

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 1250

Roll No.

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B.Tech.

(SEM. III) ODD SEMESTER THEORY
EXAMINATION 2013-14
SIGNALS AND SYSTEMS

Time : 3 Hours

Total Marks : 100

Note :—Answer all the questions.

SECTION—A

1. Attempt all parts : (10×2=20)
- (a) Determine the fundamental period of the signal :
 $x(t) = 3 \sin(7t + 2) - 4 \cos(4t + 1)$.
- (b) Consider a discrete-time system with input $x[n]$ and output $y[n]$:
 $y[n] = x[n + 2] - x[n - 2]$.
Is this system Linear ?
- (c) Determine the Z-Transform of $x[n] = a^{-n}u[-n]$.
- (d) Find Laplace Transform of $x(t) = \sum_{k=0}^{\infty} \delta(t - kT)$
- (e) Prove the time scaling property of Fourier transform.

- (f) For the following frequency response of a causal and stable LTI System :

$$H(j\omega) = \frac{1 - j\omega}{1 + j\omega}.$$

Show that $|H(j\omega)| = A$, and determine the value of A.

- (g) Consider a LTI System with step response $y(t) = e^{-t} u(t)$. Determine the output of this system to the input $x(t) = u(t - 1) - u(t - 3)$.

- (h) Find the Fourier transform of the Signal :

$$X(t) = e^{at} u(-t), a > 0.$$

- (i) $X(s) = \frac{s^2 + 5s + 7}{s^2 + 3s + 2}$, Determine the value of $x(\infty)$.

- (j) Sketch the given signal :

$$x(t) = r(t) u(3 - t).$$

SECTION-B

2. Attempt any three parts : (3×10=30)

- (a) (i) Determine the impulse response of the Discrete Time System :

$$y(n) - 3y(n - 1) + 2y(n - 2) = x(n) + 3x(n - 1) + 2x(n - 2).$$

- (ii) Let $x(t) = u(t - 3) - u(t - 5)$ and $h(t) = e^{-3t} u(t)$.

$$\text{Compute } y(t) = x(t) * h(t).$$

- (b) (i) Define Ideal frequency Selective filter. Explain time domain properties of ideal frequency selective filter.
- (ii) State and prove Sampling theorem and discuss the effect of under sampling.
- (c) (i) Find the Inverse Laplace Transform of :

$$X(s) = \frac{2}{(s+4)(s-1)} \text{ If the region of convergence is :}$$

(a) $-4 < \text{Re}(s) < 1$

(b) $\text{Re}(s) > 1$

(c) $\text{Re}(s) < -4.$

- (ii) Sketch and determine the convolution of the following signals :

$$x(t) = \pi \left(\frac{t-1}{3} \right) ; \quad h(t) = u(t-5).$$

- (d) (i) Find the Unilateral Z-Transform of :

$$x[n] = [a^n \text{Sin } \omega_0 n] u[n].$$

- (ii) If $x(z) = \frac{2z}{3z^2 - 4z + 1}$, find $x(n)$; $n \geq 0$. Given that

$$\text{ROC of } x(z) \text{ is } |z| > 1.$$

- (e) Realize $H(s) = \frac{s(s+2)}{(s+1)(s+3)(s+4)}$, by canonic direct form

I and direct form II.

SECTION-C

Note :—Attempt all questions in this Section.

3. Attempt any one part : (5×10=50)

(a) Impulse-Train sampling of $x[n]$ is used to obtain :

$$g[n] = \sum_{k=-\infty}^{\infty} x[n] \delta[n-KN]$$

If $x(e^{j\omega}) = 0$ for $\frac{3\pi}{7} \leq |\omega| \leq \pi$, determine the largest value for the sampling interval N which ensures that no aliasing takes place while sampling $x[n]$.

(b) Determine whether or not each of the following continuous-time signals are periodic. If the signal is periodic, determine its fundamental period :

(i) $x(t) = 3 \cos(4t + \pi/3)$

(ii) $x(t) = e^{j(\pi t - 1)}$

(iii) $x(t) = [\cos(2t - \pi/3)]^2$

(iv) $x(t) = \cos^2 \frac{\pi}{8} t$

(v) $x(t) = \sum_{n=-\infty}^{\infty} e^{-(2t-n)} u(2t-n)$.

