CBCS SCHEME

USN

21EC33

Third Semester B.E./B.Tech. Degree Examination, June/July 2025
Basic Signal Processing

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Define vector subspaces and explain the four fundamental subspaces. **(06 Marks)**

b. Determine whether the vectors $V_1 = (1, 2, 3)$, $V_2 = (3, 1, 7)$ and $V_3 = (2, 5, 8)$ are linearly dependent or linearly independent. **(08 Marks)**

c. Explain linear transformation in detail. **(06 Marks)**

OR

2 a. Determine whether or not each of the following forms a basis $x_1 = (2, 2, 1)$, $x_2 = (1, 3, 7)$ and $x_3 = (1, 2, 2)$ in R^3. **(08 Marks)**

b. If $U = \begin{bmatrix} 1 \\ 2 \\ 2 \end{bmatrix}$; $V = \begin{bmatrix} 2 \\ -2 \\ 1 \end{bmatrix}$; $W = \begin{bmatrix} 2 \\ 1 \\ -2 \end{bmatrix}$

Then show that U, V, W are pair-wire orthogonal vectors. Find the lengths of u, v, w and find orthonormal vectors U_1, V_1, W_1 from vectors U, V, W. **(12 Marks)**

Module-2

3 a. If $A = \begin{bmatrix} 4 & 6 & 6 \\ 1 & 3 & 2 \\ -1 & -5 & -2 \end{bmatrix}$, find eigen values and eigen vectors for matrix A. **(08 Marks)**

b. Diagonalize the matrix : $A = \begin{bmatrix} 1 & 2 \\ 0 & 3 \end{bmatrix}$. Find an invertible matrix P and a diagonal matrix D such that $A = PDP^{-1}$ and hence find A^3. **(12 Marks)**

OR

4 a. What is the positive definite matrix? Mention the methods of testing positive definiteness. **(04 Marks)**

b. Test to see if A^TA is positive definite : $A = \begin{bmatrix} 1 & 1 \\ 1 & 2 \\ 2 & 1 \end{bmatrix}$. **(04 Marks)**

c. Factorize the matrix A into $A = U\Sigma V^T$ using SVD.

$A = \begin{bmatrix} 2 & 3 \\ 0 & 2 \end{bmatrix}$. **(12 Marks)**

Module-3

5 a. Define signals and system with examples. **(05 Marks)**

b. Explain elementary discrete signals :
i) Exponential ii) Sinusoidal iii) Step iv) Impulse functions. **(05 Marks)**

c. The discrete-time signals x(n) and y(n) are shown in Fig.Q5(c)(i) and Fig.Q5(c)(ii) respectively sketch the signal $z(n) = x(2n)\,y(n-4)$. **(10 Marks)**

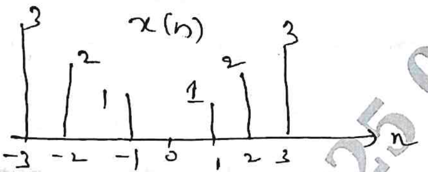

Fig.Q5(c)(i)

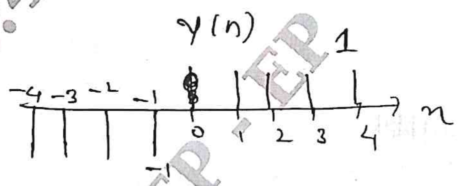

Fig.Q5(c)(ii)

OR

6 a. State and explain the properties :
i) Linearity ii) Time invariance iii) Memory iv) Causality. **(08 Marks)**

b. For the following system, determine whether the system is :
i) Linear ii) Time-invariance iii) Memoryless iv) Causal v) Stable
$T\{x(n)\} = x(-n)$. **(12 Marks)**

Module-4

7 a. Evaluate the discrete – time convolution sum given below : $y(n) = u(n) * u(n-3)$. **(08 Marks)**

b. Consider a input x(n) and a unit impulse response h(n) given by :
$x(n) = \alpha^n u(n) : 0 < \alpha < 1$
$h(n) = u(n)$
Evaluate and plot the output signal y(n). **(12 Marks)**

OR

8 a. Obtain the unit-step response for LTI system. **(06 Marks)**

b. Determine a discrete-time LTI system characterized by impulse response :
$h(n) = \left(\frac{1}{2}\right)^n u(n)$ is : i) Stable ii) Causal iii) Memory. **(06 Marks)**

c. Find the step response for the LTI system represented by the impulse response :
$h(n) = \left(\frac{1}{2}\right)^n u(n)$. **(08 Marks)**

Module-5

9 a. Explain briefly the RoC and its important properties. **(06 Marks)**

b. State and prove shifting and scaling properties of Z-transform. **(06 Marks)**

c. Find the Z-transform of the signal using properties :
$x(n) = \left(\frac{1}{2}\right)^n u(n) * \left(\frac{1}{3}\right)^n u(n)$. **(08 Marks)**

OR

10 a. Find the inverse Z-transform of the following using partial fraction expansion method.
$$X(z) = \frac{1+2z^{-1}+z^{-2}}{1-\frac{3}{2}z^{-1}+\frac{1}{2}z^{-2}} \quad \text{RoC } |z|>1.$$ **(08 Marks)**

b. A system has impulse response $h(n) = \left(\frac{1}{2}\right)^n u(n)$. Determine the input to the system if the output is given by $y(n) = \frac{1}{3}u(n) + \frac{2}{3}\left(-\frac{1}{2}\right)^n u(n)$. **(08 Marks)**

c. Define causality and stability of the Z-transform. **(04 Marks)**

* * * * *