursat Theorem.

(OR)

b) State and Prove Cauchy Integral formula.

UNIT - III

4 a) State and prove Taylor’s theorem.

(OR)

b) State and prove Laurent’s theorem.

UNIT – IV

5 a) State and prove Cauchy's residues theorem.

(OR)

b) Using residue theorem, evaluate the improper integral

$\int_{-\infty}^{\infty} \frac{cosx\ dx}{(x^2+a^2)\,(x^2+b^2)}$ (a > b > 0).

UNIT - V

6 a) State and prove Rouche's Theorem.

(OR)

b) Discuss the transformation $w = z^2$.

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NUMERICAL METHODS - 20 MAT 202

Time: 3 Hours | Max. Marks: 70

Answer **All** Questions (10x2 = 20 Marks)

1. a).Define bisection method.

   b).Write REGULA-FALSI Formula

   c).Write the condition for Guass Elimination Method fails.

   .

   d).Write system of linear equations if m=n.

   e).Prove that $\Delta= E-1$

   f).Find the third difference with arguments 2,4,9,10 of the function $f(x)=x^3-2x$

   g).Write Newton's backward interpolation Formula.

   h).Write Simpson's 1/3 formula.

   i).Solve the differential equation $y' = x+y$ with $y(0)=1, x\in[0,1]$ by Taylor Series expansion to obtain y for $x=0.1$

   j).Write second order Runge-Kutta formula.

Answer **Five** Questions Choosing one Question from Each Unit. All questions carry Equal Marks. (5x10 = 50 Marks)

UNIT-I

2. A).Use Newton-Raphson method to obtain a root, correct to 3 decimal places of the equation $x+logx=2$.

   (OR)

   B).Find a root of the equation $f(x)=x^3-4x-9=0,$ using the bisection method in Four stages.

UNIT-II

3. A).Solve the equations 10x+2y+z=9, 2x+3y-2z=-44, -2x+3y+10z=22 by Using Gauss –Seidal method.

   (OR)

   B). Solve the system of linear equations $x_1+x_2+x_3=1$, $4x_1+3x_2-x_3=6$, $3x_1+5x_2+3x_3=14$, by triangulation method.

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UNIT-III

4. A).The value of x and y are given as below:

X	5	6	9	11
f(x)	12	13	14	16

Find the value of y at x=10 by using Lagrange's formula.

(OR)

B). Given the following values of $f(x)$ and $f'(x)$.

X	$f(x)$	$f'(x)$
-1	1	-5
0	1	1
1	3	7

Estimate the values of $f(-0.5)$ and $f'(0.5)$ using Hermite interpolation.

UNIT-IV

5. A).Find $f'(0.6)$ by using stirling's formula

X	0.4	0.5	0.6	0.7	0.8
f(x)	1.5836	1.7974	2.0442	2.3275	2.6510

(OR)

B). Values of x (in degrees) and sin x are given in the following table.

x(in degree)	sin x
15	0.2588190
20	0.3420201
25	0.4226183
30	0.5
35	0.5735764
40	0.6427876

Determine the value of first derivative value of sin 38°.

UNIT-V

6. A) (i)Evaluate $\int_{-2}^{2} \frac{x}{5+2x} dx$ by using the Trapezoidal rule with five ordinates.

(ii) Evaluate $\int_{0}^{2} \frac{dx}{x^3+x+1}$ by using the Simpson's $\frac{1}{3}$ rule with h = 0.25.

(OR)

B). Solve $\frac{dy}{dx} = -2xy^2$ with y(0)=1 and h=0.2 on the interval [0,1] using Runge-Kutta fourth order method.

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PARTIAL DIFFERENTIAL EQUATIONS– 20 MAT 203

Time: 3 Hours **Max Marks: 70M**

Answer **All** questions 10x2=20m

1. a) Define orthogonal trajectories on surface of the given system of curves.
   b) Define Pfaffian differential equation and state the necessary and sufficient condition to be integrable .
   c) Define the three classes of integrals of a Partial differential equations.
   d) If the expression $(p^2 + z)dx + (x^2 + z)dy$is and exact differential equation.
   e) Define Wave equation and Laplace equation
   f) Define Greens function.
   g) Write the two types of boundary value problems for Laplace equations.
   h) Reduce the equation $u_{xx} - x^2 u_{yy} = 0$ to a canonical form.
   i) Define Helmholtzs equation.
   j) Write the Riemann-Volterra solution form one dimensional wave equation.

