

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

$$y[n] = x[n] - x[n-1] + 2x[n-2]. \quad \text{7+7}$$

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 :

$$x[n] = \{1, 2, 1, 0\}$$

$$h[n] = \{1, -1, 2\}$$

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?

Duality (b) Find the Z-transform and ROC of $x[n] = (-1)^n u[n]$. Draw the pole-zero diagram. 7+7

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$$\sum_{n=0}^{\infty} x(n) z^{-n}$$

Ans 18

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.