# Discipline Specific Elective (DSE) Courses

## Discipline Specific Elective (DSE) Course 2a: Linear Algebra

| Course Title & Code | Credits | Credit Distribution of the Course | | | Eligibility Criteria | Prerequisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture (45 Hours) | Tutorial (15 Hours) | Practical (00 Hours) | | |
| **DSE 2a: Linear Algebra** | **4** | **3** | **1** | **0** | **NIL** | **NIL** |

**Course Objectives:**

- To allow students to manipulate and understand multidimensional space.

**Course Learning Outcomes:** After successful completion of this course, student will be able to:

- Demonstrate a deep understanding of vector spaces, subspaces, linear independence, basis, and dimension.
- Analyze and interpret linear transformations, matrix representations, and change of basis, including orthogonality and inner product spaces.
- Apply orthogonality and the Gram-Schmidt process in practical problems.
- Compute eigenvalues, eigenvectors, and perform spectral and decomposition.
- Use generalized inverses and quadratic forms in practical problems.

**Unit I (10 Hours)**

Concept of groups and fields with examples, Vector spaces and Subspaces with examples, Direct sum and Algebra of subspaces viz. sum, intersection, union etc, Linear combinations, Spanning sets, Linear spans, Linear dependence and independence in vector spaces, Row and Column space of a matrix, Basis and Dimensions.

**Unit II (11 Hours)**

Linear Transformations, Kernel and Image of a linear transformation, Rank and Nullity, Matrix representation of a linear operator, Change of Basis, Similarity, Inner product spaces with examples, Cauchy-Schwarz inequality with applications, Orthogonality, Orthonormal sets and Bases, Gram Schmidt Orthogonalization Process.

**Unit III (12 Hours)**

Eigenvalues and eigenvectors, Spectral decomposition of a symmetrical matrix (Full rank and non-full rank cases), Example of spectral decomposition, Spectral decomposition of asymmetric matrix, Cayley Hamilton theorem, Algebraic and geometric multiplicity of characteristic roots, Diagonalization of matrices, Factorization of a matrix, Eigenvalues and eigenvectors for solution of Differential equations.

**Unit IV (12 Hours)**

Generalized inverse of a matrix, Different classes of Generic ized inverse, Properties of g-inverse, Reflexive g-inverse, left Weak and right Weak g-inverse, Moore- Penrose (MP) g-inverse and its properties, Real quadratic form, Linear transformation of quadratic forms, Index and signature, Reduction of quadratic form into sum of squares, Gram matrix with example, Jordan canonical form.

**Tutorial:**

Tutorial sessions will include at least one activity such as group discussion/presentation/ problem solving exercise based on the material covered in the lectures along with scholastic work related to the conceptual understanding of the subject.

**Essential Readings:**


1. Axler, S. (2024). *Linear Algebra Done Right*, Springer.
2. Searle, S.R. and Khuri, A.I. (2017). *Matrix algebra useful for statistics*. John Wiley & Sons.
3. Strang, G. (2012). *Linear Algebra and its Applications*, Academic Press.


**Suggested Readings:**


1. Biswas, S. (1997). *A Text Book of Matrix Algebra*, New Age International Publishers.
2. Golub, G.H. and Van Loan, C.F. (1989). *Matrix Computations,* John Hopkins University Press.
3. Hadley, G. (2002). *Linear Algebra,* Narosa Publishing House.
4. Rao, C.R. (1973). *Linear Statistical Inferences and its Applications*, John Wiley & Sons.
5. Robinson, D.J.S. (1991). *A Course in Linear Algebra with Applications*, World Scientific.