Answer **Five** Questions. Choose one Question from each Unit.
ALL Questions carry equal Marks. (5X10=50M)

UNIT-I

2. a) A necessary and sufficient condition that there exists between two functions u(x, y) and v(x, y) is a relation F(u, v) = 0 not involving x or y explicitly is that $\frac{\partial(u,v)}{\partial(x,y)} = 0$

(OR)

b) Verify that the equation $z(z + y^2)dx + z(z + x^2)dy - xy(x + y)dz = 0$ is integrable and find its primitive.

UNIT-II

3. a) Explain the charpits method of solving the equation $f(x, y, z, p, q) = 0$.Using this method find the complete integral of the equation $(p^2 + q^2)y = qz$.

(OR)

b) Find a complete integral of $p^2x + q^2y = z$ using Jacobi's method.

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UNIT-III

4. a) Solve the equation $r + s - 2t = e^{x+y}$ with usual notation.

(OR)

b) Solve the equation $r + 4s + t + rt - s2 = 2$ using Monge's method.

UNIT-IV

5. a) A rigid sphere of radius a is placed in a stream of fluid whose velocity in the undisturbed state is V. Determine the velocity of the fluid at any point of the disturbed stream.

(OR)

b) State and Prove Kelvin's inversion theorem.

UNIT-V

6. a) Derive D'Alembert's solution of the one-dimensional wave equation.

(OR)

b) If ψ is determined by the differential equation $a^2 \frac{\partial^2 \psi}{\partial x^2} + b^2 \psi = \frac{\partial^2 \psi}{\partial y^2}$ Where a and b are constants and by the conditions $y = 0, \psi = f(x), \frac{\partial \psi}{\partial y} = g(x)$ show by the Riemann-Volterra Method.

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LATTICE THEORY 20 MAT 204

Time: 3 Hours Max.Marks:70M

Answer **All** questions 10 X 2=20m

1. a) Define a Completely ordered set
   b) Define JDCC.
   c) Define meet irreducible element.
   d) Define a Complete Lattice.
   e) Define a closure operation.
   f) Define modular lattice.
   g) Define distributive lattice.
   h) State the Isomorphism theorem of Modular Lattices.
   i) Define Boolean Ring.
   j) Define Complete Boolean Algebra.

Answer **Five** Questions. Choose one Question from each Unit.
ALL Questions carry equal Marks. (5X10=50M)

UNIT I

2. (a) Prove that a partly ordered set can satisfy both the maximum and minimum conditions if and only if every one of its sub chain is finite.

(OR)

(b) Show that every sub chain of a partly ordered set satisfying the maximum condition has a greatest element.

UNIT II

3 (a) Define an Order isomorphism. Show that if two lattices are isomorphic if and only if they are also order isomorphic.

(OR)

(b) (i) Show that every weakly complemented lattice is semi complemented.
(ii) Show that every section complemented lattice bounded below is weakly complemented.

UNIT III

4. (a) Prove that every order preserving mapping of a complete lattice into itself has a fix element.

(OR)

(b) Show that every element of a compactly generated lattice can be represented as a meet of finite number of meet irreducible elements.

UNIT IV

4. (a) State and Prove Dedekind's modularity criterion.

(OR)

(b) Show that all irredundant irreducible meet - representations of any element of a modular lattice have the same number of components.

UNIT V

6. (a) For a complete Boolean algebra B, show that the following conditions are equivalent.
   1) B is completely meet- distributive
   2) B is atomic
   3) B is isomorphic with the subset lattice of a set.

(OR)

(b) Show that the algebra of relations R (M) of a set M forms a complete Boolean algebra.

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TOPOLOGY 20 MAT 301

Time: 3 Hours **Max Marks: 70M`**

Answer All Questions **(10 X 2 = 20 M)**

1.a) Define metric space.

b) Define continuous function and convergence sequence in a matric space.

c) Define Topological space..

d) Show that $\bar{A}$ = A U D (A).

e) Define compact space.

f) State Ascoli's Theorem.

g) Define Hausdorff space.

h) Define connected space.

i) Define Cantor set and show that the cantor set is compact.

j) Define totally disconnected space.

Answer any Five Questions choosing **One** question from **each unit.**

All questions carry equal marks **(5 X 10 = 50)**

UNIT - I

2 a) State and prove Cantor's Intersection Theorem.

(OR)

b) Let X be a metric space. Then, prove that any finite intersection of open set is open, each closed sphere is a closed set.

UNIT - II

3 a) State and Prove Lindelof's theorem

(OR)

b) Show that every separable metirc space is second countable.

UNIT - III

4 a) State and Prove Tychonoff's Theorem.

(OR)

b) Show that every sequentially compact matric space is compact.

UNIT - IV

5 a) State and Prove Urysohn's lemma.

