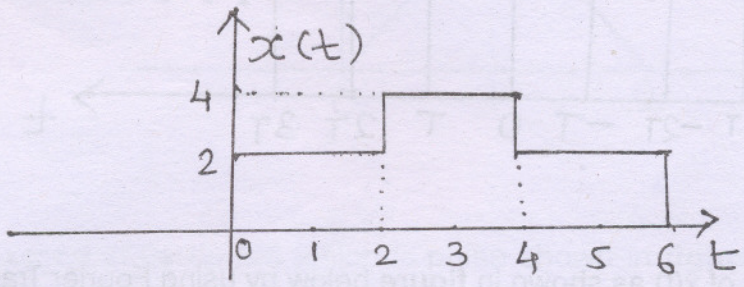
(3 Hours) [Total Marks : 100

N.B. (1) Question No. 1 is **compulsory** and answer any **four** questions out to remaining.
(2) Assume suitable data, if **necessary** with proper justifications.

1. Attempt any **four** of the following :– 20

(a) Express x(t) as shown in **figure** using unit step signal.



(b) Find whether signal is Energy signal or Power signal. Find corresponding Energy/Power if.

$x(t) = 2u\ (t-2) - 6u\ (t-3) + 4u\ (t-6)$.

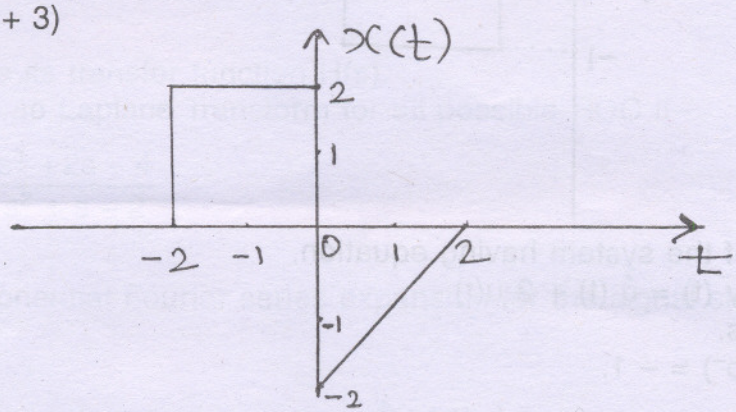
(c) Classify system as Linear/Nonlinear, Causal/Noncausal, Time varying/Time Invariant, memory/memoryless if

$y(t) = x(2t) - x\ (-t+1)$.

(d) Signal x(t) is shown in **figure** below. Sketch and Label following signal–

(i) x(2t – 2)

(ii) x(t + 3)



(e) Plot x(t) if

$x(t) = [\ u(t) + r\ (t-1) - 2u\ (t-3)\ ]\ u\ (-t+5)$.

2. (a) The T.F. of the system is given as – 12

$$H(s) = \frac{s^2+s+5}{s^3+6s^2+8s+4}.$$

Obtain state variable model using phase variables.

(b) Obtain state transition matrix e^{At} for the following model if– 8

$$A = \begin{bmatrix} 0 & -3 \\ 1 & -4 \end{bmatrix}$$

3. (a) Prove that– 8

F.T. $[\ x(t) * h(t)\ ] = X(w) \cdot H(w)$

where F.T. $[\ x(t)\ ] = X(w)$

and F.T. $[\ h(t)\ ] = H(w)$

(b) Find Fourier Transform (F.T.), if 12

$x(t) = A$ for $-\infty \leq t \leq \infty$

Hence and not otherwise find – F.T of :–

(i) $x_1(t) = \cos w_0 t$

(ii) $x_2(t) = \cos^2 w_0 t$

specify property used.

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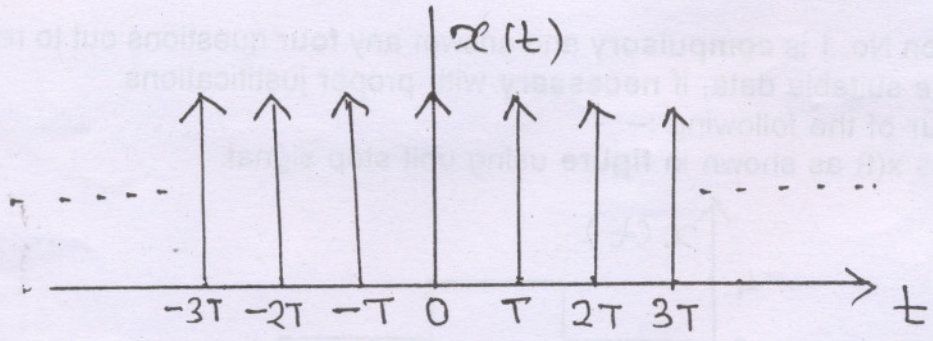
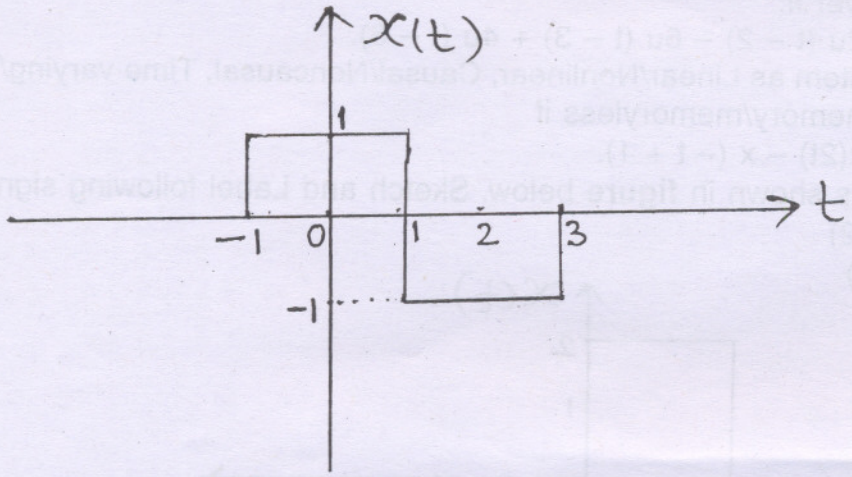
4. (a) Find Fourier Transform of periodic impulse train as shown in **figure** below– 6



