

Core VII

Linear Algebra

Course Objective:

The objective of this course is to acquaint students with matrix operations, solution of system of equations, vector spaces and linear transformations. In addition, the student will learn about eigenvalues, diagonalization, canonical forms, etc., which has many applications in almost all areas of science and engineering.

Learning Outcomes: After completing the course the student will be able to

- Determine basis and the dimension of a finite-dimensional vector space, know the relation between rank and nullity of a linear transformation.
- The relation between matrix and linear transformation.
- To find solution of system of linear equations, compute eigenvalues, eigenvectors of a matrix and linear transformation.
- About orthogonality of vectors and application of it to different form of matrix, introduced to different operators.

Unit I

Vector spaces, subspaces, span of a set, more about subspaces, linear dependence, independence, product and quotient space, dimension and basis, linear transformations, range and kernel of a linear map, rank and nullity of linear map.

Unit II

Inverse of linear transformation, consequences of rank – nullity theorem, the space $L(U, V)$, composition of linear maps, matrix associated with linear map, linear map associated with matrix, rank and nullity of a matrix, determinant minors and rank of a matrix, transpose of a matrix and special type of matrices, elementary row operations

Unit III

System of linear equations, matrix inversion, application of determinant to linear equations, eigenvalues and eigenvectors, similarity of matrices, invariant subspaces, minimal polynomial (eigenvalues and the minimal polynomial), upper triangular matrices, diagonalizable operators (diagonal matrices, conditions for diagonalizability).

Unit IV

Inner product space: inner products and norms, orthonormal bases, orthogonal complements, self-adjoint and normal operators, spectral theorems, isometries, unitary operators, characteristic polynomial, Cayley – Hamilton theorem, Jordan form, trace, quadratic form, application to reduction of quadrics.

Books Recommended:

- ✓ *V. Krishnamurthy, V.P. Mainra, J. L. Arora, An introduction to linear algebra, Affiliated East – West press Pvt. Ltd., New Delhi, 1976.*
- ✓ *Sheldon Axler, Linear algebra done right (Fourth edition), Springer, 2024.*

Books for References:

- ✓ *Seymour Lipschutz and Marc Lars Lipson, Linear Algebra (Schaum's outlines, Fourth Edition), McGraw Hill, New York, 2009.*
- ✓ *A. Ramachandra Rao and P. Bhimsankaram, Linear Algebra (Second Edition), Hindustan Book Agency, 2000.*
- ✓ *Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra (Fourth Edition), Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.*
- ✓ *Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.*
- ✓ *S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.*
- ✓ *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*
- ✓ *e-Learning Source <http://ndl.iitkgp.ac.in> ; <http://ocw.mit.edu> ; <http://mathforum.org> ; <https://linear.axler.net>; and <https://library.oapen.org/handle/20.500.12657/85067>*