(OR)

b) Show that every compact Haussdorff space is normal.

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UNIT - V

6. a) Prove that the Product of any non-empty class of connected space is connected.

(OR)

b) Let X be a Hausdorff space. If X has an open base whose sets are also closed, Then show that X is totally disconnected.

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PROBABILITY & STATISTICS 20 MAT 302

Time: 3 Hours Max.Marks:70M

Answer **All** questions 10 X 2=20m

.1.

a. Define Equally likely events.
b. Definition of Axiomatic probability.
c. Define Correlation.
d. Define random variable.
e. Define moment generating function.
f. Define Normal distribution.
g. Define characteristic function.
h. Write Application of Normal distribution.
i. Define chi-square distribution of goodness of fit.
j. Write properties of F-distribution.

Answer **Five** Questions. Choose one Question from each Unit.
ALL Questions carry equal Marks (5X10=50M)

UNIT-I

2. (a) State and prove multiplication theorem in probability

(OR)

(b) State and prove Baye's theorem.

UNIT-II

3. (a) Prove that Mx1+ x2+ x3+….+ xn= Mx1+Mx2+Mx3+…..+Mxn

(OR)

(b) Write properties of Characteristic function.

UNIT-III

4. (a) Using MGF derive mean and variance of Binomial distribution

(OR)

(b) Write properties of Normal distribution

UNIT-IV

5. (a) Calculate Karl-Pearson's coefficient of correlation between expenditure advertising and sales from the data given below advertising

Expenses (000's)	39	65	62	90	82	75	25	98	36	78
Sales (Lakhs Rs.)	47	53	58	86	62	68	60	91	51	84

(OR)

(b) What is Linear regression? Sate and prove angle between two regression lines.

UNIT-V

6. (a) The number of scooter accidents per month in a certain town were as follows:

12	8	20	2	14	10	15	6	9	4

Are there frequencies in agreement with the belief that accident conditions were the same during this 10 month period?

(OR)

(b) Ten cartons are taken at random from an automatic filling machine. The mean net weight of the 10 cartons is 11.8 and s.d. is 0.15. Does the sample mean differ significantly from the intended weight of 12.02? You are given that for v=9 and t0.05=2.20

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GALOIS THEORY 20 MAT 303

Time: 3 Hours **Max Marks : 70M**

Answer All Questions **(10 X 2 = 20 M)**

1 a) Define R-Module and a sub module.
b) Define R-homomorphism and irreducible R-module.
c) Define a root of polynomial and monic polynomial
d) Show that x^2-2 is irreducible over Z.
e) Define splitting field of a polynomial and give an example.
f) Define normal extension of a field and a prime ideal.
g) What is meant by fixed field of a Group homomorphism?
h) Write a Short notes on Galois extension of a field.
i) What is Cyclotonic polynomial? Explain with an example.
j) Define Cyclic extension and a radical extension of a field.

Answer **Five** Questions choosing **One** question from **each unit.**

All questions carry equal marks **(5 X 10 = 50)**

UNIT-I

2 a) Let f be an R-homomorphism of an R-module M into an R-module N. Then prove that $M / \ker f \cong f(M)$

(OR)

b) Let R be a ring with unity, then prove that an R-module M is cyclic iff $M \cong R/ I$, for some left ideal I or R.

UNIT-II

3 a) State and prove Gauss lemma.

(OR)

b) Define algebraic element and algebraic extension of a field. If E is a finite extension of a filed F, then prove that E is an algebraic extension of F.

UNIT-III

4. a) State and prove Uniqueness of splitting field.

(OR)

b) Let $f(x) \epsilon F[x]$ be a polynomial of degree ≥ 1 with α as a root, then prove that α is a multiple root iff $f'(\alpha) = 0$.

UNIT-IV

5 a) State and prove the fundamental theorem of Galois theory.

(OR)

b) State and prove Dedikind lemma.

UNIT-V

6. a) Let F be a field contains a primitive nth root unity, then prove the following are Equivalent.
   i. E is a finite cyclic extension of degree n over F.
   ii. E is the splitting field of an irreducible polynomial $x^n - b \in F[x]$.

(OR)

b) If a and b are constructible numbers, then prove that
   i. ab is constructible.
   ii. a / b, $b \neq 0$ is constructible.

