Course Code: PGMAT2C001T

Course Title: LINEAR ALGEBRA

Learning Outcomes:

- Solve systems of linear equations using multiple methods, including Gaussian elimination and mtrix inversion.
- Carry out matrix operations, including inverse and determinants.
- Demonstrate understanding of linear independence, span and basis.
- Determine eigenvalues and eigen vectors and solve eigen problems.
- Apply principal of matrix algebra to linear transformation.

Course Outcomes:

- To use mathematically correct language and notation for linear algebra.
- To become computational proficiency involving procedures in linear algebra.
- To understand the axiomatic structure of modern mathematical subject and learn to construct simple proofs.
- To solve problems that apply linear Algebra to Chemistry, Economics and Engineering.

Course code: PGMAT2C001T

Course title: Linear Algebra

Course Credits: 4

Unit-1

- Matrix, Operations on Matrices, Special types of Matrices, Elementary Matrices, Vectors in $\mathbb{R}^n$ and $\mathbb{C}^n$
- Row reduction, Rank of a matrix, Solution of Matrix equation $AX = B$, Determinants, Cramer's Rule

Unit-2

- Vector spaces, Subspaces, Quotient Spaces, Linear span, Linear independence and dependence, Basis and Dimension, Finite dimensional vector spaces, Existence of basis, Computations with a basis

Unit-3

- Linear Transformation, The Matrix of Linear Transformation, Rank-nullity theorem, Effect of change of basis on Matrix of a linear transformation,
- Linear Operator, Eigenvalues and eigenvectors, characteristic polynomial of a linear operator, Diagonalization

Unit-4

- Orthogonal matrices and rotations
- Bilinear forms: Symmetric forms, Hermitian forms, Orthogonality, Orthogonal Projection, Euclidean and Hermitian Spaces

Unit-5

- The Spectral Theorem, Classificaion of conics
- Modules, Submodules, Structure theorem for finitely generated modules over a Principal ideal Domain (statement only), Rational and Jordan Canonical forms

Recommended Text

1. M Artin, Algebra, Second edition, PHI Learning Private Limited, New Delhi, 2012.

References

1. I N Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. K Hoffman and R Kunze, Linear Algebra, 2nd Edition, Prentice Hall, Englewood Cliffs, New Jersey, 1971.
3. S K Jain, A Gunawardena & P B Bhattacharya, Basic Linear Algebra with Matlab, Key College Publishing (Springer-Verlag) 2001.
4. S Kumaresan, Linear Algebra, A Geometric Approach, Prentice Hall of India, 2000.

Course Code: PGMAT2C003T

Course Title: Complex Analysis:

Objectives: The course's main objective is to lay the groundwork for complex analysis field of mathematics. The goal is to introduce the fundamental concepts, methods, and applications of complex analysis. The majority of the topics taught can be used in Applied Mathematics and Engineering.

Learning Outcomes:

In this course, the students will master the algebra of complex numbers, mappings in the complex plane, the theory of multi-valued functions and the calculus of single complex variable functions.In particular, students should be able to do the following after completing this course:

- perform basic mathematical operations with complex numbers in Cartesian and polar forms;
- find the modulus of a Complex valued function and related results;
- determine the continuity, differentiability and analyticity of a function;
- find the Taylor series of a function and determine its radius of convergence;
- find the Laurant series of a function;
- to learn about the singularities of the function through Laurant series;
- learn to use Argument Principle;
- understand and develop skills in the use of Rouche's theorem;
- find the residue of a function and use the residue theory to evaluate an integral over some contour;
- to learn the conformal mappings, Mobius transformation and cross ratio;
- to learn about the open mapping theorem, maximum and minimum modulus principle.

...e Title: Complex Analysis

Duration of Examination: 3 hours

Course Code: PGMAT2C003T

Maximum-Marks: 100

Unit-1

Review of complex numbers, Stereographic projection, Chordal distance, Multi-valued functions, Branches of multi-valued functions, with special reference to *arg z*, exponential functions, Logarithm function, power functions and phase factors. Analytic functions: Limit and continuity of complex functions, complex derivative, Singularities, Cauchy- Reinmann equations, Cauchy-Reinmann equations in polar form, Harmonic functions, Harmonic conjugate.

Unit-2

Line integrals, Piecewise smooth path, Jordan curve, Green's theorem, Independence of path, Anti-derivative, fundamental theorem of calculus, Mean value property, Strict maximum principal (real and complex version), ML-estimate.

Unit-3

Complex integration and analyticity: Cauchy's theorem, Cauchy Integral formula, Cauchy integral formulae for higher order derivatives.

Liouville's theorem, Cauchy's inequality, Morera's theorem, Goursat's theorem, complex form of Cauchy-Riemann equations.

Unit-4

Power series, radius of convergence, power series expansion of an analytic function: Taylor's expansion, Isolated singularities, Laurent Series. The residue calculus, Cauchy residue theorem, fractional residues, Jordan's lemna, Evaluation of integrals using residue theorem.

Kamlesh Kumar

138

conformal mappings, Mobius transformations, composition of two Mobius transformations Translations, Dilations, Inversion, The Schwarz lemma, Conformal Self-maps of the unit disk, Mappings of the unit disk and upper half plane, The Riemann Mapping theorem (Statement only).

