Roll No.											

PRESIDENCY UNIVERSITY

BENGALURU

End - Term Examinations – MAY 2025

Date: 31-05-2025 **Time:** 09:30 am – 12:30 pm

School: SOE	**Program:** B. Tech.	
Course Code: ECE3017	**Course Name:** Linear Algebra for Communication Engineering	
Semester: VI	**Max Marks**: 100	**Weightage**: 50%

CO - Levels	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Marks	**30**	**40**	**30**		

Instructions:

(i) Read all questions carefully and answer accordingly.

(ii) Do not write anything on the question paper other than roll number.

Part A

Answer ALL the Questions. Each question carries 2marks. **10Q x 2M=20M**

1.	**Determine if the given matrix is symmetric, skew-symmetric, or orthogonal.** $$\begin{bmatrix} 3 & 1 & -2 \\ 1 & 2 & 3 \\ -2 & 3 & -4 \end{bmatrix}$$	**2 Marks**	**L2**	**CO1**
2.	**Prove that matrix A is skew-Hermitian.** $$A = \begin{bmatrix} 2i & 2-4i & -4+2i \\ -2-4i & 0 & 6-i \\ 4+2i & -6-i & -3i \end{bmatrix}$$	**2 Marks**	**L2**	**CO1**
3.	**Perform the following elementary row operation $R_2 \leftarrow R_2 + 4R_1$ on matrix A:** $$A = \begin{bmatrix} 1 & 2 & -3 \\ 4 & -5 & 6 \\ -2 & 3 & -4 \end{bmatrix}$$	**2 Marks**	**L2**	**CO1**
4.	**Determine if the provided matrix is in row-echelon form (REF) and justify your conclusion.**	**2 Marks**	**L2**	**CO1**

	$\begin{bmatrix} 1 & 2 & 3 & 5 \\ 0 & 0 & 1 & 2 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 4 \end{bmatrix}$			
5.	**Determine if the provided matrix is in row-echelon form (REF) or reduced row-echelon form (RREF) and find its rank.** $\begin{bmatrix} 1 & 0 & 4 & 0 \\ 0 & 1 & 2 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{bmatrix}$	**2 Marks**	**L2**	**CO1**
6.	**Determine if matrix A satisfies the conditions of a normal matrix and justify your conclusion.** $A = \begin{bmatrix} 6 & -3 \\ 3 & 6 \end{bmatrix}$	**2 Marks**	**L3**	**CO3**
7.	**Determine if matrix C satisfies the conditions for being positive definite and justify your conclusion.** $C = \begin{bmatrix} 1 & -2 \\ -2 & 5 \end{bmatrix}$	**2 Marks**	**L3**	**CO3**
8.	**Identify the range (or specific value) of k for which the matrix becomes positive definite.** $B = \begin{bmatrix} 4 & k \\ k & 9 \end{bmatrix}$	**2 Marks**	**L3**	**CO3**
9.	**Determine the saddle point or optimal pay-off value for matrix A.** $A = \begin{bmatrix} 3 & 1 & 1 & 0 \\ 0 & 1 & 2 & 0 \\ 1 & 0 & 2 & 1 \\ 3 & 1 & 2 & 2 \end{bmatrix}$	**2 Marks**	**L3**	**CO3**
10.	**Compute the Discrete Fourier Transform (DFT) of the given sequence using the matrix multiplication method.** $x(n) = \{1, 2, 0, 1\}$	**2 Marks**	**L3**	**CO3**

Part B

Answer the Questions. **Total Marks 80M**

11.	a.	**Determine if the vector $u = \begin{bmatrix} 1 \\ 0 \\ 4 \end{bmatrix}$ lies in the column space of the given matrix.** $A = \begin{bmatrix} 2 & 5 & 1 \\ -1 & -7 & -5 \\ 3 & 4 & -2 \end{bmatrix}$	**12 Marks**	**L2**	**CO 1**

	b.	Determine the row space of matrix $A = \begin{bmatrix} 2 & 0 & 1 \\ 1 & 0 & 1 \end{bmatrix}$.	8 Marks	L2	CO 1
Or					
12.	a.	Determine if the vector $u = \begin{bmatrix} 2 \\ -1 \\ 1 \end{bmatrix}$ lies in the column space of the given matrix. $$A = \begin{bmatrix} 2 & 5 & 1 \\ -1 & -7 & -5 \\ 3 & 4 & -2 \end{bmatrix}$$	12 Marks	L2	CO 1
	b.	Determine the left-hand null space of matrix $A = \begin{bmatrix} 2 & 0 & 1 \\ 1 & 0 & 1 \end{bmatrix}$.	8 Marks	L2	CO 1

