GUJARAT TECHNOLOGICAL UNIVERSITY
BE- SEMESTER–VII (NEW) EXAMINATION – WINTER 2024

Subject Code:2171003   **Date:19-11-2024**
Subject Name: Digital Signal Processing
Time:10:30 AM TO 01:00 PM   **Total Marks:70**

Instructions:
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Describe the process of conversion of an analog signal into a digital signal.	**03**
	(b)	What is the significance of ROC in Z-transforms? Explain by using suitable example.	**04**
	(c)	Draw and explain the block diagram of a digital signal processing system. Also explain an application of digital signal processing in detail.	**07**
Q.2	**(a)**	Define the following: a) Time invariant system. b) Static System. c) Linear System.	**03**
	(b)	Explain the process of up-sampling and down-sampling using suitable examples.	**04**
	(c)	State and prove the conditions for a system to be a) Causal b) Stable with respect to the impulse response of a system.	**07**

OR

	(c)	Compute the convolution of the signals	**07**

$$x(n) = \begin{cases} \alpha^n & -3 \le n \le 5 \\ 0 & elsewhere \end{cases}$$

$$h(n) = \begin{cases} 1 & 0 \le n \le 4 \\ 0 & elsewhere \end{cases}$$

Q.3	**(a)**	Describe the relationship between Fourier Transform and Z-Transform.	**03**
	(b)	State and prove the convolution property of Z-transform.	**04**
	(c)	Consider the system	**07**

$$H(z) = \frac{1 - 2z^{-1} + 2z^{-2} - z^{-3}}{(1 - z^{-1})(1 - \frac{1}{2}z^{-1})(1 - \frac{1}{5}z^{-1})}, \quad \frac{1}{2} < |z| < 1$$

a) Determine the poles and zeros.
b) Determine the impulse response of the system.

OR

Q.3	**(a)**	Compare DTFT and DFT.	**03**
	(b)	State and prove the time shifting property of Z-Transform and state its significance.	**04**

(c) Define ROC. Determine the Z-transform and the ROC of   **07**

a) $x_1(n) = \begin{cases} \left(\frac{1}{3}\right)^n & n \geq 0 \\ \left(\frac{1}{2}\right)^{-n} & n < 0 \end{cases}$

b) $x_2(n) = \begin{cases} \left(\frac{1}{3}\right)^n - 2^n & n \geq 0 \\ 0 & n < 0 \end{cases}$

c) $x_3(n) = x_1(n+4)$

Q.4 **(a)** Explain Minimum Phase System in brief.   **03**
(b) Draw and describe the Direct form – I structure realization of IIR system.   **04**
(c) Consider the sequences   **07**
$x_1(n) = \{0,1,2,3,4\}$ $x_2(n) = \{0,1,0,0,0\}$ and $s(n) = \{1,0,0,0,0\}$
and their 5-point DFTs
  a) Determine a sequence y(n) such that $Y(k)=X_1(k)X_2(k)$.
  b) Is there a sequence $x_3(n)$ such that $S(k) = X_1(k)X_3(k)$

<center>**OR**</center>

Q.4 **(a)** Describe the use of Inverse System. Explain Inverse System in brief.   **03**
(b) Draw the structure of radix 2 DIT FFT algorithm   **04**
(c) Let $x_a(t)$ be an analog signal with bandwidth of 3000Hz. Considering a $N=2^n$ point   **07**
DFT to compute the spectrum with resolution less than or equal to 50Hz.
Determine
  a) The minimum sampling rate
  b) The minimum number of required samples
  c) The minimum length of the analog signal record.

Q.5 **(a)** Describe the effects of coefficient quantization in FIR filters.   **03**
(b) Determine the coefficients $\{h(n)\}$ of a linear-phase FIR filter of length M = 15   **04**
which has a symmetric unit sample response and a frequency response that
satisfies the condition

$$H_r\left(\frac{2\pi k}{15}\right) = \begin{cases} 1 & k = 0,1,2,3 \\ 0.4 & k = 4 \\ 0 & k = 5,6,7 \end{cases}$$

(c) Explain pipelining and MAC architecture of a digital signal processor.   **07**
<center>**OR**</center>
Q.5 **(a)** Explain sampling rate conversion by a non-integer number.   **03**
(b) Explain forward linear predictive filter in detail.   **04**
(c) Design a two-stage decimator for the following specifications   **07**
D=100
Passband: $0 \leq F \leq 50$
Transision Band: $50 \leq F \leq 55$
Input sampling rate: 10,000 Hz
Ripple: $\delta_1=10^{-1}$, $\delta_2=10^{-3}$.
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