**DISCIPLINE-SPECIFIC CORE COURSE-6:**

**ALGEBRA FOR STATISTICS**

## CREDIT DISTRIBUTION, ELIGIBILITY, AND PRE-REQUISITES OF THE COURSE

| Course title & Code | Credits | Credit distribution of the Course | | | Eligibility Criteria | Pre-requisite of the Course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| Algebra For Statistics | 4 | 3 | 0 | 1 | Class XII pass with Mathematics | Nil |

### Learning Objectives

- Algebra serves as a building block that will enable students to learn more advanced techniques that will help them to solve problems more quickly and easily.

### Learning Outcomes:

The learning outcomes of this course are as follows:

- Understanding the fundamental concepts of matrices and determinants
- Understanding of partitioning of matrices, Echelon form
- Solving Linear equations
- Knowledge of Vector spaces and Subspaces, Orthonormal Basis
- Identifying rank of a Matrix
- Computing generalized inverse, characteristic roots and vectors, quadratic forms

## SYLLABUS OF DSC-6

### Theory

**UNIT I** **(09 Hours)**

### Algebra of matrices

A review related to triangular, symmetric, and skew-symmetric matrices, singular, and non-singular matrices, and their properties.

Idempotent matrices, Hermitian and skew Hermitian matrices, orthogonal matrices, Trace of a matrix, unitary, involutory and nilpotent matrices. Adjoint and inverse of a matrix and related properties. Partitioning of matrices and simple properties.

**UNIT II** **(12 Hours)**

### Determinants

A review related to properties and applications of determinants for 3$^{rd}$ and higher orders. Alternant determinant, Circulant determinant, Jacobi's Theorem, the product of determinants. Use of determinants in solution to the system of linear equations, row

reduction and echelon forms, the matrix equations AX=B, solution sets of linear equations, Applications of linear equations, inverse of a matrix.

**UNIT III** **(09 Hours)**

**Vector spaces**

Vector spaces, Subspaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension and basis, Gram Schmidt Orthogonalization Process. Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum, and the product of two matrices.

**UNIT IV** **(15 Hours)**

**Generalized Inverse**

Generalized inverse (concept, properties with illustrations). Characteristic roots and characteristic vector, Properties of characteristic roots and characteristic vector, Cayley Hamilton theorem and application, Spectral Decomposition. Quadratic forms, Derivatives of linear functions, and quadratic forms. Linear orthogonal transformation and their diagonalization.

**PRACTICAL – 30 Hours**

**List of Practicals:**

1. Inverse of a matrix by method of partitioning.
2. Every non-singular square matrix can be expressed as product of elementary matrices.
3. Generalised Inverse of a matrix and Symmetric Generalised Inverse of a matrix.
4. Find $XGX'$ for any matrix X of order nxk; k< n, where G is generalized inverse of $X'X$ and study its properties.
5. Construction of Idempotent matrix and study its properties.
6. Construction of Orthogonal matrix and study its properties.
7. Characteristic roots and characteristic vectors and its properties
8. Cayley Hamilton Theorem and application.
9. Quadratic Form:
   (a) Reducing Quadratic Form into canonical form and find rank, index and signature of the form.
   (b) Identify the nature of Quadratic Form.
10. Construction of an orthonormal basis vector using Gram Schmidt Orthogonalization process.

**Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS.**

**ESSENTIAL READINGS:**


- Searle, S.R.: Matrix Algebra useful for Statistics, John Wiley & Sons, 1982.
- Krishnamurthy, V., Mainra, V.P. and Arora, J.L. (2015). An Introduction to Linear Algebra, East West Press Pvt. Ltd., New Delhi.
- Hadley, G.: Linear Algebra, Narosa Publishing House (Reprint), 2002.
- Gupta, S. C.: An Introduction to Matrices (Reprint), Sultan Chand & Sons, 2008.


**SUGGESTED READINGS:**