

USN

Course Code

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

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>(RBT:CO: PI)</u>
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Module-1

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| 1. | a. Prove the following
(i) The power of the energy signal is zero over infinite time.
(ii) The energy of the power signal is infinite over infinite time
b. Determine whether the following signals are energy signals or power signals and estimate their energy or power
(i) $x(n) = \left(\frac{1}{2}\right)^n u(n)$ (ii) $x(t) = \cos^2(\omega_0 t)$ | 08 | (3 : 1: 2.1.2) |
| | (OR) | | |
| 2. | a. Construct $x(t)$ in terms of $g(t)$ where $x(t)$ and $g(t)$ are shown in Fig . Q 2(a). | 08 | (3 : 1: 2.1.2) |

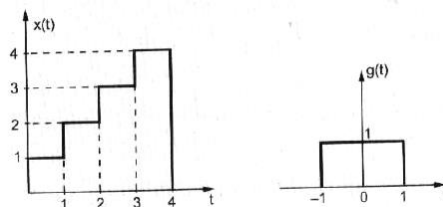


Fig. Q2(a)

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|----|--|----|----------------|
| b. | Evaluate and sketch the even and odd components of the following
(i) $x(t) = \begin{cases} t & 0 \leq t \leq 1 \\ 2-t & 1 \leq t \leq 2 \end{cases}$ (ii) | 08 | (3 : 1: 2.1.2) |
| c. | Define signal energy and power with their respective mathematical formulas. | 04 | (2 : 1: 1.3.1) |

Module-2

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|----|---|----|----------------|
| 3. | a. Evaluate 4-Point circular convolution of the sequences $y(n) = x(n) * h(n)$ where $x(n) = [1, 2, 3, 1]$ and $h(n) = [4, 3, 2, 2]$ using time domain approach and verify the same using frequency domain approach
b. Compute 8-point DFT of $x(n) = [1, 0, 1, 0, 1, 0, 1, 0]$. Use formulae method
c. Define DFT? Compute the N – Point DFT of $x(n) = 1$ | 08 | (3 : 2: 2.1.2) |
| | (OR) | | |
| | | 04 | (3 : 2: 2.1.2) |

4. a. State and prove (i) Circular Time Shift (ii) Parseval Theorem 08 (3 :2: 2.1.2)
 b. Define DFT. Compute the N – Point DFT of $x(n) = \sin n$ 08 (3 :2: 2.1.2)
 c. The 5–point DFT of a complex sequence $x(n)$ is given as $x(k) = [j, 1 + j, 1 + j, 2, 4 + j]$. Compute $Y(k)$, if $x^*(n)$. 04 (3 :2: 2.1.2)

Module-3

5. a. Develop Radix-2 DIT-FFT algorithm and draw complete signal flow graph for $N=8$. 08 (3 :3: 2.1.2)
 b. Consider a FIR filter with impulse response $h(n) = [1, 1, 1]$ if the input is $x(n) = [1, 2, 0, -3, 4, 2, -1, 1, -2, 3, 2, 1, -3]$. Compute the output $y(n)$ using overlap – save method 12 (3 :3: 2.1.2)

(OR)

6. a. Compute 8-Point DFT of $x(n) = (1, 1, 1, 1, 0, 0, 0, 0)$ using decimation in time –FFT algorithm. 08 (3 :3: 2.1.2)
 b. Consider a FIR filter with impulse response $h(n) = [1, 1, 1]$ if the input is $x(n) = [1, 2, 0, -3, 4, 2, -1, 1, -2, 3, 2, 1, -3]$. Compute the output $y(n)$ using overlap – add method 12 (3 :3: 2.1.2)

Module-4

7. a. Derive the expression for the filter order. Find the poles of $N = 3$ and plot the same in the S-Plane 10 (3 :4: 2.1.2)
 b. A Butterworth low pass filter has to meet the following specifications 10 (3 :4: 2.1.2)
 (i) Passband gain $K_p = -1\text{dB}$ at $\Omega_p = 4 \text{ rad/sec}$.
 (ii) Stopband attenuation greater than or equal to 20 dB at $\Omega_s = 8 \text{ rad/sec}$
 Evaluate the transfer function $H_a(s)$ of the lowest order butterworth filter to meet the above specifications

(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 (3 :4: 2.1.2)
 b. A digital low pass filter is required to meet the following specifications 10 (3 :4: 2.1.2)
 (i) Monotonic passband and stopband
 (ii) -3.01 dB cut-off frequency of $0.5\pi \text{ rad/sec}$
 (iii) Stopband attenuation of at least 15 dB at $0.75\pi \text{ rad/sec}$.
 Find the system function $H(z)$. Verify the design by checking for passband and stopband specifications

Module-5

9. a. A low pass filter is to be designed with the following desired frequency response 10 (2 :5: 2.1.2)

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

Determine the filter coefficients $h_d(n)$ and $h(n)$, if $w(n)$ is a rectangular window for. Also find the frequency response $H(\omega)$ of the resulting FIR filter. Take $N = 5$.

- b.** Realize the direct form and linear phase structure of FIR filter given by **10** (3 :5: 2.1.2)

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

(OR)

- 10 a.** A low pass filter has the designed frequency response **10** (2 :5: 2.1.2)

$$H_d(e^{j\omega}) = H_d(\omega) = \begin{cases} e^{-j3\omega} & |\omega| < \frac{3\pi}{4} \\ 0 & \frac{3\pi}{4} < |\omega| < \pi \end{cases}$$

Determine the frequency response of the FIR filter, if Hamming window is used with $N=7$.

- b.** Realize an FIR filter with impulse response **06** (3 :5: 2.1.2)

$$h(n) = \left(\frac{1}{2}\right)^n [u(n) - u(n-3)] \text{ using direct form-I.}$$

- c.** Write the time domain equations, width of main lobe and maximum stop band attenuation of the following windows **04** (2 :5: 2.1.2)

(i) Rectangular (ii) Bartlett (iii) Hamming (iv) Hanning

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