Seat No.: ________ Enrolment No.___________



# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER– III EXAMINATION – SUMMER 2020**

**Subject Code: 3131705** **Date:27/10/2020**

**Subject Name: Dynamics of Linear Systems**

**Time: 02:30 PM TO 05:00 PM** **Total Marks: 70**

**Instructions:**

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

| | | | Marks |
|---|---|---|---|
| **Q.1** | **(a)** | Explain continuous-time and discrete-time signals with suitable example. | **03** |
| | **(b)** | For each of the following input-output relationships, determine whether the corresponding system is linear, time invariant or both.<br>1. $y(t) = t^2 x(t-1)$<br>2. $y[n] = x[n+1] - x[n-1]$ | **04** |
| | **(c)** | What is time-variant and time-invariant system? Determine causality and stability of the following discrete-time systems with justification. Consider y[n] is the system output and x[n] is the system input.<br>1. $y[n] = x[-n]$<br>2. $y[n] = x[n-2] - 2x[n-8]$ | **07** |
| **Q.2** | **(a)** | Explain LTI systems with and without memory. | **03** |
| | **(b)** | A linear time-invariant system is characterized by its impulse response $h[n] = \left(\frac{1}{2}\right)^n u(n)$.<br>Determine energy density spectrum of the output signal when the system is excited by the signal $x[n] = \left(\frac{1}{4}\right)^n u(n)$. | **04** |
| | **(c)** | Compute and plot the convolution $y[n] = x[n] * h[n]$, where $x[n] = \left(\frac{1}{3}\right)^{-n}$ and $h[n] = u[n-1]$. | **07** |
| | | **OR** | |
| | **(c)** | Explain commutative and distributive property of a LTI system. | **07** |
| **Q.3** | **(a)** | For $x(t) = 1 + \sin w_0 t + 2\cos w_0 t + \cos\left(2w_0 t + \frac{\pi}{4}\right)$.<br>Determine Fourier series coefficient using complex exponential representation. | **03** |
| | **(b)** | Discuss applications of frequency-selective filters. | **04** |
| | **(c)** | Discuss the properties of continuous-time Fourier series. | **07** |

**OR**

**Q.3** **(a)** Each of the two sequences $x_1[n]$ and $x_2[n]$ has a period N = 4, and the corresponding Fourier series coefficients are specified as $x_1[n] \longleftrightarrow a_k$ and $x_2[n] \longleftrightarrow b_k$ **03**

Where,

$a_0 = a_3 = \frac{1}{2} a_1 = \frac{1}{2} a_2 = 1$ and $b_0 = b_1 = b_2 = b_3 = 1$. Using the multiplication property, determine the Fourier series coefficients $c_k$ for the signal $g[n] = x_1[n]\, x_2[n]$.

**(b)** Discuss applications of frequency-shaping filters. **04**

**(c)** Determine whether each of the following statements is true or false. Justify your answers. **07**

1. An odd and imaginary signal always has an odd and imaginary Fourier transform.
2. The convolution of an odd Fourier transform with an even Fourier transform is always odd.

**Q.4** **(a)** Explain time reversal and linearity property for the discrete time Fourier transforms. **03**

**(b)** Determine the Fourier transform for $-\pi \le w < \pi$ for the periodic signal $x(n) = \sin\left(\frac{\pi}{3} n + \frac{\pi}{4}\right)$. **04**

**(c)** Consider a discrete-time LTI system with impulse response **07**

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

Use Fourier transforms to determine the response for the input

$x(n) = \left(\frac{3}{4}\right)^n u(n).$

**OR**

**Q.4** **(a)** Explain differentiation and integration property for the continuous time Fourier transforms. **03**

**(b)** Determine the Fourier transform of periodic signal $x(t) = 1 + \cos\left(6\pi t + \frac{\pi}{8}\right)$. **04**

**(c)** Compute the Fourier transform of each of the following signals: **07**

1. $x[n] = u[n-2] - u[n-6]$
2. $x[n] = \left(\frac{1}{2}\right)^{-n} u[-n-1]$

**Q.5** **(a)** Determine the Laplace transform and the associated region of convergence for $x(t) = e^{-2t}u(t) + e^{-3t}u(t)$. **03**

**(b)** Determine the function of time x(t), for the following Laplace transforms and their associated regions of convergence: **04**

$\frac{1}{s^2+9}, \quad \Re e\{s\} > 0.$

**(c)** Explain properties of the Z-transform. **07**

**OR**

**Q.5 (a)** Find Z-transform and region of convergence of $x(n) = 7\left(\frac{1}{3}\right)^n u(n) - 6\left(\frac{1}{2}\right)^n u(n)$. **03**

**(b)** Find inverse Z-transform for $X(z) = \log(1 + az^{-1})$, $|z| > |a|$. **04**

**(c)** Consider the system function corresponding to causal LTI systems: H(z)=$\frac{1}{(1 - z^{-1} + \frac{1}{4}z^{-2})(1 - \frac{2}{3}z^{-1} + \frac{1}{9}z^{-2})}$. **07**

1. Draw a direct-form block diagram.
2. Draw a block diagram that corresponds to the cascade connection of two second-order block diagrams. Each second-order block diagram should be in direct form.

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