Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII (OLD) EXAMINATION – WINTER 2023

Subject Code:2171003 Date:01-12-2023

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.**

Q.1 **(a)** Define discrete time signals. Enlist classification of Discrete time signals. **03**

(b) Determine whether or not the following signals are periodic. In case a signal is periodic, specify its fundamental period **04**

(i) $x_1(n) = \sin\frac{2\pi n}{3} + \cos\frac{2\pi n}{5}$

(ii) $x_2(n) = \cos\frac{n}{2}\cos(\frac{n\pi}{3})$

(c) Classify following systems as : (a) Causal or non-causal; (b) Linear or nonlinear and (c) shift invariant or shift variant **07**

(i) $y_1(n) = Log_{10}|x(n)|$

(ii) $y_2(n) = x(n)x(n-4)$

Q.2 **(a)** Explain Dirichlet's Conditions for existence of Fourier Transform. **03**

(b) State formulas for Discrete Time Fourier Transform (DTFT) Z-transform of discrete time signal x(n). Prove relationship between Z-transform and DTFT. **04**

(c) A causal LTI system is described by following difference equation: **07**

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

Find (a) system function (b) Frequency response. (c) Plot pole zrod and Specify ROC of H(z). (d)determine whether the system is stable or not.

OR

(c) Determine response of the systems having input x(n) and inpulse response h(n) using (a) linear convolution and (b) circular convolution. **07**

$x(n) = \{1, \underset{\uparrow}{2}, 3, 4\}$ and $h(n) = \{1, \underset{\uparrow}{1}, 1, 1\}$

Q.3 **(a)** Prove that for causal sequences, the ROC of Z transform is exterior of a circle of radius r. **03**

(b) Find Direct Form-II structure for the following system function: **04**

$$H(z) = \frac{3z^3 - 5z^2 + 9z - 3}{[z - 1/2][z^2 - z + 1/3]}$$

(c) A Causal LTI system is described by the difference equation **07**

$$y(n)+\frac{1}{4}y(n-1)=x(n)+\frac{1}{2}x(n-1)$$

Determine System function of the system and give ROC. Find unit sample response of the same. Find the magnitude response of the same.

OR

Q.3 **(a)** Using properties of Z transform, compute Z transform for following signals. **03**

$x(n)=2^n u(n-2)$

(b) State and prove Time reversal property of Z transform. **04**

(c) Using partial fraction expansion, discuss all possibilities of ROCs and obtain all possible signals of the following: **07**

$$X(Z)=\frac{(\frac{1}{4})z^{-1}}{[1-(\frac{1}{2})z^{-1}][1-(\frac{1}{4})z^{-1}]}$$

Q.4 **(a)** Compute the 4 point DFT of the following four-point sequence using DFT matrix. **03**

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

(b) Explain advantages of using multi-rate signal processing. Explain Decimation or Interpolation concept by taking simple suitable example. **04**

(c) Discuss 8-point Radix-2 Decimation-in-Frequency FFT algorithm. **07**

OR

Q.4 **(a)** Find 4-point DFT of x(n)- {1,-1,2,-2}, directly using equation . **03**

(b) List out the useful properties of DFT and prove any one of them. **04**

(c) Discuss 8-point Radix-2 Decimation-in-time FFT algorithm. **07**

Q.5 **(a)** Define an adaptive filter. Draw (only a block diagram) that explains any one application of adaptive filters. **03**

(b) Explain in brief on Harvard architecture of DSP processor. **04**

(c) Explain with necessary details design of IIR filter by approximation of derivatives transformation method. Explain with justification how it is NOT better than bilinear and impulse invariance methods. **07**

OR

Q.5 **(a)** Enlist differences between FIR and IIR Filters. **03**

(b) Explain the followings in context of DSP processor architecture: **04**

(1) MAC (2) Pipelining

(c) Find the order and cut -off frequency of a IIR butter worth digital filter with the following specifications. Use impulse invariant method and take sampling period T=1 second. **07**

$0.80 \le |H(w)| \le 1 ... for\_ 0 \le w \le 0.2\pi$

$|H(w)| \le 0.20 .. for\_ 0.32\pi \le w \le \pi$.