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MATHEMATICAL METHODS 20 MAT 304

Time: 3 Hours **Max Marks: 70M**

Answer All Questions **(10 X 2 = 20 M)**

1. a) Write the Dirichlet's conditions for a Fourier series.

b) Write the Fourier series expansion of even periodic function

c) Write Euler's function formula.

d) Define Covariant vector & invariant vector.

e) Solve the difference equation Solve $y_{n+2} - 5y_{n+1} - 6y_n = 0$.

f) Find the extrimal of the functional $\frac{\sqrt{1+(y')^2}}{y}$.

g) Write the first and second shifting theorems of Laplace transformations.

h) Find the Laplace transformation of $e^{2t} + 4t^3 - 2\sin 3t + 3\cos 3t$.

i) Find Inverse Laplace transformation of $\frac{p}{p^2-a^2}$

j) Find Inverse Laplace transformation of $\log\left(\frac{p+3}{p+4}\right)$.

Answer any Five (05) Questions choosing one question from each unit.

All questions carry equal marks **(5 X 10 = 50 M)**

UNIT I

2. a) Find the Fourier series of the function $(x) = x\sin x$; $-\pi \leq x \leq \pi$.

(OR)

b) Find the Fourier series of the function $(x) = x \sin x$; $-\pi \leq x \leq \pi$. Deduce that $\frac{1}{1.3} - \frac{1}{3.5} + \frac{1}{5.7} - \ldots\ldots.. = \frac{\pi-2}{4}$

UNIT II

3. a) Find the curve passing through the points (x_1, y_1) and (x_2, y_2) and when rotated about the X-axis gives a minimum surface area.

(OR)

b) Prove that necessary condition for $I = \int_{x1}^{x2} f(x, y, y')dx$ to have an extrimal is $\frac{\partial f}{\partial y} - \frac{\partial}{\partial x}\left(\frac{\partial f}{\partial y}\right) = 0$.

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UNIT III

4. a) (i) Solve $y_{n+2} - 4y_{n+1} + 3y_n = 5^n$,

(ii) Solve $y_{n+2} - 2y_{n+1} + y_n = n^2 2^n$.

(OR)

b) Solve the difference equation $u_{n+3} - 2u_{n+2} - 5u_{n+1} + 6u_n = 0$.

UNIT IV

5. a) Prove the following Hypothesis:

If F(t) is continuous for all $t \geq 0$ and be of exponential order a as $t \to \infty$ and if $F'(t)$ is of class A, then the Laplace transformation of the derivative $F'(t)$ exist when $p > a$ and $L[F'(t)] = pL[F(t)] - F(0)$

(OR)

b) Find the Laplace transformation of $\frac{e^{-at} - e^{-bt}}{t}$, and $\{J_0(t)\}$

UNIT V

6. a) Find the inverse Laplace Transformation of the following functions

(i) $\frac{2p+1}{(p+2)^2(p-1)^2}$ (ii) $\frac{e^{-4p}}{(p-3)^4}$

(OR)

b) State and prove convolution theorem.

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MEASURE AND INTEGRATION 20 MAT 402A

Time: 3 Hours **Max.Marks:70M**

Answer All questions **10 X 2=20m**

1. a) Define Outer measure
   b) State Fatou's Lemma.
   c) State bounded Convergence Theorem
   d) State Jordan decomposition theorem.
   e) State Radon Nikodym Theorem.
   f) Define Measurable set.
   g) Define Countable set.
   h) Define Product measure.
   i) Define Measurability.
   j) Define Positive set and Negative set.

Answer **Five** Questions. Choose one Question from each Unit.

ALL Questions carry equal Marks

(5X10=50M)

UNIT I

2. (a) State and Prove Egoroff's theorem.

(OR)

(b) If{ En} is a decreasing sequence of measurable sets with mE1 finite, then show that m(En) = lim m(En).

UNIT II

3. (a) State and Prove Lebesgue convergence theorem

(OR)

(b) Let f be a non negative function which is integrable over a set E. Then Show that given Є > 0, there is a δ > 0 such that for every set A E with mA < δ, f < Є A.

UNIT III

4. (a) State and Prove Vitali Covering Lemma.

(OR)

(b) If f is absolutely continuous on [a,b] and f1(x)=0 a.e., then show that f is constant.

UNIT IV

5. (a) Define positive set and negative set with respect to a signed measure γ.Prove that the union of countable collection of positive sets is positive.

(OR)

(b) State and prove the Jordan Decomposition Theorem.

UNIT V

6. (a)State and prove the Caratheodary Extension Theorem.

(OR)

(b)State and prove Fubini's Theorem.

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GRAPH THEORY-20 MAT 402B

Time: 3 Hours **Max. Marks: 70M**
Answer All Questions **(10x2 = 20M)**

1. a) Draw an example of Hamiltonian graph
   b) Define complete graph
   c) Define a binary Tree
   d) Define Spanning Tree
   e) Define cut-vertex.
   f) Draw an example of Seperable graph
   g) Give relation between edge Connectivity and Vertex connectivity
   h) Draw Kuratowskis Second Graph
   i) Define Planar graph.
   j) Define incidence matrix.

