Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–VII (NEW) EXAMINATION – WINTER 2020

Subject Code:2171003 Date:30/01/2021

Subject Name:Digital Signal Processing

Time:10:30 AM TO 12:30 PM Total Marks: 56

Instructions:

1. **Attempt any FOUR questions out of EIGHT questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

			MARKS
Q.1	**(a)**	Compare the direct form-I and II structures of an IIR systems, with M-zeros and N-poles.	**03**
	(b)	Calculate the percentage saving in calculations in a 512-point radix-2 FFT, When compared in direct DFT.	**04**
	(c)	Draw and explain architectural block diagram of TMSC6000 DSP processor.	**07**
Q.2	**(a)**	Give any three properties of Butterworth lowpass filters.	**03**
	(b)	Give the equation specifying Kaiser window. List the advantages of Kaiser window.	**04**
	(c)	Design a single-pole lowpass digital filter with a 3-db bandwidth of 0.2π, using the bilinear transformation applied to the analog filter $$H(s) = \frac{\Omega_c}{s + \Omega_c}$$ Where Ω_c is the 3-dB bandwidth of the analog filter.	**07**
Q.3	**(a)**	List the application of an adaptive filter. Briefly explain any one of it.	**03**
	(b)	Realize the following FIR system with minimum number of multipliers. h(n)={-0.5, 0.8, -0.5}	**04**
	(c)	Determine all the FIR filters which are specified by the lattice parameters $K_1 = \frac{1}{2}, K_2 = 0.6, K_3 = -0.7$ *and* $K_4 = \frac{1}{3.}$	**07**
Q.4	**(a)**	Determine a direct-form realization for the following linear phase filter. $$h(n) = \{\underline{1}, 2,3,4,3,2,1\}$$	**03**
	(b)	Find the inverse DFT of Y(k)= {1,0,1,0}.	**04**
	(c)	Derive the signal flow graph for the N= 16-point, radix-4 decimation-in-time FFT algorithm in which the input sequence is in normal order and the computations are done in place.	**07**

Q.5 **(a)** Determine the inverse Fourier transform of **03**

$$X(e^{j\omega}) = 2\pi\delta(\omega - \omega_0), \quad |\omega_0| \leq \pi.$$

(b) Determine the inverse of the system with impulse response **04**

$$h(n) = \left(\frac{1}{2}\right)^n u(n).$$

(c) Determine $|H(\omega)|^2$ for the system **07**

$$y(n) = -0.1y(n-1) + 0.2y(n-2) + x(n) + x(n-1).$$

Q.6 **(a)** Determine the energy density spectrum of the signal **03**

$$x(n) = a^n u(n), \qquad -1 < a < 1$$

(b) Prove the Parseval's relation **04**

$$\sum_{n=-\infty}^{\infty} x_1(n)x_2^*(n) = \frac{1}{2\pi}\int_{-\pi}^{\pi} X_1(\omega)X_2^*(\omega)d\omega$$

(c) Determine the particular solution of the difference equation **07**

$$y(n) = \frac{5}{6}y(n-1) - \frac{1}{6}y(n-2) + x(n)$$

When the forcing function $x(n) = 2^n, n \geq 0$ and zero elsewhere.

Q.7 **(a)** Find the z-transform of $na^n u(n)$. **03**

(b) Test the stability of the following systems.

i. y(n) = cos[x(n)] **04**

ii. y(n) = x(- n -2)

(c) Find the response of the time invariant system with impulse response h(n) = {1,2,1,-1} to an input signal x(n) = {1,2,3,1}. **07**

Q.8 **(a)** Determine the regions of convergence of right-sided, left-sided, and finite-duration two-sided sequences. **03**

(b) An analog ECG signal contains useful frequencies up to 100Hz. **04**

i. What is the Nyquist rate for this signal?

ii. Suppose that we sample this signal at a rate of 250 samples/s. What is the highest frequency that can be represented uniquely at this sampling rate? Justify your answer.

(c) Determine the inverse z-transform of **07**

$$X(z) = \frac{1}{1 - 1.5z^{-1} + 0.5z^{-2}}$$

when ROC is $|z| < 0.5$ and $|z| > 1$.

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