C.M.R. INSTITUTE OF TECHNOLOGY
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BANGALORE - 37.

CBCS SCHEME

USN

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.***

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.

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 : $V_1(R) \rightarrow V_2(R)$ be a mapping f(x) = (3x, 5x) show that 'f' is linear transformation. **(04 Marks)**

OR

2 a. Let 'w' be the subspace of 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

$$A = \begin{bmatrix} 4 & 0 \\ 0 & 2 \\ 1 & 1 \end{bmatrix}_{3\times2} \quad \text{and} \quad b = \begin{bmatrix} 2 \\ 0 \\ 11 \end{bmatrix}_{3\times1}$$

. Also, write a program to solve linear equation Ax = b. **(07 Marks)**

c. Apply Gram – Schmidth 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 $V_3(R)$ with standard inner product and thereby write a program for Gram – Schimdth 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)**

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OR

4 a. Compute A^TA 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 $U \varepsilon V^T$ 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).

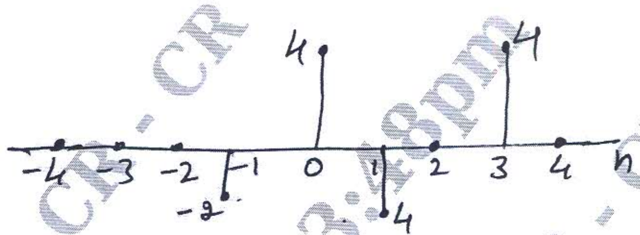

Fig.Q5(b)

Sketch :

i) $2x(n-2)$

ii) $3 - x(n)$

iii) $2x(-n) - 4$. **(08 Marks)**

c. Sketch : $x(n) = \begin{cases} 1; & -1 \le n \le 3 \\ \frac{1}{2}; & n = 4 \\ 0; & \text{otherwise} \end{cases}$ and $y(n) = \begin{cases} \frac{1}{2}n; & |n| \le 4 \\ 0; & \text{othewise} \end{cases}$

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) $y(n) = 2x(n) + \dfrac{1}{x(n-2)}$

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)**

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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 :

$$x(n) = \begin{cases} 1; & 0 \le n \le 4 \\ 0; & \text{othwerise} \end{cases} \quad \text{and} \quad h(n) = \begin{cases} \alpha^n; & 0 \le n \le 6, \alpha > 1 \\ 0; & \text{othwerise} \end{cases}$$

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 describe 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)**

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