

CBCS SCHEME

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21EC33

Third Semester B.E. Degree Examination, Jan./Feb. 2023 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. Explain vector spaces and its necessary axioms. And also explain four fundamental subspaces with example. (08 Marks)
- b. Write the vector $V = (1, 3, 9)$ as a linear combination of the vectors $u_1 = (2, 1, 3)$, $u_2 = (1, -1, 1)$ and $u_3 = (3, 1, 5)$ and thereby show that the system is consistent. (08 Marks)
- c. Let $I: V_1(\mathbb{R}) \rightarrow V_2(\mathbb{R})$ be a mapping $f(x) = (3x, 5x)$ show that 'f' is linear transformation. (04 Marks)

OR

- 2 a. Let 'w' be the subspace of \mathbb{R}^5 spanned by $x_1 = (1, 2, -1, 3, 4)$, $x_2 = (2, 4, -2, 6, 8)$, $x_3 = (1, 3, 2, 2, 6)$, $x_4 = (1, 4, 5, 1, 8)$, $x_5 = (2, 7, 3, 3, 9)$. Find a subset of vectors which forms a basis of 'w'. (06 Marks)
- b. Solve $Ax = b$ by least square and find $P = A\hat{x}$ if $A = \begin{bmatrix} 4 & 0 \\ 0 & 2 \\ 1 & 1 \end{bmatrix}_{3 \times 2}$ and $b = \begin{bmatrix} 2 \\ 0 \\ 11 \end{bmatrix}_{3 \times 1}$. Also, write a program to solve linear equation $Ax = b$. (07 Marks)
- c. Apply Gram – Schmidt process to the vectors $V_1(1, 1, 1)$, $V_2(1, -1, 2)$, $V_3(2, 1, 2)$ to obtain an orthonormal basis for $V_3(\mathbb{R})$ with standard inner product and thereby write a program for Gram – Schmidt process. (07 Marks)

Module-2

- 3 a. If $A = \begin{bmatrix} 4 & 2 & -2 \\ -5 & 3 & 2 \\ -2 & 4 & 1 \end{bmatrix}$ find Eigen values and corresponding Eigen vector for matrix 'A' and diagonalize the matrix. (10 Marks)
- b. If $A = \begin{bmatrix} 3 & -1 & 1 \\ -1 & 5 & -1 \\ 1 & -1 & 3 \end{bmatrix}$. Show that matrix 'A' is positive definite matrix using the following approaches :
i) By finding its Eigen value
ii) By finding its pivots. (10 Marks)

OR

- 4 a. Compute $A^T A$ and AA^T , find Eigen values and Eigen vectors, if $A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \\ -1 & 1 \end{bmatrix}_{3 \times 2}$, thereby multiply $U \in V^T$ to recover matrix 'A'. Also write a program to find SVD. (12 Marks)
- b. Diagonalize the matrix A, if $A = \begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$ by finding its eigen value and eigen vector. (08 Marks)

Module-3

- 5 a. Define signal and system and also explain basic discrete elementary signals with neat sketch and expressions. (04 Marks)
- b. A discrete time signal $x(n]$ is shown below Fig.Q5(b).

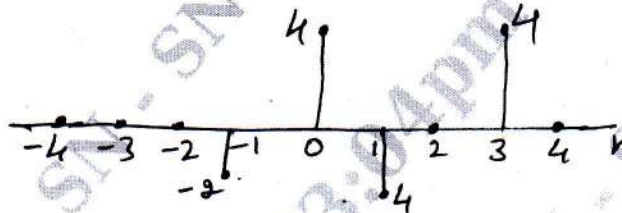


Fig.Q5(b)

Sketch :

- i) $2x(n-2)$
- ii) $3-x(n)$
- iii) $2x(-n)-4$. (08 Marks)
- c. Sketch : $x(n) = \begin{cases} 1; & -1 \leq n \leq 3 \\ 1/2; & n=4 \\ 0; & \text{otherwise} \end{cases}$ and $y(n) = \begin{cases} 1/2^n; & |n| \leq 4 \\ 0; & \text{otherwise} \end{cases}$
- Also sketch $x(n+2)y(1-2n)$. (08 Marks)

OR

- 6 a. For the following discrete time systems, determine whether the system is linear, time invariance, memoryless, causal and stable :
- i) $y(n) = 2x(n) + \frac{1}{x(n-2)}$
- ii) $y(n) = \ln(3 + |x(n)|)$
- iii) $y(n) = \cos x(n)$
- iv) $y(n) = r^n x(n); r > 1$. (16 Marks)
- b. Write a program to generate exponential and triangular waveforms. (04 Marks)

Module-4

- 7 a. Compute the discrete time convolution for the sequences $x_1(n)$ and $x_2(n)$ given below :
 $x_1(n) = \alpha^n u(n)$; $x_2(n) = \beta^n u(n)$. (08 Marks)
- b. Consider the input signal $x(n)$ and the impulse response $h(n)$ given below :
- $$x(n) = \begin{cases} 1; & 0 \leq n \leq 4 \\ 0; & \text{otherwise} \end{cases} \quad \text{and} \quad h(n) = \begin{cases} \alpha^n; & 0 \leq n \leq 6, \alpha > 1 \\ 0; & \text{otherwise} \end{cases}$$
- compute the output signal $y(n)$. (12 Marks)

OR

- 8 a. The following are the impulse responses of discrete time LTI systems. Determine whether each system is memoryless, causal and stable :
- i) $h(n) = e^{-n} \cos(n) \cdot u(n)$
- ii) $h(n) = (0.99)^n u(n+3)$
- iii) $h(n) = n \left(\frac{1}{2}\right)^n u(n)$. (10 Marks)
- b. Evaluate the step response of LTI system represented by the impulse response
 $h(n) = (-1)^n \{u(n+2) - u(n-3)\}$.
 Also write a program to compute the step response from the given impulse response. (10 Marks)

Module-5

- 9 a. Define Z-transform. Explain the properties of ROC. (06 Marks)
- b. Let $x(n) = \left(\frac{1}{2}\right)^{|n|}$.
- i) Sketch $x(n)$
- ii) Find $x(z)$ and sketch pole zero plot and ROC. (08 Marks)
- c. Find the Z-transform of $x(n) = \left(+\frac{1}{2}\right)^n u(n) * \left(\frac{1}{3}\right)^n u(n)$. (06 Marks)

OR

- 10 a. Explain the properties of Z-transform with proof :
- i) Convolution
- ii) Initial value theorem
- iii) Final value theorem. (08 Marks)
- b. Determine the discrete time sequence $x(n)$ of the sequence using partial fraction expression:
- $$X(z) = \frac{-1 + 5z^{-1}}{1 - \frac{3}{2}z^{-1} + \frac{1}{2}z^{-2}}; \text{ROC: } |z| > 1$$
- (08 Marks)
- c. Write a program to find Z-transform of the sequence. (04 Marks)