Answer Five Questions Choosing one Question from Each Unit. All questions carry Equal Marks. (5x10 = 50 Marks)

UNIT-I

2. a) Prove that a connected graph G is an Eulerian graph if and only if all vertices of G are of even degree.

(OR)

b) Prove that in a complete graph with n-vertices, there are $\frac{n-1}{2}$ edge disjoint Hamiltonian circuits, if n is odd number ≥ 3

UNIT-II

3. a) (i) Prove that any connected .graph with n vertices and n - 1 edges is a tree.

   (ii) Prove that the distance between vertices of a connected graph is a metric.

(OR)

b) Prove that with respect to any of its spanning trees, a connected graph of n vertices and e edges has n - 1 tree branches and e - n + I chords.

UNIT-III

4. a) Prove that in a connected graph G, any minimal set of edges containing atleast one branch of every spanning tree of G is a cut-set.

(OR)

b) Prove that the ring sum of two cut-sets in a graph is either a third cut-set or an edge-disjoint union of cut-sets.

UNIT-IV

5. a) Prove that Kuratowski's first graph is non planar.

(OR)

b) Prove that a connected planar graph with n vertices and e edges has e - n +2 regions.

UNIT-V

6. a) If A(G) is an incidence matrix of a connected graph G with n-vertices, then show that the rank of A(G) is n-1.

(OR)

b) Let A_f be the reduced incidence matrix of a connected digraph. The number of spanning trees in the graph equals the value of $\det(A_f . A_f^T)$.

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REAL ANALYSIS – II 20 MAT 402C

Time: 3 Hours **Max Marks: 70**

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Answer All Questions **(10 X 2 = 20 M)**

1. a) Show that the function E is periodic, with period 2π i.
   b) Define Orthogonal and Orthonormal system of functions.
   c) Define Linear Transformation and Inverse operator.
   d) Show that dim $R^n = n$.
   e) Show that a Linear operator **A** on R^n is invertable, the det $[A] \neq 0$.
   f) Let $f(0, 0) = 0$ and $f(x, y) = xy\,(x^2 - y^2)/\, x^2 + y^2$, the prove that $(D_{12}\, f)\,(0,0) = 1$ and $(D_{21}\, f)\,(0, 0) = -1$.
   g) Define Primitive mapping.
   h) Let ω and λ be k and m forms in V respectively, then show that $(\omega + \lambda)_T = \omega_T + \lambda_T$.
   i) Write a brief note on Affine-simplexes.
   j) Define exact form and show that every exact of class c' is closed.

Answer any Five Questions choosing **One** question from **each unit.**

All questions carry equal marks **(5 X 10 = 50)**

UNIT I

2 a) State and Prove Taylor's Theorem.

(OR)

b) State and Prove Bessel's Inequality.

UNIT II

3 a) A Linear Operator **A** on a finite dimensional vector space X is one-one, if and only if the range of **A** is all of X.

(OR)

b) Define a contraction mapping. State and prove Contraction Principle.

UNIT III

4 a) State and prove Inverse function theorem.

(OR)

b) Suppose f is defined in an open set $E \subset R^n$, suppose that D_1f, $D_{21}f$ and D_2f exists at every point of E, and $D_{21}f$ I continuous at some point $(a, b) \in E$. Then show that $D_{12}\, f$ exists and $(D_{12}\, f)\,(a, b) = D_{21}\, f(a, b)$

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UNIT IV

5 a) For every f ϵ C (I^K), Show that L(f) = L (f ').

(OR)

b) Suppose E is an open set in R^n. If w is of class ¢" in E, then show that $d^2w = 0$

UNIT V

6 a) State and prove States Theorem.

(OR)

b) Show that closed forms are exact in convex sets.

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RINGS & MODULES 20 MAT 402 D

Time: 3 Hours **Max Marks: 70**

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Answer All Questions **(10 X 2 = 20 M)**

1.a) Define Boolean Algebra and Boolean ring.

b) In a boolean ring R, R is commutative. Show that ab = ba, a, b ϵ R.

c) Define right R-module & left R-module.

d) Define congruence relation and homomorphic relation

e) Define Artinian and Noetherian Modules.

f) Define prime radical and Nilpotent element.

g) Define prime ideal and regular ring.

h) Define Annihilator of a subset R

i) Define lower set in an ordered set.

j) Define Compact topological space, and properties of topological space.

