

KU5DSCMAT303
MATRICES, FOURIER SERIES
AND
PARTIAL DIFFERENTIAL EQUATIONS

| Semester | Course Type | Course Level | Course Code | Credits | Total Hours |
|----------|-------------|--------------|--------------|---------|-------------|
| V | DSC | 300-399 | KU5DSCMAT303 | 4 | 60 |

| Learning Approach (Hours/ Week) | | | Marks Distribution | | | Duration of ESE (Hours) |
|---------------------------------|-----------------------|----------|--------------------|-----|-------|-------------------------|
| Lecture | Practical/ Internship | Tutorial | CE | ESE | Total | |
| 4 | | 1 | 30 | 70 | 100 | 2 |

Course Description

This course introduces fundamental concepts in matrices, Fourier series, and partial differential equations, with applications. Topics include matrix operations, eigenvalues and eigenvectors, Fourier series representations of periodic functions, and methods for solving first- and second-order partial differential equations such as the heat and wave equations. The course emphasizes both theoretical understanding and practical problem-solving skills.

Course Prerequisite

Basic knowledge of differentiation and integration, matrices and ordinary differential equations.

Course Outcomes

| CO No. | Expected Outcome | Learning Domains |
|--------|---|------------------|
| 1 | Comprehend basic matrix operations and rank of a matrix | Understand |
| 2 | Apply Gauss-Jordan elimination, matrix inversion and Cayley-Hamilton theorem to solve systems of linear equations efficiently | Understand |
| 3 | Comprehend eigenvalues and eigenvectors of matrices | Understand |
| 4 | Understand and construct Fourier series for periodic functions, including arbitrary periods and half-range expansions | Understand |
| 5 | Understand and solve basic PDEs by separating variables and Fourier series, including specific solutions for the wave and heat equations. | Apply |

| Mapping of Course Outcomes to PSOs | | | | | | | |
|------------------------------------|-------|-------|-------|-------|-------|-------|-------|
| | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PSO 7 |
| CO 1 | ✓ | | | | | | |
| CO 2 | ✓ | | | | | | |
| CO 3 | ✓ | | | | | | |
| CO 4 | ✓ | | | | | | |
| CO 5 | ✓ | | ✓ | | | | |

COURSE CONTENTS

Contents for Classroom Transaction

| M O D U L E | U N I T | DESCRIPTION | HOURS |
|----------------------------|-------------------|--|-------|
| I | Matrices I | | 14 |
| | 1 | Basic Operations | |
| | | (a) Quick review of Matrix Addition, Subtractions, Scalar Multiplication, Matrix Multiplication and Transpose of a Matrix. | |
| | | (b) Row-Echelon form | |
| | | (c) Elementary Row and Column Operations | |
| | | (d) Rank of a Matrix | |
| | 2 | Simultaneous Linear Equations | |
| | | (a) Consistency, Matrix notation | |
| | | (b) Theory of solutions, Simplifying operations, Gaussian elimination algorithm, Pivoting strategies | |
| | | (c) Gauss-Jordan elimination. | |

| | | | |
|---|--|---|--|
| II | Matrices II | | 14 |
| | 1 | Matrix inversion | |
| | | (a) The Inverse | |
| | | (b) Simple inverses | |
| | | (c) Calculating inverses (Using elementary row operations) | |
| | | (d) Simultaneous linear equations | |
| | | (e) Properties of the inverse | |
| | 2 | Eigenvalues and Eigenvectors | |
| | | (a) Characteristic equation, characteristic polynomial, eigenvalues, eigenvectors | |
| (b) Properties of eigenvalue and eigenvectors | | | |
| (c) Cayley-Hamilton theorem | | | |
| III | Fourier Series | | 13 |
| | 1 | (a) Fourier Series | |
| | | (b) Functions of Any Period $p=2L$ | |
| | | (c) Even and Odd Functions. Half-Range Expansions | |
| IV | Partial Differential Equations | | 14 |
| | 1 | a) Basic Concepts of PDEs | |
| | | b) Solution by Separating Variables. Use of Fourier Series | |
| | | c) D'Alembert's Solution of the Wave Equation. | |
| | | d) Heat Equation: Solution by Fourier Series (exclude other problems) | |
| Teacher specific module | | 5 | |
| 1 | Proofs of properties of eigenvalues and eigenvectors | | |
| | 2 | | Vectors, linearly independent vectors, row rank, column rank |

Essential Readings

1. Bronson, R., *Theory and Problems of Matrix Operations* (2nd ed.), Schaum's Outline Series, McGraw-Hill.
2. Erwin Kreyszig, *Advanced Engineering Mathematics* (10th edition).

Reference Distribution

| Module | Unit | Reference No. | Sections | Remarks |
|------------|------|---------------|--------------------------------|--|
| I | 1 | 1 | Chapter 1 | <i>Quick review of matrix addition, subtraction, scalar multiplication, matrix multiplication, and transpose of a matrix. Questions from these topics should not be asked in the End Semester Examination.</i> |
| | 2 | 1 | Chapter 2 | <i>Proofs of all theorems are excluded. Pivoting strategies and Gauss-Jordan elimination are also excluded</i> |
| II | 1 | 1 | Chapter 4 | <i>4.13 and 4.14 are excluded</i> |
| | 2 | 1 | Chapter 7 | <i>All problems related to linearly independent vectors, left and right eigenvalues, the proof of the Cayley-Hamilton theorem, and the proofs of properties of eigenvalues and eigenvectors are excluded.</i> |
| III | 1 | 2 | Sections 11.1,11.2, 11.3 | |
| IV | 1 | 2 | Section 12.1, 12.3, 12.4, 12.6 | |

Suggested Readings

1. Lay, D. C., Lay, S. R., & McDonald, J. J. (2020). Linear Algebra and Its Applications (6th ed.). Pearson Education.
2. Narayan, S., & Mittal, P. K. (2004). Textbook of Matrices. S. Chand & Company Ltd.
3. Ayres, F. Jr. (1966). Theory and Problems of Matrices (Schaum's Outline Series). McGraw-Hill.
4. Higher Engineering Mathematics, B.S. Grewal (43rd edition), Khanna Publishers
5. S.L. Ross, Differential Equations, 3rd Edition, Wiley.
6. G. Birkhoff and G.C. Rota, Ordinary Differential Equations, Wiley and Sons, 3rd Edition
7. E.A. Coddington, An Introduction to Ordinary Differential Equations, Printice Hall

Assessment Rubrics

| Evaluation Type | | Marks |
|-------------------------|--------------------|--------------|
| End Semester Evaluation | | 70 |
| Continuous Evaluation | | 30 |
| a) | Test Paper * | 12 |
| b) | Assignment | 12 |
| c) | Seminar, Viva-Voce | 6 |
| Total | | 100 |

* A student has to appear for at least two written tests. The average mark of the best two tests is to be considered for the internal mark.

** **Use of Scientific Calculators below 100 functions (that is, upto *fx 99*) shall be permitted.**