2024

ELECTRONIC SCIENCE

Paper : ITGE-31

(Digital Signal Processing)

Full Marks : 50

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

Symbols have their usual significances.

Answer *any five* questions.

Instructions :

- Attempt **any 5 questions** out of the 7 provided.
- Each question carries **10 marks.**
- Write all assumptions and steps clearly.

1. (a) Define the unit step, delta, ramp, sine, and cosine sequences with suitable mathematical expressions and sketches.

   (b) Consider the sequence $x[n] = 2u[n] - u[n - 4]$. Find and plot $x[n]$.

2. (a) Explain how any arbitrary time sequence can be represented using the delta sequence. Provide an example.

   (b) Represent the sequence $x[n] = \{3, 1, -1, 2\}$ using the delta sequence.

3. (a) Derive the output of an LTI system given input $x[n]$ and impulse response $h[n]$ using the convolution sum.

   (b) Given $x[n] = \{1, 2, 3\}$ and $h[n] = \{1, -1\}$, compute $y[n] = x[n]*h[n]$ (convolution).

4. (a) State and prove the periodicity and linearity properties of the DFT.

   (b) Compute the 4-point DFT of the sequence $x[n] = \{1, 0, 1, 0\}$.

5. (a) Find the Z-transform and ROC of the sequence $x[n] = a^n u[n]$, where $|a| < 1$.

   (b) Discuss the significance of ROC in determining the stability and causality of a system.

6. (a) Explain the design principles of high-pass and low-pass digital filters.

   (b) Derive the transfer function of a simple low-pass digital filter and sketch its magnitude response.

7. (a) Explain the process of convolution using the Discrete Fourier Transform (DFT).

   (b) Compute the linear convolution of $x[n] = \{1, 2\}$ and $h[n] = \{1, 1\}$ using DFT and inverse DFT.

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