

Semester II

Linear Algebra

Course Code	Teaching hours per week				Credits	Exam Hours	Course Type	CIE Marks	ESE Marks
	L	T	P	R					
26ANNBS201	2	1	0	0	3	2 Hrs. 30 Mins.	Theory	40	60

- Preamble:** To provide a comprehensive understanding of linear algebra focusing on fundamental concepts and applications and to develop necessary skills to effectively utilize linear algebra in advanced studies and professional practice.
- Prerequisites:** Elementary Matrix Operations.

Syllabus

Module Number	Syllabus Description	Contact Hours
1	Linear systems of equations - Linear systems of equations, Solution by Gauss elimination, Row echelon form and rank of a matrix, Fundamental theorem for linear systems - homogeneous and non-homogeneous (without proof), Eigen values and Eigen vectors of matrices, Diagonalization of matrices, Application of eigen values - Singular Value Decomposition, Principal Component Analysis, Linear Discriminant Analysis (Concept only) [Relevant topics from Text 1 - Sections: 7.3, 7.4, 7.5, 8.1, 8.4]	9
2	Vector Spaces - Vector Spaces, Examples of vector space – R^n and $M_{m \times n}$ only, Subspaces, Examples as subspaces of R^n and $M_{m \times n}$, Linear combinations of vectors in a vector space, Spanning sets, Linear dependence and independence, Basis for a vector space, The dimension of vector space, Coordinate representation in R^n , Change of basis in R^n : Transition Matrix (without proof). [Relevant topics from Text 2 - Sections: 4.2, 4.3, 4.4, 4.5, 4.7]	9
3	Linear Transformations - Linear Transformations, Properties of linear transformations, Linear Transformation given by a matrix, Rotation in R^2 , Projection in R^3 , Kernel of a Linear Transformation	9

Module Number	Syllabus Description	Contact Hours
	and its basis, Range of a Linear Transformation and its basis, Rank and Nullity of a Linear Transformation, Sum of Rank and Nullity (without proof), Matrices for Linear Transformations. [Relevant topics from Text 2 - Sections: 6.1, 6.2, 6.3]	
4	Inner product Space - Vector length and unit vector, Dot product and angle between two vectors, Inner product, Examples as R^n and $M_{2 \times 2}$, Properties of inner products, Definitions of length, distance and angle, Orthogonal projections in inner product spaces, Orthogonal and orthonormal sets, Orthogonal and orthonormal basis, Gram-Schmidt orthonormalization process (without proof), The least squares problem, Solving the least square problems (without proof). [Relevant topics from Text 2 - Sections: 5.1, 5.2, 5.3, 5.4]	9
Total hours		36

3. Course Assessment Method (CIE: 40 Marks, ESE: 60 Marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination -1 (Written)	Internal Examination -2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions.

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 = 24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

4. Course Outcomes

At the end of the course students should be able to:

Course Outcome		Blooms Taxonomy Level
CO1	Solve systems of linear equations, evaluate eigenvalues and eigen vectors and diagonalize matrices.	K3
CO2	Utilize the concepts and properties of vector spaces and subspaces.	K3
CO3	Apply the concepts of linear transformations to analyze their properties, rank and nullity.	K3
CO4	Use the properties of inner product spaces and orthonormalization	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

5. Mapping of Course Outcomes with Program Outcomes

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	-	-	-	-	-	-	2
CO2	3	3	2	2	-	-	-	-	-	-	2
CO3	3	3	2	2	-	-	-	-	-	-	2
CO4	3	3	2	2	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), - : No Correlation

6. Text Books

Sl No	Title of Book	Name of Author/s	Publisher	Edition and Year
1	Advanced Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons	10/e, 2016
2	Elementary Linear Algebra	Ron Larson	Cengage Learning	8/e, 2017

7. Reference Books

Sl No	Title of Book	Name of Author/s	Publisher	Edition and Year
1	Mathematics for Machine Learning	Marc Peter Deisenroth, A. Aldo Faisal & Cheng Soon Ong	Cambridge University Press	1/e, 2020
2	Linear algebra and	Gilbert Strang	Wellesley	1/e, 2019

Sl No	Title of Book	Name of Author/s	Publisher	Edition and Year
	learning from data		Cambridge Press	
3	Elementary Linear Algebra	Stephen Andrilli & David Hecker	Academic Press Inc.	4/e, 2010
4	Elementary Linear Algebra	Howard Anton,	Chris Rorres Wiley	11/e, 2019

8. Video Links or any other Reference Materials

Sl No	Details Like Weblink, Publication Details	Module
1	https://archive.nptel.ac.in/courses/111/107/111107164/	1
2	https://archive.nptel.ac.in/courses/111/107/111107164/	2
3	https://archive.nptel.ac.in/courses/111/107/111107164/	3
4	https://archive.nptel.ac.in/courses/111/107/111107164/	4

9. Model Question Paper

MODEL QUESTION PAPER			
FEDERAL INSTITUTE OF SCIENCE AND TECHNOLOGY(FISAT) (Autonomous) SECOND SEMESTER B. TECH DEGREE EXAMINATION (2026 Scheme)			
Course Code: 26ANNBS201 Course Name: Linear Algebra			
Programme : CSE/CSD			
Max. Marks: 60		Duration: 2 hours 30 minutes	
	PART A		
	<i>Answer all questions. Each question carries 3 marks</i>	CO	Marks
1	Write a linear system of two equations with two unknowns, which has infinitely many solutions.	CO1	(3)
2	Find the rank of the matrix $\begin{bmatrix} 1 & -1 & 2 \\ 4 & 1 & 4 \\ 3 & 5 & 4 \end{bmatrix}$	CO1	(3)