Answer any Questions choosing **One** question from **each unit.**

All questions carry equal marks **(5 X 10 = 50)**

UNIT I

2 a) Show that a Boolean algebra becomes a complemented distributive lattice by defining a v b = (a ' Λ b ')' & 1=0' and conversely, any complemented distributive lattice is a Boolean algebra in which these equations are provable identities.

(OR)

b) In a Boolean algebra, show that a''=(a')'=a

UNIT II

3 a) Show that the following statements are equivalent.

(a) R is isomorphic to a finite direct product of rings R_i (i =1,2,…,n)

(b) There exist central orthogonal idempotent e_i ε R such that $1=\sum_{i=1}^{n} e_i$, $e_i R \cong R_i$

(c) R is a finite direct sum of ideals $K_i \cong R_i$

(OR)

b) Let B be a sub module of A_R. Then show that A is Artinian if and only if B and A/B are Artinian.

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UNIT III

4 a) Show that the radical of a ring R consists of all elements r ∈ R such that 1 – r x is a unit for all X ∈ R.

(OR)

b) Let R be a sub directly irreducible commutative ring with smallest non zero ideal J. Then show that

(a) The annihilator J* of J is the set of all zero divisors.
(b) J* is a maximal ideal and J** = J.

UNIT IV

5 a) If R is any commutative ring, then show that Q(R) is rationally complete.

(OR)

b) If R is commutative semi prime and rationally complete, then show that every annihilator of R is a direct summand.

UNIT V

6. a) Show that a Boolean algebra is isomorphic to the algebra of all subsets of a set if and only if it is complete and atomic.

(OR)

b) If P is a prime ideal of the commutative ring R, then show that **P/0*P*** is a prime

Ideal of **R/0*p*** and it contains all zero – divisors of **R/0*p*.**

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ELECTIVE -II

ALGEBRAIC CODING THEORY 20 MAT 403A

Time: 3 Hours **Max.Marks:70**

Answer All questions **10 X 2=20m**

1. a) Define Hamming weight and Hamming distance of a Code.
   b) Define Information Rate.
   c) Is S = {1101,1110,1011} a linearly independent set.
   d) Find the generating matrix for the code C = {000,001,010,011}.
   e) Define Coset of a Linear Code.
   f) Define a Generator polynomial for a Cyclic Code.
   g) Define Dual Code.
   h) Check whether the following code is cyclic: C = {000,100,011,111 }
   i) Let C={1000,0100,0010,0001}be the code. Check whether C detects 1001 or not.
   j) Define Reed-Muller Code.

Answer **Five** Questions. Choose one Question from each Unit.

ALL Questions carry equal Marks

(5X10=50M)

UNIT – I

2. a) Define CMLD, IMLD. Construct IMLD table for the code C = {0000,1001,0110,1111}

(OR)

b) Suppose p=0.90 , M =3, n=4, and C ={0000,1010,0111}. For each v in C, calculate p(C, v) and Find the error patterns that corrected by C ={000,111}.

UNIT II

3. a) Explain in about Error detecting and Error correcting codes.

(OR)

b) Explain Linear codes in detail.

UNIT III

4. a) Find a parity check matrix for the code C={000000,010101,101010,111111}

(OR)

b) If H is a parity –check matrix for a linear code C then show that C has distance d if and only if any set of (d-1) rows of H are linearly independent and at least one set of d rows of H is linearly dependent.

UNIT IV

5. a) State and prove Hamming bound theorem.

(OR)

b) Construct an SDA for a Hamming Code of length 7 and use it to decode the following words:

(i) 1101011

(ii) 0101011.

UNIT V

6. a) Show that g(x) is a generator polynomial for a linear cyclic code C of length n if and only if g(x) divides (1+x n).

(OR)

b) Explain about the Polynomials Encoding and Decoding.

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LINEAR PROGRAMMING 20 MAT 403B

Time: 3 Hours **Max. Marks: 70M**
Answer All Questions **(10x2 = 20 Marks)**

1. a). Write the general form of a linear programming problem(LPP).
   b). With reference to an LPP define slack and surplus variables
   c). Explain artificial variable of a LPP
   d). Explain unbounded solution of a LPP.
   e). State the dual primal relation ships
   f). What is meant by duality in LPP.
   g).State the transportation problem in the format of a LPP.
   h). Explain North-West corner rule.
   i). Give a mathematical formulation of the assignment problem.
   j). What is an assignment problem.

