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Course Code

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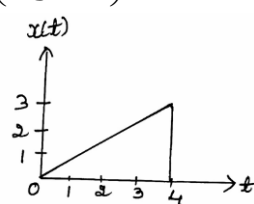
Sixth Semester B.E. Degree Examinations, May/June 2026

SIGNALS AND DIGITAL SIGNAL PROCESSING

Duration: 3 hrs

Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Missing data, if any, may be suitably assumed

<u>Q. No</u>	<u>Question</u>	<u>Marks</u>	<u>(RBTL:CO: PI)</u>
<u>Module-1</u>			
1.	a. Define signal. Explain basic elementary signals with mathematical expressions.	06	(2 :1: 1.2.1)
	b. Find the even and odd components of following signals	08	(3:1: 2.1.3)
	(i) $x(t) = 1 + t \cos(t) + t^2 \sin(t) + t^3 \sin(t) \cos(t)$		
	(ii) $x(t) = \begin{cases} 1 & -1 \leq t \leq 1 \\ -1 & 1 \leq t \leq 2 \\ 0 & \text{otherwise} \end{cases}$		
	c. Determine whether the system is linear, time-invariant, memory less, causal and stable when $y(n) = 0.5^n x(n)$.	06	(3:2: 2.1.3)
(OR)			
2.	a. Define system. Explain with any two examples.	06	(2 :1: 1.2.1)
	b. Perform the following operation on the signal shown in figure	08	(3:1: 2.1.3)
	(i) $x(t) = 2x(t+3)$ (ii) $x\left(-\frac{1}{3}t + 2\right)$ (iii) $x(t+2)$ (iv) $x(t-4)$		
			
	c. Determine whether the system is linear, time-invariant, memory less, causal and stable $y(t) = x\left(\frac{t}{2}\right)$.	06	(3:2: 2.1.3)
<u>Module-2</u>			
3.	a. Compute 8-point DFT of $x(n) = [1 \ 0 \ 1 \ 0 \ 1 \ 0 \ 1 \ 0]$.	08	(3:3: 2.1.3)
	b. State and prove the following properties of DFT	06	(2 :3: 1.2.1)
	(i) Linear (ii) Circular time shift		
	c. Determine 4-point IDFT of $X(k) = [2, 1+j, 0, 1-j]$ also find IDFT of $Y(k) = X((k-1))_4$ using property.	06	(3:3: 2.1.3)

(OR)

4. a. A long sequence $x(n)$ is filtered with a filter of impulse response $h(n)$ To produce output $y(n)$. Compute $y(n)$ using overlap add method when $x(n)=[1,3,-2,4,1,0,5,-1,2,3,3,1]$ and $h(n)=[1,2]$. Use 6-pt circular convolution in your approach. **08 (3:3: 2.1.3)**
- b. State and prove the following properties of DFT **06 (2 :3: 1.2.1)**
(i) Circular time shift (ii) Circular Folding
- c. Find N-Point Circular Convolution of $y(n)=x(n)\otimes_4 h(n)$ when **06 (3:3: 2.1.3)**

$$x(n)=\cos\left(\frac{2\pi n}{N}\right) \text{ and } h(n)=\sin\left(\frac{2\pi n}{N}\right), \quad 0 \leq n \leq N-1$$

Module-3

5. a. Compute 8-Point DFT using decimation in time FFT algorithm. **10 (3:3: 2.1.3)**
 $x(n)=[1,0,1,0,1,0,1,0]$
- b. Find the circular convolution of $x(n)$ and $h(n)$ when $x(n)=[1,0,-1,0]$ and $h(n)=[2,1,2,0]$ using the radix-2 DIT-FFTA. **10 (3:3: 2.1.3)**
- (OR)**
6. a. Compute 8-Point IDFT of $X(K)$ using decimation in time –FFT algorithm $X(K)=[0,2+j2,-j4,2-j2,0,2+j2,j4,2-j2]$. **10 (3:3: 2.1.3)**
- b. Find the 8-point DFT of $x(n)=\sin\left(\frac{\pi}{2}n\right)$. Use DIF FFTA. **10 (3:3: 2.1.3)**

Module-4

7. a. Derive the expression for the filter order N and cut-off frequency for low pass Butterworth Filter. **10 (2:4: 1.3.1)**
- b. Design a Butterworth analog high pass filter that will meet the following specifications: Maximum pass band attenuation = 2 dB. Passband edge frequency = 200 rad/sec. Minimum stopband attenuation = 20 dB. Stopband edge frequency = 100 rad/sec. **10 (3:4: 2.1.3)**
- (OR)**
8. a. Derive and discuss the general mapping properties of bilinear transformation and show the mapping between the s-plane and the z-plane **10 (2:4: 1.3.1)**
- b. Design a Chebyshev analog low pass filter that has a -3 dB cut-off frequency of 100 rad/sec and a stopband attenuation of 25 dB or greater for all radian frequencies past 250 rad/sec. **10 (3:4: 2.1.3)**

Module-5

9. a. Obtain a cascade and parallel realisation of IIR Filter described by 10 (2:5: 1.2.1.)

$$H(Z) = \frac{1 + \frac{1}{4}z^{-1}}{\left(1 + \frac{1}{2}z^{-1}\right)\left(1 + \frac{1}{2}z^{-1} + \frac{1}{4}z^{-2}\right)}$$

- b. A low pass filter is to be designed with the following desired frequency 10 (3:4: 2.1.3)

$$\text{response } H_d(\omega) = \begin{cases} e^{-2j\omega} & |\omega| < \frac{\pi}{4} \\ 0 & \frac{\pi}{4} < |\omega| < \pi \end{cases}.$$

Determine the filter coefficients $h_d(n)$ and $h(n)$, if $\omega(n)$ is a rectangular window Also find the frequency response $H(\omega)$ of the resulting FIR filter.

(OR)

10. a. Realize the direct form and linear phase structure of FIR filter given by 10 (3:5: 2.1.3)

$$H(Z) = 1 + \frac{1}{2}z^{-1} + \frac{1}{3}z^{-2} + \frac{2}{5}z^{-3} + \frac{1}{3}z^{-4} + \frac{1}{2}z^{-5} + z^{-6}$$

- b. Design a Low Pass FIR Digital Filter to meet the following specification 10 (3:4: 2.1.3)

$$H_d(\omega) = \begin{cases} e^{-3j\omega} & |\omega| < \frac{\pi}{4} \\ 0 & \frac{\pi}{4} < |\omega| < \pi \end{cases}$$

Determine the frequency response $H(\omega)$ of the resulting FIR filter if hamming window $N=7$ is used

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