Text-Books:

1. TW Gamelin, Complex Analysis, Springer–Verlag, New York Berlin Heidelberg 2001.

References:

1. Walter Rudin; Real & Complex Analysis, Tata Mc-Graw Hill,2006
2. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 2005
3. J.W. Brown & R.V. Churchill, Complex variables and applications, Mc-Graw Hill International VIII-Edition, 2009
4. J.B. Conway, Function of One complex variable, Springer International Student Edition, 1980
5. L.V. Ahlfors, Complex Analysis, International Edition, McGraw Hill International Editions, 1979.

Course Code: PGMAT2E001T

Course Title: PARTIAL DIFFERENTIAL EQUATIONS

OBJECTIVES: The goal of this course is to introduce partial differential equations to students. The goal of this project is to create analytical tools for solving partial differential equations. To have a better understanding of the properties of partial differential equation solutions. Following objectives are introduced:

1. Introduce partial differential equations to pupils.
2. Show pupils how to solve linear partial differential equations using various strategies.
3. In 2D and 3D, derive heat and wave equations.
4. Determine the solutions of PDEs based on conditions at the spatial domain's border and initial conditions at time zero.
5. Separation of variables technique for solving PDEs and analysing solution behaviour in terms of eigen function expansions.

LEARNING OUTCOMES:

On completion of the course the student should have the following learning outcomes. Students will be able to

1. Categorise partial differential equations and transform them into canonical form after completing the course.
2. Solve first- and second-order linear partial differential equations
3. Use partial derivative equations to forecast the behaviour of various phenomena.
4. Conduct research and generate creative results in the area of speciality using specialised procedures, techniques, and resources.
5. In order to interpret reality, extract information from partial derivative models.
6. Recognize real-world occurrences as partial derivative equation models.

Kamlesh Kumar

se Title: Partial Differential Equations Course Code: PGMAT2E002T

Duration of Examination: 3 hours Maximum marks: 100

Objective: This course is an important part of applied Mathematics for understanding the physical sciences, Engineering and Technology. A large number of physical phenomena occurring in Physics and Engineering can be formulated mathematically in the form of Partial Differential equations.

A pre-requisite for this course is the course on Ordinary differential equations.

Unit-1

- Formulation of first order partial differential equations: Derivation of PDE by elimination method of arbitrary functions, Solution of linear first order partial differential equations (Lagrange method), Integral surfaces passing through a given curve, The Cauchy Problem for first order PDE, Lagranges linear PDE and non Linear PDE of first order

Unit-2

- Compatible systems of first order partial differential equations, Charpits method for solving first order non linear Partial differential equations
- Classification of second order Partial Differential Equations, Canonical form: Elliptic, Parabolic and Hyperabolic PDE

Unit-3

- Laplace Equation and its derivation, Boundary value Problems, Properties of Harmonic functions: Spherical mean, Mean Value theorem, Maximum-Minimum Principle and its applications, Separation of variables, Dirichlet and Neumann problem for a rectangle

Kamlesh Kumar

...it-4

• Heat Equation: Boundary equations, Fundamental solutions of Heat equation, Dirac Delta function, Separation of variables method

Unit-5

• Wave Equation: Derivation of one dimensional wave equation and its solution by canonical reduction, Initial value problem of Cauchy's type; D' Alembert's solution, Vibrating string-variables separable solution, Boundary and initial value problems for two-dimensional wave equations-Eigen function method, uniqueness of solution for the wave equation

Text book:

1. K Sankara Rao, Introduction to partial differential equations, Prentice Hall of India, 2nd Edition, New Delhi, 2007.

Reference books:

1. Renardy and Rogers, An introduction to PDEs, Springer-Verlag, 1999.
2. Smoller, Shock Waves and reaction-diffusion equations, second edition, 1994.
3. Kevorkian, Partial Differential equations, Wadsworth and Brooks/ cole
4. F John, Partial differential equations
5. L C Evans, Partial differntial equations, AMS, 1998.
6. B Folland, Introduction to partial differential equations.
7. D Gilbarg and N S Trudinger, Elliptic Partial differential equations of second order.
8. W A Strauss, Partial differential equations, An Introduction, Wiley, John and sons 1992.
9. B P Parashar, Differential and Integral equations, Oscar Publication

Course Code: **PGMAT2C004T**

Course Title: **OPTIMIZATION TECHNIQUES**

OBJECTIVE: The goal of this course is to cover the fundamentals of linear programming, nonlinear programming, dynamic programming problems, classical optimization techniques, numerical methods of optimization, the basics of different evolutionary algorithms, explain integer programming techniques, and apply different optimization techniques to solve models.

LEARNING OUTCOMES

Upon successful completion of this course, students will be:

- Able to explain the essential understanding of Linear Programming, Non-linear Programming, and Dynamic Programming problems after completing the topic.
- Able to formulate the LPP for a real-world situation and provide a solution utilising appropriate optimization approaches.
- Able to use the Graphical, Simplex, and Big-M methods to solve LPP.
- Able to complete the assignment and the problem of the travelling salesman.
- Able to use traditional optimization techniques as well as numerical optimization methods.