13.	a.	Given the vectors $u_1 = (1, 2, 4), u_2 = (2, -3, 1)$, and $u_3 = (2, 1, -1)$ in $\Re^3$. i) Verify orthogonality: Show that u_1, u_2, u_3 are mutually orthogonal. ii) Express v as a linear combination: Decompose $v = (7, 16, 6)$ in terms of u_1, u_2, u_3.	10 Marks	L3	CO 2
	b.	For the matrix $A = \begin{bmatrix} 4 & 2 \\ 3 & -1 \end{bmatrix}$, determine the following: i) Characteristic polynomial ii) Eigen values iii) Eigen vectors iv) diagonal matrix (if diagonalizable)	10 Marks	L3	CO 2
Or					
14.	a.	Given the vectors $u_1 = (1, 2, 4), u_2 = (2, -3, 1)$, and $u_3 = (2, 1, -1)$ in $\Re^3$. i) Verify orthogonality: Show that u_1, u_2, u_3 are mutually orthogonal. ii) Express v as a linear combination: Decompose $v = (3, 5, 2)$ in terms of u_1, u_2, u_3.	10 Marks	L3	CO 2
	b.	For the matrix $A = \begin{bmatrix} 5 & -1 \\ 1 & 3 \end{bmatrix}$, determine the following: i) Characteristic polynomial ii) Eigen values iii) Eigen vectors iv) diagonal matrix (if diagonalizable)	10 Marks	L3	CO 2

15.	a.	Prove that the matrices $A = \begin{bmatrix} 2 & 4 \\ 0 & -2 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & 0 \\ -4 & -2 \end{bmatrix}$ are similar via the invertible matrix $P = \begin{bmatrix} 2 & -2 \\ 2 & 2 \end{bmatrix}$.	7 Marks	L3	CO 2
	b.	Determine the singular value decomposition (SVD) for the given matrix: $$A = \begin{bmatrix} 2 & 3 \\ 4 & 10 \end{bmatrix}$$	13 Marks	L3	CO 2
Or					

16.	**a.**	**Perform a singular value decomposition (SVD) on the matrix:** $$A = \begin{bmatrix} 4 & 0 \\ 3 & -5 \end{bmatrix}$$	**13 Marks**	**L3**	**CO 2**
	b.	**Compute matrix B such that A and B are similar, where: Given $A = \begin{bmatrix} 1 & 2 \\ 3 & -1 \end{bmatrix}$ and $P = \begin{bmatrix} 0 & 1 \\ 2 & 3 \end{bmatrix}$.**	**7 Marks**	**L3**	**CO 2**

17.	**a.**	**A payoff matrix that lacks a saddle point falls under mixed strategy games. One approach to solving such problems is the odd games method. Apply the odd games method to solve the given payoff matrix.** $$A = \begin{bmatrix} 1 & 5 \\ 4 & 2 \end{bmatrix}$$	**10 Marks**	**L3**	**CO 3**
	b.	**Determine the possible values of a and b that make the (2,2) position a saddle point in the given payoff matrix.** $$A = \begin{bmatrix} 2 & 4 & 5 \\ 10 & 7 & b \\ 4 & a & 6 \end{bmatrix}$$	**5 Marks**	**L3**	**CO 3**
	c.	**Determine the optimal mixed strategies for both players when Player I selects rows and Player II selects columns in the provided payoff matrix.** $$A = \begin{bmatrix} 3 & 1 & 1 & 0 \\ 0 & 1 & 2 & 0 \\ 1 & 0 & 2 & 1 \\ 3 & 1 & 2 & 2 \end{bmatrix}$$	**5 Marks**	**L3**	**CO 3**
Or					
18.	**a.**	**Determine the maximum and minimum values of the objective function $z = 5x + 3y$ subject to the given constraints.** $$x + 2y \leq 14$$ $$3x - y \geq 0$$ $$x - y \leq 2$$	**10 Marks**	**L3**	**CO 3**
	b.	**Determine the range of values for parameters a and b that create saddle points at both (2,2) and (2,3) positions in the given payoff matrix.** $$A = \begin{bmatrix} 2 & 4 & 5 \\ 10 & 7 & b \\ 4 & a & 6 \end{bmatrix}$$	**5 Marks**	**L3**	**CO 3**
	c.	**Determine the dual formulation for the given linear programming problem.** $$\min 6x_1 + 4x_2 + 2x_3$$ $$\text{s.t. } 4x_1 + 2x_2 + x_3 \geq 5$$ $$x_1 + x_2 \geq 3$$ $$x_2 + x_3 \geq 4$$ $$x_i \geq 0, \text{for } i = 1, 2, 3$$	**5 Marks**	**L3**	**CO 3**