Answer **Five** Questions Choosing one Question from each Unit.
ALL Questions carry equal Marks (5x10=50M)

UNIT-I

2. a). Solve the following LP by graphical method.
   Maximize $z = x_1 + 3x_2$
   Subject to $3x_1 + 6x_2 \leq 8$
   $5x_1 + 2x_2 \leq 10$ and $x_1, x_2 \geq 0.$
   (OR)
   b). Solve the following LPP by simplex procedure
   Maximize $Z = 5x_1 + 3x_2$
   Subject to constraints $x_1 + x_2 \leq 2$
   $5x_1 + 2x_2 \leq 10$
   $3x_1 + 8x_2 \leq 12$ and $x_1, x_2 \geq 0.$

UNIT-II

3. a). Solve the following LPP by Big-M method.
   Minimize $Z = 4x_1 + 3x_2$
   Subject to constraints $2x_1 + x_2 \geq 10$
   $-3x_1 + 2x_2 \leq 6$
   $x_1 + x_2 \geq 6$ and $x_1, x_2 \geq 0$
   (OR)
   b). Use Two-phase simplex method to
   Minimize $Z = 3x_1 + 2x_2$
   Subject to constraints $2x_1 + x_2 \leq 2$
   $3x_1 + 4x_2 \geq 12$ and $x_1, x_2 \geq 0$

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UNIT-III

4. a). Use dual simplex method to solve the following LPP.

Minimize $Z = x_1 + 2x_2 + 3x_3$

Subject to constraints $x_1 - x_2 + x_3 \geq 4$

$x_1 + x_2 + 2x_3 \leq 18$

$x_2 - x_3 \geq 2$

and $x_1, x_2, x_3 \geq 0$

(OR)

b). Use complementary slackness conditions to solve the following LPP:

$Min\ Z = 3x_1 + x_2 s.t. x_1 + x_2 \geq 1;\ 2x_1 + 3x_2 \geq 2;\ x_1, x_2 \geq 0$

UNIT-IV

5. a). Solve the following TP by considering the initial feasible solution obtain by Vogel's

Approximation method

	M_1	M_2	M_3	M_4	Supply
A	6	3	5	4	22
B	5	9	2	7	15
C	5	7	8	6	8
Demand	7	12	17	9	

(OR)

b). Find the optimal solution to the following transportation problem obtaining the initial basic feasible solution by North-West Corner rule.

	M_1	M_2	M_3	M_4	Supply
A	7	9	3	2	16
B	4	4	3	5	14
C	6	4	5	8	20
Demand	11	9	22	8	

UNIT-V

6. a).Describe an algorithm for the solution of the assignment problem.

(OR)

b). Solve the following assignment problem represented by the following matrix

	A	B	C	D
1	10	25	15	20
2	15	30	5	15
3	35	20	12	24
4	17	25	24	20

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ANALYTICAL NUMBER THEORY 20 MAT 403C

Time: 3 Hours **Max Marks: 70M**

Answer All Questions **(10 X 2 = 20 M)**

1. a) Define Mobius function $\mu(n)$.
   b) Define multiplicative function.
   c) Define the average order of d(n).
   d) Write the average order of $\mu(n)$ and ^(n).
   e) Define Chebyshev's functions.
   f) State Shapiro's Tauberian theorem.
   g) Write an expression of an asymptotic formula for the partial sums.
   h) Prove congruence is an equivalence relation.
   i) State Little Fermat's Theorem.
   j) Solve the congruence $5x \equiv 3 (mod 24)$.

Answer any **Five** Questions choosing one question from each unit.

All questions carry equal marks**(5 X 10 = 50 M)**

UNIT-I

2. a) Define the Dirichlet product. State and prove Mobius Inversion formula.

(OR)

b) Show that if both g and f*g are multiplicative, and then f is also multiplicative.

UNIT-II

3. a) State and prove Euler's summation formula.

(OR)

b) State and prove Legendre's Identity

UNIT-III

4. a) Show that the following relations are logically equivalent:

(i) $\lim_{x\to\infty}(\frac{\pi(x)\log x}{x}) = 1$

(ii) $\lim_{x\to\infty}\frac{\vartheta(x)}{x} = 1$

(iii) $\lim_{x\to\infty}\frac{\psi(x)}{x} = 1$

(OR)

b) State and prove Abel's Identity.

UNIT-IV

5. a) State and prove Chinese Remainder Theorem

(OR)

b) State and prove Wilson's Theorem.

UNIT-V

6. a) Show that a finite abelian group G of order n has exactly n distinct characters

(OR)

b) Let A* denote the conjugate transpose of a matrix A, then show that AA* = nI, Where I is the nxn identity matrix and hence n^{-1} A* is the inverse of A.