3	Check whether $W = \{(x, x+3) : x \in \mathbb{R}\}$ is a subspace of $\mathbb{R}^2$ under standard operations.	CO2	(3)
4	Find the coordinate matrix of $u = (1, -1)$ relative to the non-standard basis $\{(1, 0), (1, 1)\}$ in $\mathbb{R}^2$.	CO2	(3)
5	Find the norm of $u + v$, where $u = (1, -1, 3, 2)$ and $v = (-1, 1, 0, 2)$.	CO3	(3)
6	Find the vector v with length 3 and in the direction of $u = (1, 2, 2)$.	CO3	(3)
7	Let $T: \mathbb{R}^5 \rightarrow \mathbb{R}^7$ be a linear transformation. Find the dimension of the kernel of T when the dimension of the range is 2.	CO4	(3)
8	Let $T: \mathbb{R}^2 \rightarrow \mathbb{R}^2$ be a linear transformation defined by $T(x, y) = (x - y, x+3y)$. Find the standard matrix for T .	CO4	(3)
PART B			
<i>Answer any one full question from each module. Each question carries 9 marks</i>			
Module 1			
9	a)	Using Gauss elimination method, solve the linear system $x + y - z = 9$, $8y + 6z = -6$, $-2x + 4y - 6z = 40$.	CO1 (4)
	b)	Find the eigenvalues and eigenvectors of $\begin{bmatrix} 2 & 0 \\ -1 & 4 \end{bmatrix}$	CO1 (5)
10	a)	Find the values of λ and μ for which the system of equations $x + 3y - 2z = 2$, $x + 3y - 2z = 4$, $2x + y - \lambda z = \mu$ has (i) no solution (ii) a unique solution (iii) one parameter family of solutions.	CO1 (4)
	b)	Diagonalize the matrix $A = \begin{bmatrix} 3 & 5 & 3 \\ 0 & 4 & 6 \\ 0 & 0 & 1 \end{bmatrix}$ if possible.	CO1 (5)
Module 2			
11	a)	Check whether the set of all points on the plane $x + y - 2z = 0$ is a subspace of $\mathbb{R}^3$ under standard operations.	CO2 (4)
	b)	Show that the set of vectors $\{(1, 3, -1), (2, 3, 3), (3, 0, -1)\}$ forms a basis of $\mathbb{R}^3$.	CO2 (5)
12	a)	Check whether the vector $(1, -2, 2)$ can be written as a linear combination of the vectors in the set $\{(1, 2, 3), (0, 1, 2), (-1, 0, 1)\}$.	CO2 (4)
	b)	Given $B = \{(1, 3), (-2, -2)\}$ and $B' = \{(-12, 0), (-4, 4)\}$ are two bases of $\mathbb{R}^2$. Find the transition matrix from B' to B .	CO2 (5)
Module 3			
13	a)	Verify the Cauchy-Schwarz inequality for	CO3 (4)

		$A = \begin{bmatrix} 1 & -1 \\ 2 & 0 \end{bmatrix}$ $B = \begin{bmatrix} 1 & 1 \\ 0 & 3 \end{bmatrix}$														
	b)	Find the least squares regression line for the following data: <table><tr><td>x</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>y</td><td>2</td><td>3</td><td>5</td><td>9</td><td>7</td></tr></table>	x	1	2	3	4	5	y	2	3	5	9	7	CO3	(5)
x	1	2	3	4	5											
y	2	3	5	9	7											
14	a)	Find the orthogonal projection of $u = (1, -2)$ onto $v = (3, 2)$ in $\mathbb{R}^2$.	CO3	(4)												
	b)	Find the orthonormal basis corresponding to the basis $B = \{(1, -1, 0), (1, 0, 3), (0, 1, 2)\}$ for $\mathbb{R}^3$.	CO3	(5)												
Module 4																
15	a)	Determine whether the function $T : \mathbb{R}^2 \rightarrow \mathbb{R}^2$ defined by $T(x, y) = (3x, x+1)$ is a linear transformation.	CO4	(4)												
	b)	Find a basis for the kernel and nullity of the linear transformation $T: \mathbb{R}^4 \rightarrow \mathbb{R}^4$ defined by $T(x) = Ax$, where $x \in \mathbb{R}^4$ and $A =$ $\begin{bmatrix} 2 & -1 & 0 & 1 \\ 3 & 2 & 1 & -1 \\ 0 & 1 & -1 & 2 \\ 5 & 0 & -2 & 2 \end{bmatrix}$	CO4	(5)												
16	a)	Let $T : \mathbb{R}^2 \rightarrow \mathbb{R}^3$ be a linear transformation such that $T(1, 2) = (1, 0, 1)$, $T(-1, 1) = (0, 1, -1)$. Find $T(1, 1)$ and $T(0, 0)$.	CO4	(4)												
	b)	Let $T: \mathbb{R}^3 \rightarrow \mathbb{R}^2$ be a linear transformation defined by $T(x, y, z) = (3x - 2z, 2y - z)$. Find the matrix for T relative to the bases $B = \{(1, 0, 1), (1, -1, 0), (0, 1, 1)\}$ and $C = \{(1, 1), (1, 0)\}$.	CO4	(5)												
