

2025

INFORMATION TECHNOLOGY

Paper : IT-502

(Digital Signal Processing)

Full Marks : 70

*The figures in the margin indicate full marks.**Candidates are required to give their answers in their own words as far as practicable.*Answer *any five* questions.

1. (a) Explain the fundamental processes involved in converting an analog signal into discrete-time samples — namely sampling, quantization and encoding. Discuss their significance, limitations and impact on signal fidelity. Use suitable examples.
- (b) For the discrete-time sequence $x[n] = 3u[n] - 2u[n-4]$, sketch the sequence and compute its energy. 7+7

2. (a) Define Linear Shift Invariant (LSI) systems. State and prove any two important properties of LSI systems.
- (b) Determine the impulse response $h[n]$ of the system defined by
- $$y[n] = x[n] - x[n-1] + 2x[n-2]. \quad 7+7$$

3. (a) Explain the convolution sum and its significance in LTI system analysis. State any three properties of convolution.
- (b) Compute the convolution of the following sequences :
- $$x[n] = \overset{0}{1}, \overset{1}{2}, \overset{2}{1}, \overset{3}{0}$$
- $$h[n] = \overset{0}{1}, \overset{1}{-1}, \overset{2}{2}$$
- Show all intermediate steps. 7+7

4. (a) Define the Discrete Fourier Transform (DFT). Explain any two properties of the DFT.
- (b) Compute the 4-point DFT of the sequence $x[n] = \{1, 1, 1, 1\}$. 7+7

5. (a) Explain the Z-transform and the Region of Convergence (ROC). How does ROC determine the stability of a system?
- (b) Find the Z-transform and ROC of $x[n] = (-1)^n u[n]$. Draw the pole-zero diagram. 7+7

Duality

$$\sum_{n=-\infty}^{\infty} x(n)Z^{-n}$$

Please Turn Over

(2618)

sign cos

- ✓ 6. (a) Design a simple FIR low-pass filter using a window-based method for cutoff frequency $\pi/3$. Provide all steps clearly.
- (b) Realize a first-order IIR high-pass filter and derive its difference equation. 7+7
7. Explain the key architectural characteristics, computational features and application domains of
- (a) DSP processors
 - (b) Vector processors
 - (c) GPU-based processors.