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**

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

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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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV EXAMINATION – SUMMER 2025

Subject Code:3141005 **Date:12-05-2025**

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)**	Explain Energy and Power signals.	**03**
	(b)	Define: System Determine whether the system $y(t) = tx(t)$ is 1. Causal or Non-Causal 2. Time-variant or Time-invariant 3. Static or Dynamic	**04**
	(c)	Explain properties of continuous time and discrete time systems.	**07**
Q.2	**(a)**	State and explain associative property of convolution sum.	**03**
	(b)	Find the natural response of the system described by difference equation $y(n) - 1.5y(n-1) + 0.5y(n-2) = x(n)$ $y(-1) = 1 \quad and y(-2) = 0$	**04**
	(c)	Determine the convolution integral of $x(t) = 1 \quad for -1 \le t \le 1 \quad and h(t) = 1 \quad for\ 0 \le t \le 2$	**07**
		OR	
	(c)	Compute the convolution sum $y(n) = x(n) * h(n)$ 1. $x(n) = \delta(n) - \delta(n-2) \quad and \quad h(n) = u(n)$ 2. $x(n) = u(n) \quad and \quad h(n) = u(n)$	**07**
Q.3	**(a)**	State and prove time shifting property of Fourier transform.	**03**
	(b)	Determine whether the following system with impulse response $h(n) = 2^n u(-n)$ is stable or not.	**04**
	(c)	Compute the Fourier transform of $x(n) = (1)^n u(n)$. Also give applications of Fourier transform.	**07**
		OR	
Q.3	**(a)**	State and prove time scaling property of Fourier transform.	**03**
	(b)	State and prove a condition for a discrete time LTI system to be stable.	**04**
	(c)	Enlist and explain properties of Fourier transform.	**07**
Q.4	**(a)**	Determine the Z – Transform & ROC of the following sequence $x(n) = 3^n u(n) - 4^n u(n)$.	**03**
	(b)	Find DTFT of the sequence$x(n) = \{1,0,2,3\}$.	**04**
	(c)	Using partial fraction method, determine the sequence that goes with the following z-transforms: $X(z) = 3/z \; - \frac{1}{4} - \frac{1}{8} z^{-1}$ and $x(n)$ is absolutely summable.	**07**

OR

Q.4 **(a)** Find the z-transform of the signal $x(n) = \left(-\frac{1}{5}\right)^n u(n) + 5\left(\frac{1}{2}\right)^n u(-n-1)$. **03**

(b) Explain the time shifting property of Fourier Transform. **04**

(c) Using partial fraction expansion find the inverse z-transform of **07**

$$X(z) = 1 - \frac{1}{3}z^{-1}/(1 - z^{-1})(1 + 2z^{-1}) \ , \quad |z| > 2$$

Q.5 **(a)** Find 4-point DFT of the sequence $x(n) = \{1, 3, 4, -2\}$. **03**

(b) List out the difficulties faced during signal reconstruction. **04**

(c) State and prove differentiation property of z-transform. **07**

OR

Q.5 **(a)** Explain aliasing effect. **03**

(b) Explain signal reconstruction using interpolation technique. **04**

(c) State and prove Sampling theorem. **07**

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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – SUMMER 2024