Course Title: Optimization Techniques Course Code: PGMAT2C004T

Duration of Examination: 3 hours Maximum marks: 100

Unit-1

- Linear programming-I (Graphical method) Formulation of a linear programming problem with different types of constraints, requirements, assumptions, merits and demerits, applications of LP, Graphical analysis, Graphical solution, Multiple, unbounded solution and infeasible problems and its applications
- Linear programming-II (Simplex method (SM)) Simplex Method: Principle, Computational aspect, SM with several decision variables. Two phase LP problem, Big-M method, multiple, unbounded solution, infeasible problems, Sensitivity and duality analysis in LP.

Unit-2

- Assignment Problem (AP): Approach, procedure and maximization, unbalanced and crew assignment problems.
- Transportation Problem (TP): Structure and formulation of TP, Procedure for TP, Methods for finding initial solution and optimality, Unbalanced, maximization, degeneracy, transhipment in TP.

Unit-3

- Sequencing problems: Processing of n-jobs through two, three, M-machines, Processing of n-jobs through m-machines.
- Replacement Problems: Replacement of items that deteriorate with time (with and without change in money value), Staff replacement problem.

1

Course Title: Topology

Course Code: PGMAT2C002T

Duration of Examination 3 hours

Maximum Marks: 100

Objective:

This course is aims at familiarizing the students with the basic concepts of Topology. A preliminary knowledge of real and complex analysis is essential.

Unit-1

• Topological Spaces: Definition and some examples, Interior, Closure, and Boundary of a set, Basis and Subbasis, First and second countable spaces, Continuous function, Open and Closed Functions, Homeomorphism, Subspaces

Unit-2

• Connectedness: Connected and disconnected Spaces, Results on Connectedness, Connected subsets of real Line, Applications of connectedness, Path Connected Spaces, Locally connected and Locally Path connected Spaces

Unit-3

• Compact Spaces and Subspaces, Compactness and Continuity, Properties related to Compactness, OnePoint Compactification, The Cantor Set

Unit-4

• Finite Products, Arbitrary Products, Comparison of Topologies, Quotient Spaces • Separation Axioms: T0, T1, and T2 Spaces

Unit-5

• Regular Spaces, Normal Spaces, Separation by Continuous functions: Uryshon's Lemma, Completely regular spaces, Tietze extension theorem

Text book:

1. F H Croom, Principles of Topology, Cengage Learning India Private Limited, New Delhi, First Indian Reprint 2008.

Reference books:

1. G F Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill

2. James R Munkeres, Topology, Afirst course, Prentice Hall of Indi Pvt. Ltd., New Delhi, 2000.

3. J Dugundji, Topology, Allyn and Bacon, 1966(reprinted in India by PHI Pvt. Ltd.)

Kamlesh Kumar

4. K D Joshi, Introduction to general Topology, Wiley, Eastern Ltd. 1983.

5. S T Hu, Elements of General Topology, Holden-Day, Inc. 1965.

6. W J Pervin, Foundations of General Topology, Academic Press Inc., New York, 1964.

7. S Willard, General Topolgy, Addison - Wesley, Reading, 1970.

Course Title: **Introduction to Measure Theory** Course No: [illegible]

Course Type: **Elective (Disciplinary)**

Duration of Examination: 2 Hours Maximum Marks: [illegible]

Objective: The aim of this course is to study general theory of measure and integration. The theory of measure has its origin in the idea of length, area and volume in Euclidean space. It is a pre-requisite course for Fourier Analysis and Wavelets and has lots of applications in [illegible] Operator theory, integral equations, Probability theory and several branches of Physics.

Unit-1

- σ -algebra of sets, limits of sequences of sets, Generation of σ-algebras, Bor[illegible] algebra, Measure on a σ-algebra, Measurable spaces and measure spaces, Out[illegible] construction of Measure by means of outer measure (statement only), Construction of [illegible] measures by means of sequential covering class (statement only)

Unit-2

- Lebesgue measure on ***R***, some **properties** of Lebesgue measure, Translation [illegible] Lebesgue measure, Existence of non-Lebesgue measurable sets, Measurable function[illegible] Operations with measurable functions (without proof), Equality almost everywhere, Sequence of measurable functions

Unit-3

- Lebesgue Integration, Integration of step functions, Approximation theorem (statement only), Lebesgue integral of non-negative functions, Lebesgue integral of measurable functions, Convergence a.e., Almost uniform convergence, Convergence in measure, Convergence in mean, Cauchy sequence in measure (only definitions)
- Statements of following theorems :
  Fatous Lemma, Lebesgue monotone convergence theorem, Lebesgue dominat[illegible] convergence theorem.

Text book:

1. J. Yeh, Lectures on Real Analysis, World Scientific, 2000

Reference books:

1. M E Munroe, Measure and Integration, 2nd edition, Addison Wesley 1971
2. G De Barra, Measure theory and Integration, Wiley Eastern Ltd., 1987
3. H L Royden, Real Analysis, 3rd edition, Macmillan, New York, 1988