[This question paper contains 4 printed pages.]

Sr. No. of Question Paper : 1795 **C** **Roll No............**

Unique Paper Code : 251201

Name of the Course : B.Sc. (H) Electronics

Name of the Paper : Signals & Systems : ELHT-201

Semester : II

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **FIVE** questions in all.
3. Question No. **1** is compulsory.
4. **All** questions carry equal marks.
5. Use of Scientific non-programmable calculators is allowed.

1. Attempt all the **five** questions. (3×5)

   (a) What is the impulse response of a discrete linear time invariant system in terms of its step response ?

   (b) Identify the causality of the system given below with input x(t) and output y(t). Also identify whether this system has memory or not.

   $$y(t) = x(t)\cos(t + 1).$$

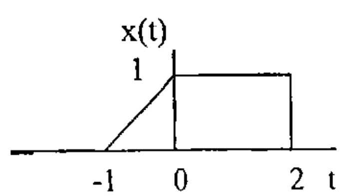
   (c) Sketch the inductor element 'L' with a current i(t) through it and a voltage v(t) across it in the time domain. Represent it in the s-domain with non-zero initial conditions.

   (d) Find the Fourier series coefficients for the continuous time signal x(t), where

   $$x(t) = 4\cos\left(\frac{\pi}{2}t + \frac{\pi}{8}\right)$$

   (e) Sketch the signal x(t) = u(t+2) – u(t–4).

2. (a) For the given pulse x(t) sketch the following signals



(i) $x_1(t) = 2x(-t)$

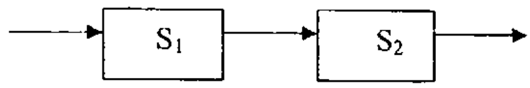
(ii) $x_2(t) = x(2t)u(t)$

(iii) $x_3(t) = x(t-3)$

(iv) $x_4(t) = x\left(\frac{t}{2}-1\right)$ (4)

(b) Explain a linear, time invariant, stable and invertible system properties. (5)

(c) Consider the system S which is cascade of the following two systems S_1 and S_2.



The input output relationships for S_1 and S_2 are

S_1: $y_1[n] = 2x_1[n] + 4x_1[n-1]$.

S_2: $y_2[n] = x_2[n-2] + \frac{1}{2}x_2[n-3]$.

where $x_1[n]$ and $x_2[n]$ denote input signals and $y_1[n]$ and $y_2[n]$ denote output signals for system S_1 and S_2 respectively.

Determine the input-output relationship for the cascaded system S. (6)

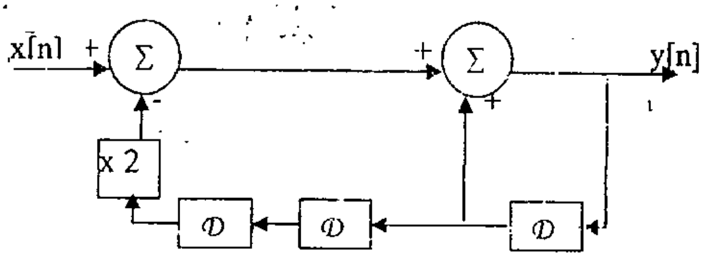
3. (a) Determine whether or not the following signals are periodic. If the signal is periodic, determine its fundamental period.

(i) $x[n] = \cos\left(\frac{\pi}{8}n^2\right)$

(ii) $x(t) = e^{j(\pi t+1)}$ (5)

(b) Determine and plot the even and odd parts of a unit step signal u(t). (5)

(c) Obtain the difference equation for the causal discrete – time invariant system represented by the block diagram given below ($\mathcal{D}$ indicates a unit delay, x 2 indicates a multiplier). Also identify if the system is recursive or non recursive in nature. Justify. (5)



4. (a) Compute the output $y(t) = x(t) * h(t)$ for a continuous time LTI system whose input $x(t)$ and impulse response $h(t)$ are the following :

$$x(t) = u(t-3) - u(t-5)$$

$$h(t) = e^{3t}\,u(t).$$ (5)

(b) For a discrete LTI system an input $x[n]$ and a unit impulse response $h[n]$ is given by

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

$$h[n] = u[n+2].$$

Determine and plot the output $y[n] = x[n] * h[n]$ for this discrete system. (5)

(c) Find whether the LTI systems having the following impulse response are causal and/or stable. Justify your answer.

(i) $h[n] = (0.5)^n u[3\ n]$

(ii) $h(t) = e^{-6t}$ (5)

5. (a) The impulse response of an LTI system is $h(t) = e^{2t}u(t)$. Find the response of the system to input signal $x(t) = e^{3t}u(t)$ using Fourier transforms. (5)

(b) Determine and plot the magnitude and phase of the Fourier coefficients of the signal.

$$x(t) = 1 + \sin\omega_0 t + 2\cos\omega_0 t + \cos\left(2\omega_0 t + \frac{\pi}{4}\right)$$ (5)

(c) Verify the differentiation property of Fourier transforms i.e.

$$\frac{dx(t)}{dt} \leftrightarrow j\omega X(j\omega)$$ (5)

6. (a) Find the transfer function $H(j\omega)$ for the first order RC low pass filter and plot its magnitude and phase spectra. (5)

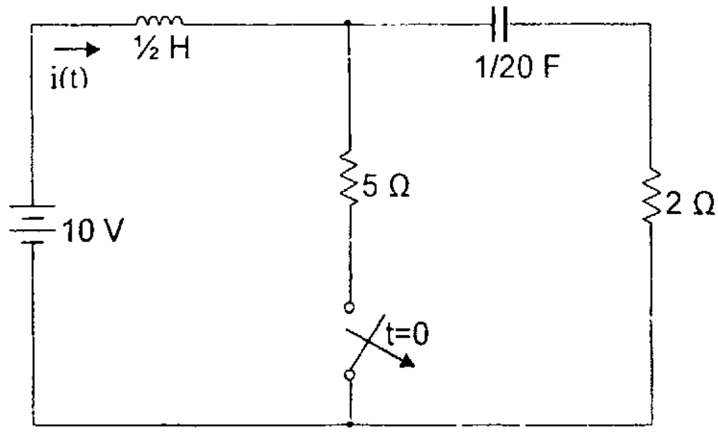
(b) Determine the Laplace transform and the associated region of convergence (ROC) for the function $x(t)$.

$x(t) = -e^{t}u(-t) + e^{5t}u(-t)$ (5)

(c) Find the inverse Laplace Transform of

$$X(s) = \frac{2s+4}{s2+4s+3} \qquad \mathrm{Re}(s) < -3$$ (5)

7. (a) In the circuit given below the switch is in the closed position for a long time before it is opened at $t = 0$. Find the inductor current $i(t)$ for $t \geq 0$. (6)



(b) Find the response of an LTI system described by the following differential equation with specified input and initial conditions. (Use Laplace transforms)

$$\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = \frac{dx(t)}{dt} + x(t)$$

where $x(t) = e^{-4t}u(t)$;

$y(0^-) = 2$;

$\frac{dy(0^-)}{dt} = 1$ (6)

(c) For an LTI system, identify the conditions on the region of convergence (ROC) of its system function for the system to be stable and causal. (3)