This question paper contains 4+2 printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **6465**

Unique Paper Code : **251201** **D**

Name of the Paper : **Signals and Systems (ELHT-201)**

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

Semester : **II**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all.

Question No. **1** is compulsory.

All questions carry equal marks.

Use of scientific non-programmable calculator is allowed.

1. Attempt all *five* questions : 5×3=15

   (*a*) What are causal and non-causal systems ?

   (*b*) Find the convolution $y[n] = x[n] * h[n]$ where $x[n] = h[n] = u[n]$.

   (*c*) Sketch the capacitor element 'C' 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.

P.T.O.

(*d*) Find the Fourier coefficients of the continuous time signal $x(t)$, where :

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

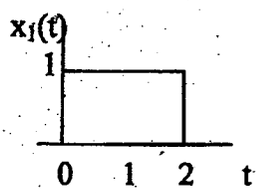
(*e*) Sketch the signal $x(t) = u(t) - 2u(t - 1) + u(t - 2)$.

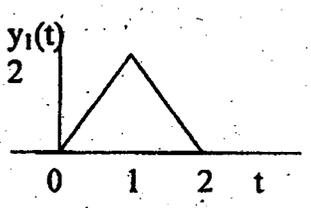
2. (*a*) Find the energy, E_∞ and power, P_∞ of the signal $x[n] = \cos\left[\frac{\pi}{4} n\right]$. 5

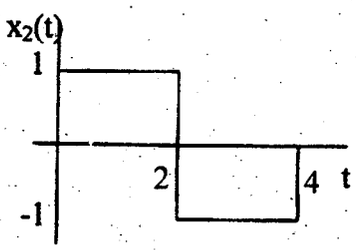
(*b*) The output $y[n]$ of the system is related to the input $x[n]$ via the relation given below. Identify whether this system is memoryless, time invariant and stable. Justify : 5

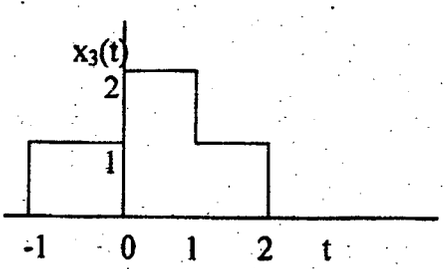
$$y[n] = nx[n].$$

(*c*) An LTI system whose response to the signal $x_1(t)$ is the signal $y_1(t)$ as illustrated in the figure below. Determine and sketch the response of the system to the inputs $x_2(t)$ and $x_3(t)$ as depicted in the figure below : 5









3. (*a*) Compute the output $y(t)$ for a continuous time LTI system whose impulse response $h(t)$ and input $x(t)$ are : 5

$$h(t) = e^{-at}\, u(t),$$

$$x(t) = e^{at}\, u(-t), \qquad \text{for } a > 0.$$

(*b*) For a discrete LTI system an input $x[n]$ and a unit impulse response $h[n]$ is given by : 5

$$x[n] = \alpha^n\, u[n], \qquad 0 < \alpha < 1$$

$$h[n] = u[n]$$

Determine the output for this discrete system.

(*c*) Find whether the systems having the following impulse response are causal and/or stable. Justify your answer : 5

(*i*) $h[n] = (0.8)^n\, u[n + 2]$

(*ii*) $h(t) = te^{-t}\, u(t)$.

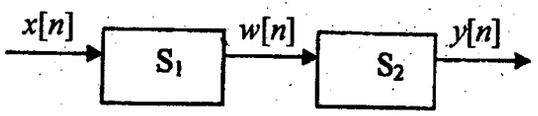
4. (*a*) Determine whether or not the following signals are periodic. If the signal is periodic, determine its fundamental period : 5

(*i*) $x[n] = \cos\,(n/8 - \pi)$

(*ii*) $x(t) = je^{j10t}$.

(*b*) Determine and plot the even and odd parts of a unit step signal $u[n]$. 4

(*c*) Consider the system S which is cascade of the following two systems S_1 and S_2 : 6



S_1 : Causal LTI with input $x[n]$ and output $w[n]$

$$w[n] = \frac{w[n-1]}{2} + x[n]$$

S_2 : Causal LTI with input $w[n]$ and output $y[n]$

$$y[n] = \alpha y[n-1] + \beta\, w[n].$$

S : Cascaded system

The difference equation relating $x[n]$ and $y[n]$ is :

$$y[n] = -\frac{y[n-2]}{8} + \frac{3y[n-1]}{4} + x[n].$$

(*i*) Determine α and β

(*ii*) Determine the impulse response of system S.

5. (*a*) The discrete time signal $x[n]$ is a real and odd periodic signal with period N = 7 and has Fourier coefficients a_k. It is given that $a_{15} = j$, $a_{16} = 2j$, $a_{17} = 3j$. Determine the values of a_0, a_{-1}, a_{-2} and a_{-3}. 5

(*b*) Compute the Fourier transform of the signal $(e^{-\alpha t} \cos \omega_0 t)\, u(t)$, $\alpha > 0$. 4

(*c*) The following are the facts about a continuous time signal $x(t)$:

(*i*) $x(t)$ is a real signal

(*ii*) $x(t)$ is periodic with period T = 4, and it has Fourier series coefficients a_k

(*iii*) $a_k = 0$ for $|k| > 1$

(*iv*) The signal with Fourier coefficients $b_k = e^{-j\pi k/2}\, a_{-k}$ is odd.

(*v*) $\frac{1}{4}\int_4 |x(t)|^2\, dt = \frac{1}{2}$.

Identify the signal $x(t)$. 6

6. (*a*) Determine the inverse Fourier transform of : 5

$$X_1(j\omega) = 2\pi\delta(\omega) + \pi\delta(\omega - 4\pi) + \pi\delta(\omega + 4\pi).$$

(*b*) Determine the Laplace transform and the associated region of convergence (ROC) for the function $x(t)$: 5

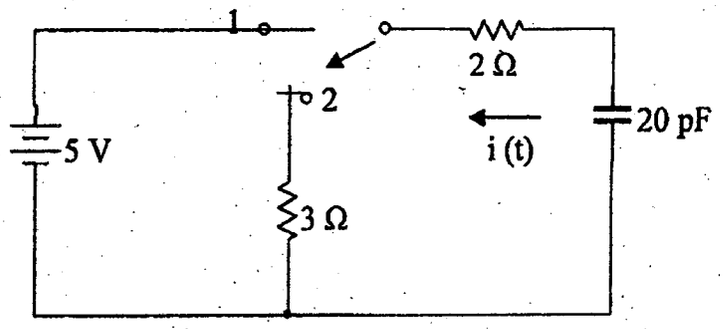
$$x(t) = e^{-4t}u(t) + e^{-5t} \sin 5t\, u(t).$$

(*c*) Find the inverse Laplace transform of : 5

$$X(s) = \frac{2s + 4}{s^2 + 4s + 3} \qquad -3 < \text{Re}(s) < -1.$$

P.T.O.

7. (*a*) Solve for the current $i(t)$ in the circuit shown if the switch changes from positio position 2 at $t = 0$. Assume that the switch has been in position 1 since a time :



(*b*) Verify for the Laplace transform the differential property in the s domain *i.e.* :

$$-tx(t) \leftrightarrow \frac{dX(s)}{ds}.$$

(*c*) Find the response of an LTI system described by the following differential equatio specified input and initial conditions. (Laplace transform to be used) :

$$\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = -4x(t) - 3\frac{dx}{dt}$$

where :

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

$$y(0^-) = -1$$

$$\frac{dy^{(0^-)}}{dt} = 5.$$