Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII (NEW) EXAMINATION – WINTER 2022

Subject Code:3171003 Date:18-01-2023

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.**

			MARKS
Q.1	**(a)**	For an energy signal $x\,(n)$ with energyE_x, show that the energy of $y\,(n) = a^2 E_x$.	**03**
	(b)	Determine whether signal $x\,(n) = \cos(0.01\,\pi n)$ is periodic or not. Find the period if the signal is periodic.	**04**
	(c)	Consider a system as $y\,(n) = log_{10}\lvert x(n)\rvert$. Determine whether the given system is linear, causal and stable or not.	**07**
Q.2	**(a)**	State and prove differentiation in frequency domain property of D.T.F.T.	**03**
	(b)	Explain the need of Z-transform over D.T.F.T. How to convert Z-transform into D.T.F.T.	**04**
	(c)	Let $X\left(e^{j\omega}\right)$ denote the Fourier transform of the signal $x\,(n) = \{2, 1, 0, 1, 2, 1, 0, -1\}$. Evaluate: $\int_{-\pi}^{\pi} X\left(e^{j\omega}\right)\,\mathrm{d}\omega$ and $\int_{-\pi}^{\pi} \lvert X\left(e^{j\omega}\right)\rvert^2\,d\omega$.	**07**
		OR	
	(c)	Consider a causal LTI system that is characterized by the difference equation $y\,(n) - \frac{3}{4}\,y\,(n-1) + \frac{1}{8}\,y\,(n-2) = 2\,x\,(n)$. Find the frequency response $H(e^{j\omega})$ and the impulse response $h\,(n)$ of the system.	**07**
Q.3	**(a)**	Determine the z-transform of $x\,(n) = \left(\frac{1}{2}\right)^n u(n) + 2^n u(n)$ and depict the ROC and the locations of poles and zeros in the z-plane.	**03**
	(b)	Determine the inverse z-transform of $X(z) = \frac{1}{1-1.5\,z^{-1}+0.5z^{-2}}$ if ROC: $0.5 < \lvert z\rvert < 1$	**04**
	(c)	Determine the zeros for the following FIR systems and indicate whether the system is minimum phase, maximum phase, or mixed phase. $H_1(z) = 6 + z^{-1} - z^{-2}$ $H_2(z) = 1 - z^{-1} - 6z^{-2}$ $H_3(z) = 1 - \frac{5}{2}z^{-1} - \frac{3}{2}z^{-2}$ $H_4(z) = 1 + \frac{5}{3}z^{-1} - \frac{2}{3}z^{-2}$	**07**

OR

Q.3 **(a)** Determine the z-transform of $x(n) = \left(\frac{1}{2}\right)^n u(n) + 2^n u(-n-1)$ and depict the ROC and the locations of poles and zeros in the z-plane. **03**

(b) State and prove time shifting and scaling in z-domain property of z-transform. **04**

(c) List all the properties of Region-Of-Convergence (ROC). **07**

Q.4 **(a)** Draw the Direct form-I implementation of the given system transfer function $H(z) = \frac{1+2z^{-1}+z^{-2}}{1-0.75z^{-1}+0.125z^{-2}}$. **03**

(b) Draw the Cascade form implementation of the given system transfer function $H(z) = \frac{1+2z^{-1}+z^{-2}}{1-0.75z^{-1}+0.125z^{-2}}$. **04**

(c) Draw Direct form-I and Direct form-II structure for the function of $y(n) = x(n) + 0.3x(n-1) - 0.4x(n-2) - 0.8y(n-1) + 0.7y(n-2)$. Compare both the structure for hardware requirement. **07**

OR

Q.4 **(a)** Compare IIR and FIR filter. **03**

(b) Find out H (Z) for the given $H(S) = \frac{2}{S^2+3S+2}$ using impulse invariance method. Assume T=1s. **04**

(c) Using a rectangular window, design an LPF with a pass-band gain of unity, cut-off frequency of 1000 Hz, and working at a sampling frequency of 5 KHz. Take the length of the impulse response as 7. **07**

Q.5 **(a)** Prove periodicity property of DFT. **03**

(b) Find DFT of x (n) $= \{0, 1, 2, 3\}$. **04**

(c) Consider input sequence $x(n) = \{1, 2, 3\}$ and impulse response of a system$h(n) = \{1, 1\}$. Find the linear convolution using graphical circular convolution method. Match result of same using tabulation/ matrix method. **07**

OR

Q.5 **(a)** Using decimation in time algorithm, compute 4-point DFT of the sequence x(n)={0, 1, 2, 3} **03**

(b) Explain how computation complexity is reduced in FFT compared to DFT. **04**

(c) Discuss in brief: Radix-2 Decimation-in-Time FFT algorithms. **07**

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