Subject Code:3141005 **Date:18-07-2024**

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.**

			Marks
Q.1	**(a)**	Compare Energy and Power signal.	**03**
	(b)	State & prove a condition for a discrete time LTI system to be stable.	**04**
	(c)	Define R.O.C. of Z-Transform. Write its properties.	**07**
Q.2	**(a)**	Find even and odd parts of $x(t)=u(t)$.	**03**
	(b)	Prove the duality property of the Fourier Transform.	**04**
	(c)	Explain the properties of continuous time and discrete time systems.	**07**
		OR	
	(c)	State & Prove Sampling Theorem.	**07**
Q.3	**(a)**	Find DTFT of the sequence x(n) = {1, 0, 4, 2}.	**03**
	(b)	Explain the Differentiation property of Z-Transform.	**04**
	(c)	Classify signals. Give examples of each.	**07**
		OR	
Q.3	**(a)**	Prove that a DT LTI system is causal if and only if h(n) = 0 for n<0.	**03**
	(b)	Prove Commutative property of Convolution.	**04**
	(c)	Determine Inverse Z- Transform of $X(z) = \frac{1}{(1+z^{-1})(1-z^{-1})^2}$, $ROC: \lvert z\rvert > 1$	**07**
Q.4	**(a)**	Sketch the following waveform: $x(t) = u(t+1)-2u(t)-2u(t-1)$.	**03**
	(b)	Obtain relationship between Laplace and Fourier Transform.	**04**
	(c)	Compute convolution using graphical method: 1.) y(n)=x(n)*h(n), x(n)={1,1, 0 ,3}, h(n)={1,-2,3, -4}	**07**
		OR	
Q.4	**(a)**	Find the Fourier Transform of $x(t) = e^{-5t}u(-t)$.	**03**
	(b)	Bring out difference between DFT and Fourier Transform (FT).	**04**
	(c)	Evaluate continuous time (CT) convolution integral given as: $y(t)=e^{2t}u(t)*u(t+2)$	**07**
Q.5	**(a)**	Determine the z-transform of following finite duration sequence X(n)={1,-3,4,5, 7}	**03**
	(b)	Write a short note on zero order hold with its application.	**04**
	(c)	Compute DFT of the following sequence using its definition. $x[n]=\{0,1,3,2\}$	**07**
		OR	
Q.5	**(a)**	Explain time shifting and periodicity property of Laplace Transform.	**03**
	(b)	Find the Fourier Transform of the periodic signal $x(t)=\sin(2\pi ft)u(t)$	**04**
	(c)	Determine the Inverse Z-Transform of $X(z) = \frac{1+z^{-1}}{1-z^{-1}+0.5z^{-2}}$ Assume that $x[n]$ is causal.	**07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– IV(NEW) EXAMINATION – SUMMER 2023

Subject Code:3141005 Date:11-07-2023

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.**

			MARKS
Q.1	**(a)**	State Dirichlet condition for Fourier Series Representation.	**03**
	(b)	Prove the duality property of Fourier Transform.	**04**
	(c)	Explain reconstruction of a signal from its samples using interpolation.	**07**
Q.2	**(a)**	List out properties of convolution.	**03**
	(b)	Obtain the relationship between Laplace transform and Fourier Transform.	**04**
	(c)	Obtain Z-Transform of $x(n) = n^2u(n)$ and $x(n) = (-2)^nu(-n-1)$	**07**
		OR	
	(c)	Classify signals. Give examples of each.	**07**
Q.3	**(a)**	Find the even and odd components of $x(t) = \cos(t)\sin(t)$	**03**
	(b)	Write a short note on zero order hold with its application.	**04**
	(c)	Compute DFT of the sequence, $x[n] = \{1,2,3,4\}$ using its definition.	**07**
		OR	
Q.3	**(a)**	Find the Fourier Transform of $x(t) = e^{-3t}u(t)$.	**03**
	(b)	Define R.O.C. of Z-Transform. Write its properties.	**04**
	(c)	A system is described by difference equation $y(n) = 0.5y(n-1) + x(n)$. Input given to system is $(1/3)^nu(n)$ and initial condition is $y(-1) = 1$. Determine the zero state response.	**07**
Q.4	**(a)**	State & prove a condition for a discrete time LTI system to be stable.	**03**
	(b)	Prove Commutative property of convolution.	**04**
	(c)	Determine the Inverse Z-Transform of $X(Z) = \frac{\frac{1}{4}z^{-1}}{\left(1-\frac{1}{2}z^{-1}\right)\left(1-\frac{1}{4}z^{-1}\right)}$ $\text{ROC} : \lvert Z\rvert > \frac{1}{2}$	**07**
		OR	
Q.4	**(a)**	Prove that a DT LTI system is causal if and only if $h(n) = 0$ for $n<0$.	**03**
	(b)	Find the Fourier Transform of the periodic signal $x(t)=\cos(2\pi ft)u(t)$	**04**
	(c)	Determine Inverse Z- Transform of $X(z) = \frac{1}{(1+z^{-1})(1-z^{-1})^2}$, $ROC : \lvert z\rvert > 1$	**07**
Q.5	**(a)**	Obtain DFT of unit impulse $\delta(n)$.	**03**
	(b)	State and prove differentiation property of Z-Transform.	**04**
	(c)	Explain the properties of continuous time and discrete time systems	**07**
		OR	
Q.5	**(a)**	Compare Energy and Power signal.	**03**
	(b)	State and prove time scaling property of Fourier Transform.	**04**

