

Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
B.Tech Degree S4 (Hons.) Examinations April 2026 (2024 Admn)



**Course Code: HNECT409**  
**Course Name: Linear Algebra for Communication**

Max. Marks: 60

Duration: 2 hours 30 minutes

**PART A**

*(Answer all questions. Each question carries 3 marks)*

- |   |  | CO  | Marks |
|---|--|-----|-------|
| 1 | Let $A = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$ .<br>Determine the condition for $\det(A+B) = \det(A) + \det(B)$ . | CO1 | (3)   |
| 2 | Define subspace of a vector space.   | CO1 | (3)   |
| 3 | Show that if $A^2$ is the zero matrix, then the only eigen value of $A$ is zero.   | CO2 | (3)   |
| 4 | Find the characteristic equation and eigen values of $A = \begin{bmatrix} 1 & -4 \\ 4 & 2 \end{bmatrix}$ .   | CO2 | (3)   |
| 5 | Compute the inner product $u \cdot v$ and $v \cdot u$ of two vectors<br>$u = \begin{bmatrix} -1 \\ 2 \end{bmatrix}$ and $v = \begin{bmatrix} 4 \\ 6 \end{bmatrix}$ .             | CO3 | (3)   |
| 6 | If a vector $y$ is orthogonal to vectors $u$ and $v$ . Show that $y$ is orthogonal to the vector $u+v$ .   | CO3 | (3)   |
| 7 | Express the quadratic form<br>$Q(x, y) = x^2 + 4xy + 7y^2$<br>in matrix form.  | CO4 | (3)   |
| 8 | What is a positive definite quadratic form?  | CO4 | (3)   |

**PART B**

*(Answer any one full question from each module, each question carries 9 marks)*

**Module -1**

- |    |   |     |     |
|----|---|-----|-----|
| 9  | Given $u_1$ and $u_2$ in a vector space $U$ and $H = \text{Span}(u_1, u_2)$ . Show that $H$ is a subspace in $V$ .  | CO1 | (9) |
| 10 | Determine the value of $c$ for which $z$ in the subspace of $\mathbb{R}^3$ spanned by $u_1, u_2, u_3$ if $u_1 = \begin{bmatrix} 1 \\ -1 \\ -2 \end{bmatrix}, u_2 = \begin{bmatrix} 5 \\ -4 \\ -7 \end{bmatrix}, u_3 = \begin{bmatrix} -3 \\ 1 \\ 0 \end{bmatrix}, z = \begin{bmatrix} -4 \\ 3 \\ c \end{bmatrix}$ | CO1 | (9) |

**Module -2**

- 11 a) What is meant by algebraic multiplicity of an eigenvalue? CO2 (4)
- b) Let  $A = PDP^{-1}$  and compute  $A^k$  given, CO2 (5)
- $P = \begin{bmatrix} 5 & 7 \\ 2 & 3 \end{bmatrix}$  and  $D = \begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix}$
- 12 Let  $A = \begin{bmatrix} 0.5 & -0.6 \\ 0.75 & 1.1 \end{bmatrix}$ . Find the eigen values of A and find a basis for each CO2 (9)
- eigen space.

**Module -3**

- 13 a) What is the least-squares problem in linear algebra? CO3 (4)
- b) Given vectors  $v_1 = \begin{bmatrix} 3 \\ 0 \\ -1 \end{bmatrix}$  and  $v_2 = \begin{bmatrix} 8 \\ 5 \\ -6 \end{bmatrix}$  and  $W = \text{Span}(v_1, v_2)$ . Use the CO3 (5)
- Gram-Schmidt process to find an orthogonal basis for W.
- 14 a) Compute the distance between the vectors  $u = (7, 1)$  and  $v = (3, 2)$ . CO3 (4)
- Check if they are orthogonal.
- b) Find the least square solution of the inconsistent system  $Ax = b$  for CO3 (5)
- $A = \begin{bmatrix} 4 & 2 \\ 0 & 2 \\ 1 & 1 \end{bmatrix}$  and  $b = \begin{bmatrix} 2 \\ 0 \\ 11 \end{bmatrix}$ .

**Module -4**

- 15 a) Determine whether matrix  $A = \begin{bmatrix} 0 & 8 & 3 \\ 8 & 0 & -2 \\ 3 & -2 & 0 \end{bmatrix}$  is symmetric? CO4 (3)
- b) Compute the quadratic form of matrix  $B = \begin{bmatrix} 4 & 0 \\ 0 & 3 \end{bmatrix}$  if  $x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ . CO4 (3)
- (c) What is Singular Value Decomposition (SVD)? CO4 (3)
- 16 a) For  $x$  in  $\mathbb{R}^3$ , if  $Q(x) = 5x_1^2 + 3x_2^2 + 2x_3^2 - x_1x_2 + 8x_2x_3$ . Obtain the CO4 (5)
- quadratic form as  $x^T Ax$  and compute  $Q(x)$  for  $(-3, 1, 1)$
- b) What is principal component analysis (PCA)? CO4 (4)

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