

Third Semester B.E./B.Tech. Degree Examination, Dec.2024/Jan.2025
Basic Signal Processing

Time: 3 hrs.

Max. Marks: 100

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

Module-1

- 1 a. Show that the vectors $(1, 2, 1)$, $(2, 1, 0)$, $(1, -1, 2)$ form a basis of R^3 . (08 Marks)
b. Apply Gram Schmidt process to the vectors $V_1 = (2, 2, 1)$, $V_2 = (1, 3, 1)$, $V_3 = (1, 2, 2)$ to obtain an orthonormal basis for $V_3(R)$ with the standard inner product. (12 Marks)

OR

- 2 a. Reduce the matrix A to echelon form and also find the rank.

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

(10 Marks)

- b. Determine the null space of each of the following matrices.

i) $A = \begin{bmatrix} 2 & 0 \\ -4 & 10 \end{bmatrix}$ ii) $B = \begin{bmatrix} 1 & -7 \\ -3 & 21 \end{bmatrix}$

(10 Marks)

Module-2

- 3 a. Find the eigen values and eigen vectors of the matrix

$$A = \begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$$

(10 Marks)

- b. Diagonalize the following matrix

$$A = \begin{bmatrix} 1 & 3 & 3 \\ -3 & -5 & -3 \\ 3 & 3 & 1 \end{bmatrix}$$

Find an invertible matrix P and a diagonal matrix D such that $A = PDP^{-1}$.

(10 Marks)

OR

- 4 a. Find the singular value decomposition of the matrix $A = \begin{bmatrix} 2 & 3 \\ 0 & 2 \end{bmatrix}$

(10 Marks)

- b. What is the positive definite matrix? If $A = \begin{bmatrix} 3 & -1 & 1 \\ -1 & 5 & -1 \\ 1 & -1 & 3 \end{bmatrix}$, show that A is positive definite matrix.

(10 Marks)

Module-3

- 5 a. Define systems. Explain the communication system with a suitable block diagram. (06 Marks)
b. Given the signal $x[n]$ show in Fig Q5(b), sketch the following :
i) $x[4 - n]$
ii) $x[2n + 1]$.

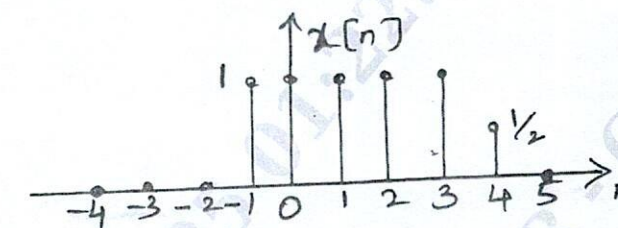


Fig Q5(b)

(06 Marks)

- c. Explain the following elementary signals

- i) Unit step signal
ii) Impulse signal
iii) Ramp function
iv) Sinusoidal function.

(08 Marks)

OR

- 6 a. Explain with an example :

- i) Amplitude scaling
ii) Time scaling
iii) Time shifting
iv) Precedence rule.

(08 Marks)

- b. Verify the following system for linearity, time invariance, memoryless, stability and causality.

i) $y(n) = nx(n)$ ii) $y(n) = 2x[2^n]$.

(12 Marks)

Module-4CMRIT LIBRARY
BANGALORE - 560 037

- 7 a. What do you mean by impulse response of an LTI system? Starting from fundamental, deduce the equation for the response of an LTI system, if the input sequences $x[n]$ and the impulse response $h[n]$ are given. (08 Marks)
b. Find the discrete time convolution sum given below
 $y(n) = \beta^n u(n) * \alpha^n u(n)$; $|\beta| < 1$ & $|\alpha| < 1$ (06 Marks)
c. With suitable diagram, explain the cascade connection and parallel connection of systems. (06 Marks)

OR

- 8 a. A LTI system has an impulse response $h(n) = \begin{cases} 1 & n = \pm 1 \\ 2 & n = 0 \\ 0 & \text{otherwise} \end{cases}$.

Determine the output of this system in response to the input.

$$x(n) = \begin{cases} 2 & n = 0 \\ 3 & n = 1 \\ -2 & n = 2 \\ 0 & \text{otherwise} \end{cases}$$

(08 Marks)

- b. Explain the following properties of system in terms of impulse response
 i) Memoryless ii) Causal iii) Stable.
 c. Consider the interconnection of four LTI systems as depicted in Fig Q8(c).

(06 Marks)

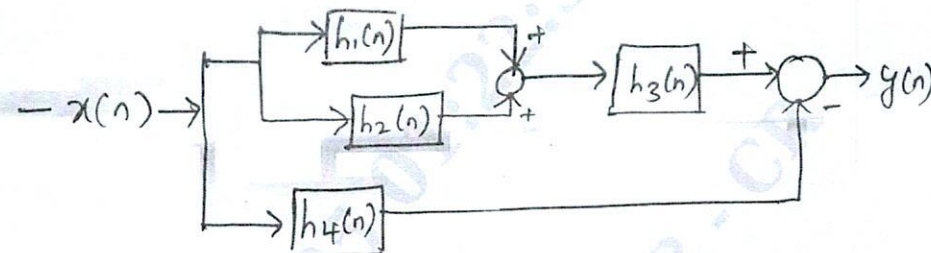


Fig Q8(c)

The impulse response of the systems are

$h_1(n) = U(n)$; $h_2(n) = U(n+2) - U(n)$; $h_3(n) = \delta(n-2)$, $h_4(n) = \alpha^n U(n)$. Find impulse response $h(n)$ of the overall system.

(06 Marks)

CMRIT LIBRARY
 BANGALORE - 560 037

Module-5

- 9 a. State and prove :
 i) Time reversal
 ii) Differentiation in Z-domain property of Z-transform.
 b. Use partial fraction expansion to find the inverse Z-transform of

(08 Marks)

$$x(z) = \frac{1+2z^{-1}+z^{-2}}{1-\frac{3}{2}z^{-1}+\frac{1}{2}z^{-2}} \text{ with ROC ; } |z| > 1$$

(12 Marks)

OR

- 10 a. List the properties of z-transform. (06 Marks)
 b. A causal system has input $x(n]$ and output $y(n]$. find the impulse response of system if

$$x(n) = \delta(n) + \frac{1}{4}\delta(n-1) - \frac{1}{8}\delta(n-2)$$

$$y(n) = \delta(n) - \frac{3}{4}\delta(n-1)$$
 (08 Marks)
 c. Find the Z-transform of the signal $x(n) = a^n U(n)$. Indicate the ROC and location of poles and zeros of $x(z)$ in the Z plane. (06 Marks)
