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^TA 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

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

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).

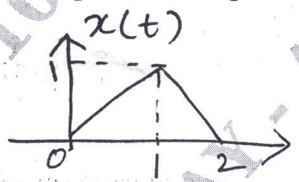
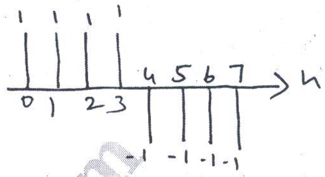


Fig.Q5(b)(i)



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 :
i) $h(t) = u(t + 1) - u(t - 1)$
ii) $h(n) = (1/2)^n u(n)$. **(08 Marks)**

b. Determine whether the following system defined by their impulse response are causes memoryless and stable.
i) $h(t) = e^{-2t}u(t-1)$
ii) $h(n) = 2u(n) - 2u(n-5)$. **(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 : $Y_3(t) = 1 + 2X_3(t)$
H4 : $Y_4(t) = \cos(X_4(t))$.

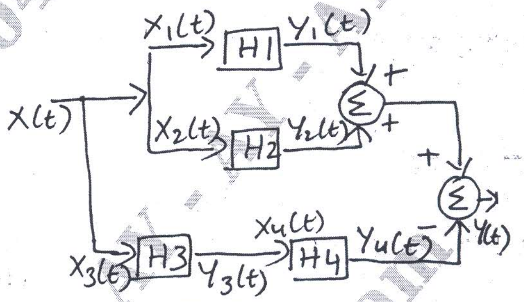


Fig.Q8(c) **(04 Marks)**

Module-5

9 a. Describe the properties of region of convergence and sketch the ROL of two sided, ,right sided and lift sided sequence. **(08 Marks)**

b. Find Z – tranform 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 $X(z) = \dfrac{\left(\frac{1}{4}\right)z^{-1}}{\left(1-\frac{1}{2}z^{-1}\right)\left(1-\frac{1}{4}z^{-1}\right)}$. **(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 :
i) The system is causal
ii) The system is stable
iii) The system is stable and causal at the same time : $H(z) = \dfrac{3z^{+2} - z}{(z-2)\left(z + \frac{1}{2}\right)}$. **(10 Marks)**

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