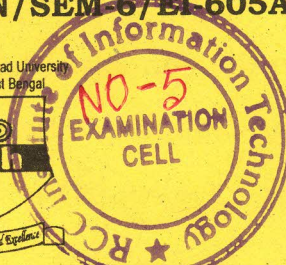


Maulana Abul Kalam Azad University
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**MAULANA ABUL KALAM AZAD UNIVERSITY OF
TECHNOLOGY, WEST BENGAL**

Paper Code : EI-605A

DIGITAL SIGNAL PROCESSING

Time Allotted : 3 Hours

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.*

GROUP - A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the
following : $10 \times 1 = 10$

i) If $x_1(n)$ and $x_2(n)$ are finite length sequences of
sizes L and M respectively, their linear convolution
has the length

- | | |
|----------------|-------------------------|
| a) $L + M - 2$ | b) $L + M - 1$ |
| c) $L + M$ | d) $\text{Max}(L, M)$. |

- ii) In the context of sampling with sampling interval T , the mapping between S and Z plane is
- a) $Z = \exp(ST)$ b) $S = ZT$
c) $S = \exp(ZT)$ d) $Z = ST$.
- iii) The inverse Z transform of $\frac{Z}{Z-1}$ is
- a) $u(n)$ as well as $u(-n)$
b) $u(-n)$ but not $u(n)$
c) $u(n)$ as well as $u(-n-1)$
d) $u(n)$ but not $u(-n-1)$.
- iv) In FFT, for calculating N -point DFT total number of complex addition required is
- a) N^2 b) $(N-1) \log_2 N$
c) $\frac{N}{2} \log_2 2N$ d) $N \log_2 N$.
- v) For a stable system, the impulse response $h(nT)$
- a) is defined for $n \geq 0$ b) contains impulses
c) decays to zero d) is infinite in length.
- vi) A control system has a Z transform ROC
- a) within a circle b) outside a circle
c) on a circle d) through the plane.

- vii) Chebyshev type I filter
- is all pole filter
 - is all zero filter
 - contains both poles and zeros
 - contains either poles and zeros.
- viii) FIR filter is of
- non-recursive and non-linear type
 - non-recursive and linear type
 - recursive and non-linear type
 - recursive and linear type.
- ix) If Fourier transform of $x(n)$ is $X[\omega]$, the Fourier transform of $n \times (n)$ is
- $-j \frac{dX[\omega]}{d\omega}$
 - $\frac{dX[\omega]}{d\omega}$
 - $j \frac{dX[\omega]}{d\omega}$
 - none of these.
- x) Zero padding is a signal, if it
- reduces aliasing
 - increases time resolution
 - increases frequency resolution
 - has no effect.

- xi) The system having input $x(n)$ related to output $y(n) = \log_{10} |x(n)|$ is
- a) non-linear, causal, BIBO stable
 - b) linear, non-causal, BIBO stable
 - c) linear, non-causal, BIBO unstable
 - d) non-linear, causal, BIBO unstable.
- xii) Impulse invariant method of digital filter design can be used to design
- a) low-pass filter
 - b) high-pass filter
 - c) any type of filter
 - d) FIR filter.

GROUP - B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Determine whether or not $x(n)$ is periodic.

If periodic, determine its fundamental period :

$$x(n) = \cos \frac{\pi}{3} n + \cos \frac{3\pi}{4} n.$$

3. What are the different methods available to find out inverse Z transform of a sequence ?

Determine the inverse Z transform of causal signal given

$$\text{by } X(Z) = \frac{1}{(1 - 2z^{-1})(1 - z^{-1})^2}.$$

4. Find the DFT of $x(n) = \{1, 1, 2, 2\}$.
 \uparrow
5. Find out the impulse response of the system described by given differential equation using Z transform.

$$y(n) - 0.7y(n-1) + 0.12y(n-2) = x(n-1) + x(n-2)$$

6. For the function $x_1(n)$ and $x_2(n)$ compute $y(n) = x_1(n) * x_2(n)$ using graphical method :

$$x_1(n) = \delta(n) + \delta(n-1) - \delta(n-2) - \delta(n-3)$$

$$x_2(n) = \delta(n) - \delta(n-2) + \delta(n-4).$$

GROUP - C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Prove that an LTI system is BIBO stable if and only if the ROC of the system function includes the unit circle.

- b) Determine the inverse Z transforms of

$$X(z) = \log(1 - 0.5z^{-1}), |z| > 0.5$$

- c) Compute the circular convolution of the following two sequences using concentric circle method :

$$x(n) = \{1, 2, 3, -1, 2\}, h(n) = \{2, 2, 1\} \quad 3 + 6 + 6$$

$$\uparrow \quad \quad \quad \uparrow$$

8. a) Find out the 8-point DFT of the following sequence

$$x(n) = \{1, 1, 1, 1, 0, 0, 0, 0\}$$

↑

- b) What do you mean by zero padding ?

- c) Find the output $y(n)$ of a filter whose impulse response is $h(n) = \{1, 1, 1\}$ and the input signal $x(n) = \{3, -1, 0, 1, 3, 2, 0, 1, 2, 1\}$ using (i) Overlap-save method, (ii) Overlap-add method.
- 6 + 2 + 7

9. a) What is the difference between IIR and FIR filter ?

- b) Explain Gibbs phenomenon in digital filter design.

How can it be eliminated ?

- c) Design a Butterworth filter the bilinear transformation for the specifications :

$$0.8 \leq |H(e^{j\omega})| \leq 1, \quad 0 \leq \omega \leq 0.2\pi$$

$$\leq |H(e^{j\omega})| \leq 0.2, \quad 0.6\pi \leq \omega \leq \pi$$

3 + 4 + 8

10. a) Explain the bit reversal technique.

- b) Find the DFT of a sequence

$$x(n) = \{1, 2, 3, 4, 4, 3, 2, 1\}$$

↑

using DIT-FFT Algorithm.

- c) Write down the properties of ROC.

2 + 10 + 3

11. a) Determine whether the signal is energy or power signal : $x(n) = r(n) - r(n - 4)$.
- b) An interconnection of LTI systems is shown below. The impulse responses are

$$h_1(n) = \left(\frac{1}{2}\right)^n [u(n) - \delta(n)] \text{ and } h_2(n) = u(n - 2).$$

Let the impulse response of the overall system from $x(n)$ to $y(n)$ be denoted as $h(n)$. Evaluate $h(n)$.



- c) Obtain the cascade form realization for the system given by the difference equation
- $$y(n) = -0.1y(n - 1) + 0.2y(n - 2) + 3x(n) + 3.6x(n - 1) + 0.6x(n - 2).$$

4 + 6 + 5

12. Write short notes on any *three* of the following : 3 × 5

- Mapping of S-plane and Z-plane
- Circular Convolution
- Warping effect & Prewarping
- Radix-2 DIT algorithm
- Discrete LTI system
- DSP TMS320C 5416 processor.