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DISCRETE MATHEMATICAL STRUCTURES 20 MAT 403 D

Time: 3 Hours **Max Marks: 70 M**

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Answer All Questions **(10 X 2 = 20 M)**

1. a) Define a tautology with an example.
   b) Define disjunctive normal form and conjunctive normal form of a statement formula.
   c) Define partially ordered relation with an example.
   d) Give an example of a relation which is neither reflexive nor irreflexive
   e) Define lattice and give an example.
   f) What is a distributive lattice.
   g) Define Boolean Algebra with an example.
   h) Obtain the value of the Boolean form $x_{1*(}x_1^1 \oplus x_2)$
   i) Define minterm & maxterm.
   j) Define transition diagram.

Answer any Questions choosing **One** question from **each unit.**

All questions carry equal marks **(5 X 10 = 50)**

UNIT-I

2. a) Show that n^3 +2n is divisible by n.

(OR)

b) Show that SVR is tautologically implied by (PVQ) ,P→ Q , Q →S.

UNIT-II

3. a) Let $X = \{1, 2, 3\}$ if $R = \{(x, y)/\ x \in X \wedge y \in X \wedge ((x - y)$ is an integral non-zero multiple of 2)}, $S = \{(x, y)/\ x \in X \wedge y \in X \wedge ((x - y)$ is an integral non-zero multiple of 3)}.Find $R \cup S$ and $R \cap S$ (b) If $X = \{1, 2, 3, \dots .\}$, What is $R \cap S$ for R and S as defined in (a)

(OR)

.

b) Draw Hasse diagrams of $((A), \subseteq)$ for (a) A= {a}; (b) A={a, b}; Let A be a given finite set and $\rho(A)$ its power set. Let $\subseteq$ be the inclusion relation on the A= {a, b, c} (d) A= {a, b, c, d}

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UNIT-III

4. a) Let (L, ≤) be a lattice . For any a, b, c ∈ L show that the followingholds:
   $a \leq c \Leftrightarrow a \oplus (b * c) \leq (a \oplus b) * c$

(OR)

b) Show that in a lattice (L,≤), for any a , b, c∈ L, the distributive inequalities hold:

$$a \oplus (b * c) \leq (a \oplus b) * (a \oplus c)$$

$$a * (b \oplus c) \geq (a * b) \oplus (a * c)$$

UNIT-IV

5. a) Write the following Boolean expression in an equivalent sum of products Canonical form in three variables x_1, x_2 and x_3 (a) $x_1 * x_2$; (b) $x_1 \oplus x_2$; (c) $(x_1 \oplus x_2)^u * x_3$

(OR)

b) Obtain the values of the Boolean forms $x_1 * (x^{1'} \oplus x_2)$, $x_1 * x_2$ and $x_1 \oplus (x_1 * x_2)$ over the ordered pairs of the two-element Boolean algebra.

UNIT-V

6. a) Draw the karnaugh map for one variable, two variables, 3-variable, 4-variable

(OR)

b) Discuss the model of a finite state machine.

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FUNCTIONAL ANALYSIS 20 MAT 404

Time: 3 Hours **Max Marks: 70**

`Answer All Questions **(10 X 2 = 20 M)**

1. a) State Schwarz inequality and Triangle Inequality.
   b) Define inner product space & orthogonality.
   c) Define Hilbert space and Banach space.
   d) State Baire's Category Theorem in Complete metric space.
   e) Define Total Orthonormal Set.
   f) Define Hilbert-Adjoint operator.
   g) Define reflexive space.
   h) Define Closed-Linear operator.
   i) Define Contraction T on a metric space.
   j) Define Fredholm and Volterra integral equations.

Answer any Five (05) Questions choosing **One** question from **each unit.**

All questions carry equal marks. (5x10=50)

UNIT - I

2. A) Show that every finite dimensional subspace Y of a normal space X is complete. In particular, every finite dimensional normed space is complete.

(OR)

B) If Y is a Banach space then, prove that (the set of all bound linear operators from X into Y) B(X, Y) is a Banach space.

Unit-II

3 A) State and prove Bessell Inequality.

(OR)

B) State and prove Minimizing vector Theorem.

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Unit-III

4 A) State and prove Riesz-Representation Theorem.

(OR)

B) Let the Operators $U: H \rightarrow H$ and $V: H \rightarrow H$be unitary and His Hilbert space. Then, prove that a bounded linear operator T on a complete Hilbert space H is unitary if and only if T is isomeric and surjective.

Unit-IV

5 A) State and prove Generalized Hahn-Banach Theorem.

(OR)

B) State and prove Open Mapping Theorem.

Unit-V

6 A) State and prove Banach fixed point theorem.

(OR)

B) State and prove Picard's Existance and Uniqueness theorem.