CBCS SCHEME

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21EC33

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) from 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].

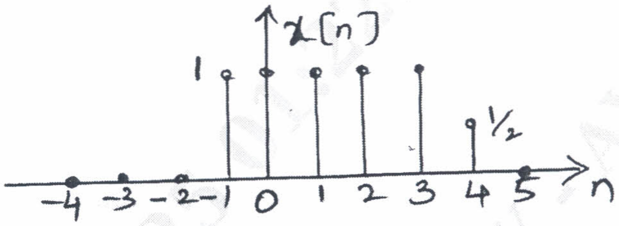

Fig Q5(b) **(06 Marks)**

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-4

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. **(06 Marks)**

c Consider the interconnection of four LTI systems as depicted in Fig Q8(c).

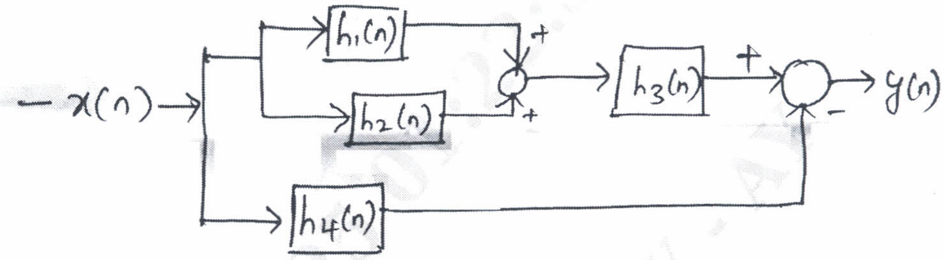

Fig Q8(c)

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)**

Module-5

9 a. State and prove :
i) Time reversal
ii) Differentiation in Z-domain property of Z-transform. **(08 Marks)**

b. Use partial fraction expansion to find the inverse Z-transform of

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

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