(c) Obtain x(n) using long division method for $X(Z) = \frac{z}{z-1}$ for both possible ROCs. **07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – SUMMER 2022

Subject Code:3141005 Date:27-06-2022

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.**

			MARKS
Q.1	**(a)**	Define (1) Signal (2) System (3) Deterministic Signal.	**03**
	(b)	(1) Describe Inverse System. (2) Describe Time-Invariant System.	**04**
	(c)	Determine if the following systems described by (1) $y(t) = \sin[x(t+2)]$; (2) $y[n] = x[2-n]$ are memoryless, causal, linear, time invariant, stable.	**07**
Q.2	**(a)**	Write any three properties of Convolution Integral.	**03**
	(b)	(1) Write the relation between Unit Step and Impulse function. (2) Write the relation between Unit Step and Ramp function.	**04**
	(c)	Determine the response of the system with impulse response $h(t) = u(t)$ for the input $x(t) = e^{-2t}u(t)$.	**07**
		OR	
	(c)	The impulse response of the relaxed LTI system is given as, $h[n] = a^n u[n]$ and $\|a\| < 1$. Determine the response of this system if it is excited by unit step sequence.	**07**
Q.3	**(a)**	State equations for trigonometric Fourier Series and exponential Fourier Series.	**03**
	(b)	Bring out the difference between DFT and Fourier Transform.	**04**
	(c)	Use definition of the Fourier Series to determine the time domain signal represented by the following Fourier series coefficients: $X[k] = j\delta[k-1] - j\delta[k+1] + \delta[k-3] + \delta[k+3]. \omega_0 = 2\pi$	**07**
		OR	
Q.3	**(a)**	State frequency shifting, time shifting and time scaling properties of Fourier Transform.	**03**
	(b)	Obtain the Fourier Transform of following functions: (1) $x(t) = 1$ (2) $x(t) = sgn\,(t)$.	**04**
	(c)	Obtain the Fourier Transform of following functions: (1) $x(t) = \cos \omega_0 t$ (2) $x(t) = \cos \omega_c t\, u(t)$.	**07**
Q.4	**(a)**	Evaluate the convolution $x[n] * \delta[n - n_0]$.	**03**
	(b)	Explain (1) Time Shifting and (2) Time Scaling operation with neat figures.	**04**
	(c)	Determine 2 – point and 4 – point DFT of a sequence $x[n] = u[n] - u[n-2]$.	**07**
		OR	
Q.4	**(a)**	Discuss Causality and Stability of LTI systems using z – transform.	**03**
	(b)	Prove the duality property of Fourier Transform.	**04**

(c) Define Convolution sum. Show that (1) $x[n] * \delta[n] = x[n]$ (2) $x[n] * u[n - n_0] = \sum_{k=-\infty}^{n-n_0} x[k]$ **07**

Q.5 **(a)** State final value and initial value theorem for z – transform. **03**

(b) Write any four properties of ROC with respect to z – transform. **04**

(c) Determine z – transform of $x[n] = \cos(\Omega_0 n)\, u[n]$ **07**

OR

Q.5 **(a)** State any three properties of z – transform. **03**

(b) Find the z – transform and ROC of the following sequence: **04**

$$x[n] = \frac{1}{2}\delta[n+1] + 5\left(\frac{1}{2}\right)^{-n} u[n] + 4^n u[-n-1]$$

(c) Determine the inverse z – transform of the following $X(z)$ by partial fraction expansion method, **07**

$X(z) = \frac{(z+2)}{2z^2-7z+3}$ if the ROCs are (1) $|z| > 3$ (2) $|z| < \frac{1}{2}$ and (3) $\frac{1}{2} < |z| < 3$.

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