

**Course Title:** Linear Algebra

**Course Code:** MATH-303

**Course Type:** Major Math

**Prerequisites:** Group Theory

**Credit Hours:** 3 (3 + 0)

**Course Objectives:** After completion of this course, the students will be able to:

- Analyze and solve complex systems using linear equations for practical applications utilizing MATLAB/Python for computational efficiency.
- Explore the structure and properties of vector spaces and linear transformations.
- Apply linear transformations, eigenvalues, and eigenvectors to real-world problems, enhancing skills in matrix diagonalization.
- Utilize linear algebra techniques in diverse applications such as fractals, chaos theory and cryptography.

**Course Contents:**

**Systems of Linear Equations and Matrices:** Definition of matrix, various types of matrices(Diagonal, Triangular, Symmetric Matrices), Algebra of matrices, Determinants, Systems of Linear Equations, Gaussian elimination and Gauss Jordan method. Applications of linear systems: Network analysis (Traffic flow), Electrical circuits

**Vector Spaces:**Additive Abelian group, Definition of a field and examples, Real vector spaces, subspaces, Linear combination and spanning set, Linear independence and linear dependence, Basis, Dimension, Quotient space, Rank of a matrix and its applications.

**Orthogonality in Vector spaces:** Inner product, Orthogonality, Gram-Schmidt process, Orthogonal Complement, Method of least squares.

**Eigenvalues and Eigenvectors:** Eigenvalues and eigenvectors, Characteristic polynomial, Diagonalization of a matrix, Cayley-Hamilton Theorem.

**Linear Transformations:** Definition of linear transformations, Invertibility and singularity of linear transformations, Rank and nullity of linear transformations, Matrix of a linear transformation.

**Applications of Linear Algebra:** Fractals, Chaos theory, and Cryptography.

**Recommended Books:**

1. Anton, H. and Rorres, C., *Elementary Linear Algebra Applications Version*, John Wiley and Sons Inc. 9th Edition, 2005.
2. Friedberg, S. H., Insel, A. J. and Spence, L. E., *Linear Algebra*, Prentice Hall, 3rd Edition, 2000.

3. Kolman, B. and Hill, D. R., *Introduction Linear Algebra with Applications*, Prentice Hall International, Inc. 7th Edition, 2001.
4. Lipschutz, S., *Schaum's Outline of Beginning Linear Algebra*, Mc-Graw Hill Company, New York, 1996.
5. Nicholuson, W. K., *Elementary Linear Algebra*, PWS-Kent Publishing Company, Boston, 2004.

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