4. Attempt any one part :

(a) Find the Z-Transform $x(z)$ and sketch the pole-zero plot with the ROC of following sequence :

$$x[n] = \left(\frac{1}{3}\right)^n u[n] + \left(\frac{1}{2}\right)^n u[-n-1]$$

(b) Using the power series expansion technique, find the inverse Z-Transform of the following $x(z)$:

(i) Using Long Division Method :

$$X(z) = \frac{z^2 + 2z}{z^3 - 3z^2 + 4z + 1} \quad \text{ROC } |z| > 1$$

(ii) $X(z) = \log_e(1 + az^{-1})$ ROC $|z| > a$.

5. Attempt any one part :

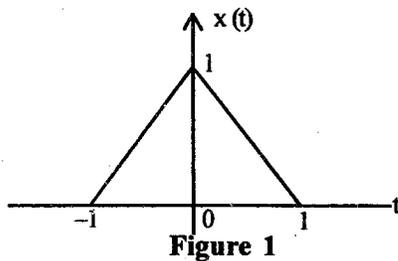
(a) Consider a continuous-time LTI System described by :

$$\frac{dy(t)}{dt} + 2y(t) = x(t)$$

Using the Fourier transform, find the output $y(t)$ of the following input signal :

$x(t) = e^{-t} u(t)$ and determine the frequency response $H(e^{j\omega})$ of the system.

(b) Consider the signal $x(t)$ in figure 1.



(i) Find the Fourier transform $x(j\omega)$ of $x(t)$.

(ii) Sketch the signal :

$$y(t) = x(t) * \sum_{k=-\infty}^{\infty} \delta(t - 4k).$$

6. Attempt any one part :

- (a) Consider two Right-Sided Signals $x(t)$ and $y(t)$ related through the differential equations :

$$\frac{dx(t)}{dt} = -2y(t) + \delta(t) \text{ and } \frac{dy(t)}{dt} = 2x(t).$$

Determine $y(s)$ and $x(s)$ alongwith their regions of Convergence.

- (b) The input $x[n]$ and output $y[n]$ of a causal LTI system are related through the block diagram representation shown in figure 2 :

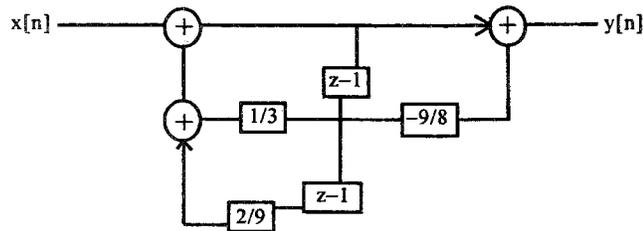


Figure 2

- (i) Write a difference equation relating $y[n]$ and $x[n]$.
 (ii) Explain the Stability Analysis of the given system as shown in figure 2.

7. Attempt any two parts :

- (a) Let $x(t)$ be a signal with Nyquist rate ω_0 . Determine the Nyquist rate for the following signals :
- (i) $x(t) + x(t-1)$
 (ii) $x^2(t)$.

- (b) Suppose that $x(t) = e^{-(t-2)} u(t-2)$ and $h(t)$ is shown in figure 3 :

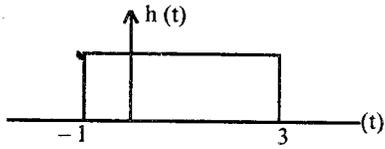


Figure 3

Verify the convolution property for this pair.

- (c) Obtain the Fourier series for the wave form shown in figure 4 :

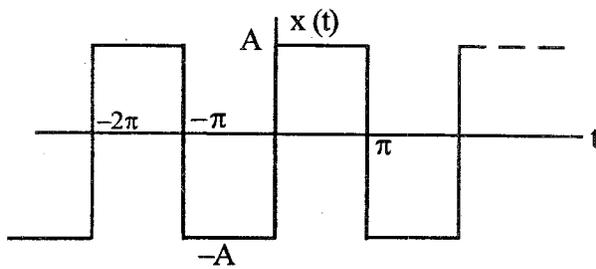


Figure 4