

CBCS SCHEME

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21EC33

Third Semester B.E. Degree Examination, Dec.2023/Jan.2024 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. Write the complete solution $x = x_p + x_n$ to

$$A = \begin{bmatrix} 1 & 2 & 2 & 2 \\ 2 & 4 & 6 & 8 \\ 3 & 6 & 8 & 10 \end{bmatrix}$$

(10 Marks)

- b. Define the four fundamental vector spaces and find the Dimension and basis for four fundamental subspaces for :

$$A = \begin{bmatrix} 1 & 2 & 3 & 5 \\ 2 & 4 & 8 & 12 \\ 3 & 6 & 7 & 13 \end{bmatrix}$$

(10 Marks)

OR

- 2 a. Illustrate the transformation of the plane that comes from four matrices and list the transformations $T(x)$ that are not possible with Ax . (10 Marks)

- b. Compute $A^T A$ and their eigen values and unit eigen vectors for V and u . Then check $AV = u\Sigma$.

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

(10 Marks)

Module-2

- 3 a. What is an orthogonal matrix. Apply the gram Schmidt process to

$$a = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad b = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} \quad c = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$$

and write the result in the form of $A = QR$.

(10 Marks)

- b. Find the projection of b onto the column space of A .

$$A = \begin{bmatrix} 1 & 1 \\ 1 & -1 \\ -2 & 4 \end{bmatrix} \quad b = \begin{bmatrix} 1 \\ 2 \\ 7 \end{bmatrix}$$

(10 Marks)

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.

OR

- 4 a. Find eigen values and eigen vectors for the matrix. A can the matrix be diagonalized.

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

(10 Marks)

- b. i) What is a positive definite matrix? Mention the methods of testing positive definiteness.

(04 Marks)

- ii) Decide for or against the positive definiteness of

$$A = \begin{bmatrix} 2 & -1 & -1 \\ -1 & 2 & -1 \\ -1 & -1 & 2 \end{bmatrix} \quad B = \begin{bmatrix} 2 & -1 & -1 \\ -1 & 2 & 1 \\ -1 & 1 & 2 \end{bmatrix}$$

(06 Marks)

Module-3

- 5 a. Define a signal. List the elementary signals. Differentiate between even and odd signals, energy and power signals.

(10 Marks)

- b. Sketch the even the odd part of the signals shown in Fig.Q5(b)(i) and 5(b)(ii).

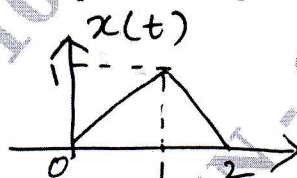


Fig.Q5(b)(i)

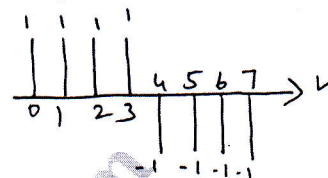


Fig.Q5(b)(ii)

(08 Marks)

- c. Determine whether the following signal is periodic or not. If periodic find the fundamental period $x(n) = \cos\left(\frac{n\pi}{5}\right) \sin\left(\frac{n\pi}{3}\right)$.

(02 Marks)

OR

- 6 a. Determine whether the following systems are memoryless, causal time invariant, linear and stable. i) $y(n) = nx(n)$ ii) $y(t) = x(t/2)$.

(08 Marks)

- b. For the signal $x(t)$ and $y(t)$ shown in Fig.6(a) sketch the following signals :

- i) $x(t+1)y(t-2)$ ii) $x(t)y(t-1)$

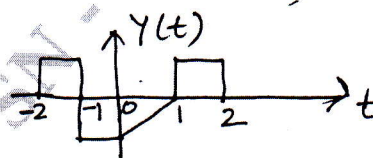
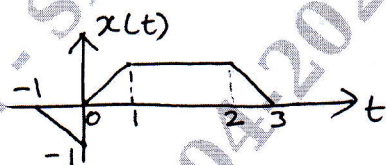


Fig.Q6(b)

(08 Marks)

- c. Sketch the waveform of the signal : $x(t) = u(t+1) - 2u(t) + u(t-1)$.

(04 Marks)

Module-4

- 7 a. Compute the following convolution :

i) $y(t) = e^{-2}u(t-2) * \{u(t-2) - u(t-12)\}$

ii) $y(n) = \alpha^n \{u(n) - u(n-6)\} * 2\{u(n) - 4(n-15)\}$.

(14 Marks)

- b. Prove the following :

i) $x(t) * \delta(t-t_0) = x(t-t_0)$

ii) $x(n) * u(n) = \sum_{k=-\infty}^n X(k)$.

(06 Marks)

OR

- 8 a. Evaluate the step response for LTI system represented by the following impulse response :
- $h(t) = u(t+1) - u(t-1)$
 - $h(n) = (1/2)^n u(n)$. (08 Marks)
- b. Determine whether the following system defined by their impulse response are causes memoryless and stable.
- $h(t) = e^{-2t} u(t-1)$
 - $h(n) = 2u(n) - 2u(n-5)$. (08 Marks)
- c. A system consists of several subsystems connected as shown in Fig.Q8(c). Find the operator H relating $x(t)$ to $y(t)$ for the following subsystem operators.
- H1 : $Y_1(t) = X_1(t)X_1(t-1)$
 H2 : $Y_2(t) = |X_2(t)|$
 H3 : $Y_3(t) = 1 + 2 X_3(t)$
 H4 : $Y_4(t) = \cos(X_4(t))$.

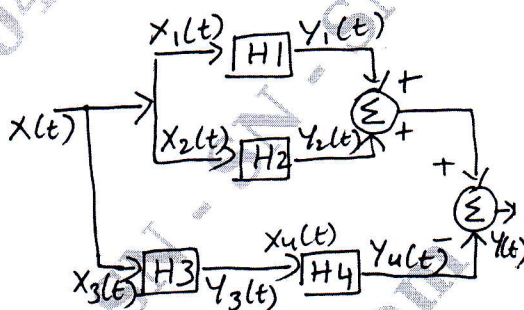


Fig.Q8(c)

(04 Marks)

Module-5

- 9 a. Describe the properties of region of convergence and sketch the ROL of two sided, right sided and left sided sequence. (08 Marks)
- b. Find Z - transform of the following and specify its ROC
- $$x(n) = \sin\left(\frac{\pi}{4}n - \frac{\pi}{2}\right)u(n-2)$$
- $$x(n) = \left(\frac{2}{3}\right)^n u(n) * 2^n u(-n-3).$$
- (08 Marks)
- c. Find inverse Z-transform if $X(z) = \frac{(1/4)z^{-1}}{(1 - 1/2 z^{-1})(1 - 1/4 z^{-1})}$. (04 Marks)

OR

- 10 a. Describe the transfer function and the impulse response for the causal LTI system described by the differential equation :
- $$y(n) - \frac{1}{4}y(n-1) - \frac{3}{8}y(n-2) = -x(n) + 2x(n-1).$$
- (10 Marks)
- b. Determine the impulse response of the following transfer function if :
- The system is causal
 - The system is stable
 - The system is stable and causal at the same time : $H(z) = \frac{3z^{+2} - z}{(z-2)\left(z + \frac{1}{2}\right)}$. (10 Marks)
