Seat No./Enrollment No.: _____

GUJARAT TECHNOLOGICAL UNIVERSITY
BACHELOR OF ENGINEERING – SEMESTER 4 – EXAMINATION – SUMMER 2026

Subject Code: 3141005 **Date: 21/05/2026**

Subject Name: Signal & Systems

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)**	Plot the unit step u(t) and the unit ramp r(t) signals in CT. What is the relationship between these two?	**03**
	(b)	Classify the following signals as periodic or not-periodic giving the plots (i) $\sin(2\pi t)$, (ii) $(1/2)^t u(t)$. Specify the time-period in case of the periodic signal.	**04**
	(c)	(i) State the conditions on a CT system to be classified as a LTI system. (ii) State whether the CT signal x(t)= 1-|t|, for |t|<1, and x(t)=0 otherwise; has odd, even, or no symmetry. Also state the effect on the nature of its Fourier Transform due to the same. (iii) Suppose a DT signal x[n]={1, 2, 1} then determine its z-transform.	**07**
Q.2	**(a)**	A CT-LTI system has an impulse response h(t), then just from this information and applying LTI behavior of the system derive the input-output relationship in CT for this system.	**03**
	(b)	State whether the following two LTI systems are causal and stable or not, giving the reasons. (i) Impulse response h(t) = $2^t u(t)$ (ii) Difference eq. y[n] = x[n+1] + 2x[n] + x[n-1]	**04**
	(c)	A CT-LTI system has the impulse response h(t) = $e^{-t} u(t)$, then determine the corresponding output y(t) for an input x(t)=1, for $0 \le t \le 1$, and x(t)=0, otherwise. Plot the input and output signals in this example.	**07**
		OR	
Q.2	**(c)**	A causal DT-LTI system is given by the difference eq., y[n] = (2/3)y[n-1] + x[n], where x[n] is the input signal and y[n] is the output signal. Plot the impulse response and determine from it whether the system is (i) FIR or IIR, (ii) Causal or Not, (iii) Stable or Not. Give clear reasons for your answers.	**07**
Q.3	**(a)**	For a periodic CT signal x(t), x(t-2n) = x(t) for any integer value of n. Then determine the following for x(t) (i) time-period, (ii) fundamental frequency, (iii) harmonic-frequencies.	**03**
	(b)	Define the DTFT for any DT signal x[n]. If x[n]={1, 3, 3, 1} then determine the expression of DTFT for the same. Also evaluate the DTFT expression at $\omega=0$ and $\omega=\pi$ (rad).	**04**
	(c)	Determine the expression of Fourier Transform of a CT signal x(t)= 1, for $-1/2 \le t \le 1/2$, and x(t)=0, otherwise. Plot the magnitude spectrum from the derived expression, with clear marking of values of the max point and zero-crossing points.	**07**
		OR	
Q.3	**(a)**	Determine the Fourier Transform of x(t) = 10 cos (10πt), and sketch the plot of the same in frequency-domain.	**03**
	(b)	Calculate X[k], the 4-point DFT of the sequence x[n]={1, 2, 2, 1}.	**04**

(c) State the relationship between the Laplace Transform and the Fourier Transform for any CT signal. If for any causal CT-LTI system, the transfer-function is given as H(s) = 1/(s+1), then determine the following **07**
(i) Whether the system is stable or not, why?
(ii) Derive the frequency response for the same.
(iii) Derive and sketch the magnitude response for the same.

Q.4 **(a)** If the z-transform of x[n] is X(z), then determine, Y(z) the z-transform of y[n] given by y[n]=2x[n]+3x[n-1]+2x[n-2], in terms of X(z). **03**

(b) Determine h[n] the inverse z-transform of H(z) if H(z) =1/(1-0.7z^{-1}), with RoC: |z| > 0.7. Also plot the sequence h[n] in time-domain. **04**

(c) Determine the z-transform of DT-LTI with the impulse response h[n] = a^n u[n]. Also give the RoC (Region of Convergence) in terms of the constant 'a' here. Also plot the RoC in z-plane for the following three values of 'a': (i) a=1/2, (ii) a=1, (iii) a=2. **07**

OR

Q.4 **(a)** Determine h[n] the inverse z-transform of H(z) if H(z) =1 + 3z^{-1} + 3z^{-2} + 1z^{-3} , with RoC: z≠0. **03**

(b) If the z-transform of x[n] is X(z), then determine, Y(z) the z-transform of y[n] given by y[n]=(1/2)y[n-1] + x[n], in terms of X(z). Also state RoC for the same. **04**

(c) Determine the z-transform of DT-LTI with the impulse response h[n] = b^n u[-n-1]. Also give the RoC (Region of Convergence) in terms of the constant 'b' here. Also plot the RoC in z-plane for the following three values of 'b': (i) b=1/2, (ii) b=1, (iii) b=2. **07**

Q.5 **(a)** Give a block-diagram of the sampling of a CT signal to obtain a DT signal in time-domain. **03**

(b) A DT signal x[n]={1, 2, 1, 2} is reconstructed using a line-interpolation considering the sampling-time Ts = 2 second to obtain an equivalent CT signal x(t), then plot x(t) in time-domain. **04**

(c) A CT signal x(t) has the Fourier Transform X(f) given as **07**

$$X(f) = \begin{cases} 1-(|f|/100), & \text{for } |f| \le 100 \text{ Hz;} \\ 0, & \text{otherwise.} \end{cases}$$

If x(t) is sampled at the sampling frequency denoted by fs then plot the spectra of the sampled signals for the following three values of the fs: (i) fs = 150 Hz, (ii) fs = 200 Hz, (iii) fs = 300 Hz. Also comment on aliasing if it is present in each case.

OR

Q.5 **(a)** Give a block-diagram of the reconstruction of a CT signal from a DT signal in time-domain. **03**

(b) A CT signal x(t) = 10 cos(2πt) is sampled at the sampling frequency fs=8Hz to obtain DT signal x[n] then plot x[n] for its first cycle starting from n=0. **04**

(c) Suppose a CT signal x(t)= cos(2πt) + 2 cos(4πt) + cos(6πt)is sampled at the sampling frequency of 4Hz and then reconstructed back in continuous time at the same sampling frequency then determine the reconstructed signal. State which frequencies from the original signal x(t) got modified and why? **07**

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