25MT103 LINEAR ALGEBRA

Hours Per Week :

L	T	P	SL	C
3	2	0	3	4

PREREQUISITE KNOWLEDGE: Basics of Geometry and Algebra.

COURSE DESCRIPTION AND OBJECTIVES:

This course introduces students to the core concepts of linear algebra, including matrix operations, linear systems, vector spaces and inner product spaces. The objective is to equip students with the necessary mathematical tools to model, analyze and solve real-world problems across various engineering and scientific fields.

MODULE-1

UNIT-1 **18L+12T+0P+18SL= 48 Hours**

MATRICES:

Elementary row and column operations, Elementary matrices, Similar Matrices, Echelon form, Row reduced echelon form, Rank of a matrix, Inverse of a matrix by Gauss-Jordan method, LU decomposition.

UNIT-2

SYSTEMS OF LINEAR EQUATIONS:

Systems of linear equations, Matrix representation, Consistency using rank of the coefficient matrix, Solutions: Gaussian elimination method, Gauss-Jordan method, Do-Little method.

PRACTICES:

- Perform elementary row/column operations and find the rank of a matrix.
- Compute the inverse of a matrix using the Gauss-Jordan method and LU decomposition.
- Check consistency of a system of linear equations.
- Solve homogeneous and non-homogeneous linear systems using Gauss elimination, Gauss-Jordan and Do-Little methods.
- Solve linear systems using the ***Vyaktāvyakta-Nyāya*** (Substitution) and compare with Gaussian elimination. Analyze consistency and computational efficiency.

MODULE-2

UNIT-1 **27L+18T+0P+27SL=72 Hours**

EIGENVALUES, EIGENVECTORS AND DIAGONALIZATION:

Characteristic Equation, Eigenvalues, Eigenvectors and their Properties (without proofs), Cayley-Hamilton Theorem (without proof), Diagonalization of a Matrix (only for diagonalizable matrices).

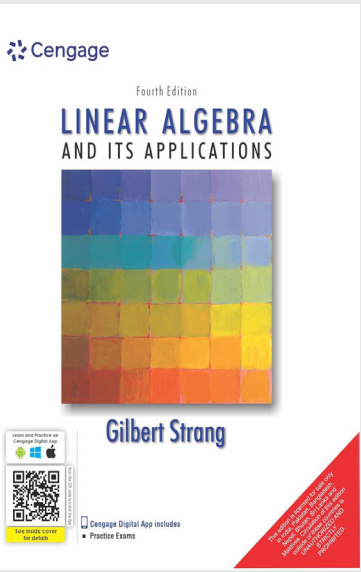
Applications: Inverse of a matrix by Cayley-Hamilton Theorem, Power of a diagonalizable square matrix.

UNIT-2

REAL VECTOR SPACE:

Real vector space, Subspace, Linear dependence and independence, Linear span, Bases and dimension.

Applications: Row space and column space of a matrix, Determining rank of a matrix using row space and column space, Row and column spaces of similar matrices.



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SKILLS:

- ✓ *Understanding abstract algebraic structures.*
- ✓ *Solving linear systems using various numerical techniques.*
- ✓ *Evaluating eigenvalues, eigenvectors and matrix transformations.*
- ✓ *Applying linear algebra in engineering applications.*
- ✓ *Using rthogonalization and decomposition in advanced algorithms*

UNIT-3

REAL INNER PRODUCT SPACE:

Real inner product space, Norm of a vector, Orthogonal set, Orthonormal set, Cauchy-Schwarz inequality, Gram-Schmidt orthogonalization process.

Applications: QR decomposition and singular value decomposition (SVD).

PRACTICES:

- Find eigenvalues and eigenvectors of a given matrix and verify Cayley-Hamilton theorem.
- Determine the diagonalization of a matrix and compute its power using diagonalization.
- Identify vector subspaces, bases and dimensions.
- Determine rank of a matrix using row and column spaces.
- Apply Gram-Schmidt process to find an orthonormal basis of a vector space.
- Perform QR decomposition.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Mapping with POs
1.	Determine the rank of matrices using row operations and solve systems of linear equations to assess their consistency.	Apply	1, 2
2.	Compute eigenvalues, eigenvectors and diagonalization for advanced matrix computations.	Evaluate	1, 2, 5, 9
3.	Analyse and apply inner product space concepts for orthogonalization and decomposition techniques.	Analyze	1, 3, 5
4.	Compare the row and column spaces of similar matrices and evaluate their structural properties for advanced computations.	Apply	1, 2, 9, 10
5.	Utilize linear algebra concepts in real-world applications such as optimization, control systems and artificial intelligence.	Analyze	1, 2, 4, 6, 7, 11

MAPPING OF SUSTAINABLE DEVELOPMENT GOALS (SDGS) AND INDIAN KNOWLEDGE SYSTEM (IKS):

TEXT BOOKS:

1. Gilbert Strang, "Linear Algebra and Its Applications", Cengage Learning, 5th Edition, 2016.
2. Kanti B. Datta, Varma, P. Sekhar, "Calculus, Linear Algebra and Ordinary Differential Equations", Cengage Learning, 1st Edition, 2024.

REFERENCE BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley, 10th Edition, 2011.
2. Sheldon Axler, "Linear Algebra Done Right", Springer, 3rd Edition, 2015.
3. George B. Thomas & Ross L. Finney, "Calculus and Analytic Geometry", Addison-Wesley, 9th Edition, 1995.