(b) Find Fourier Transform of x(t) as shown in **figure** below by using Fourier Transform of gate function, and property of Fourier Transform. Specify property used. 4



(c) Find the response of the system having equation. 10

$$\ddot{y}(t) + \dot{y}(t) - 2y(t) = \dot{u}(t) + 2u(t)$$

with initial conditions.

$y(o^-) = 1$ and $y'(o^-) = -1$.

5. (a) Find Laplace Transform of following signals. Draw ROC in each case– 8

(i) $x_1(t) = \cos(3t + \pi/4)\, u(t)$

(ii) $x_2(t) = t^2 u(t-1)$

(iii) $x_3(t) = \int_0^t 7u(t)\, dt$

(iv) $x_4(t) = 5\, e^{-3t} \sin(7t)\, u(t)$

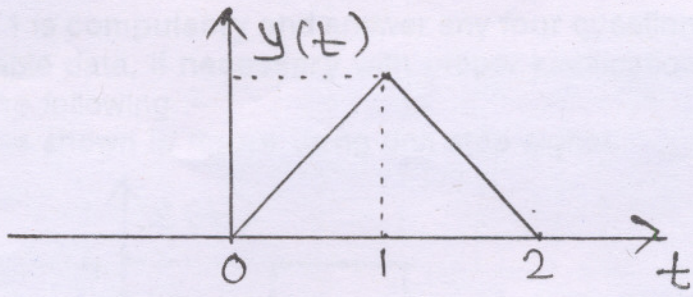
Use property of L.T. and specify property used.

(b) A system has an output– 12

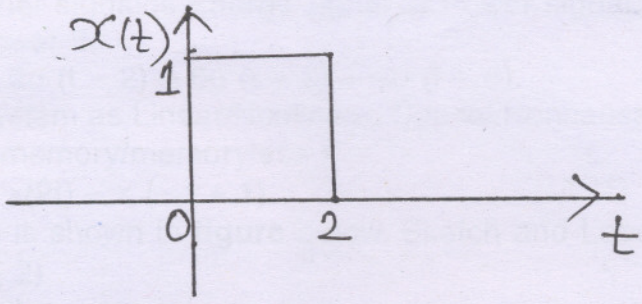
$y(t) = 2(1 - e^{-0.5t})$ for $t \geq 0$

when an I/p $x(t) = 2u(t)$ is applied to it. What will be the o/p if applied I/p is $x(t) = (e^{-t} + e^{-3t})\, u(t)$.

6. (a) An LTI system gives at its o/p a triangular waveform as shown in **figure** below– 10



when excited at its I/p x(t) which is pulse shown in **figure** below

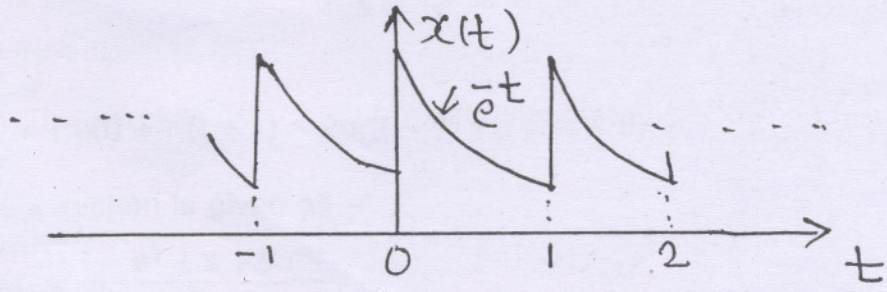


determine its transfer function H(s).

(b) Find Inverse Laplace Transform for all possible ROC if– 10

$$X(s) = \frac{s^3 + 2s - 4}{s^2 + s - 2}.$$

7. (a) Find Exponential Fourier series expansion for the signal shown below : 8



(b) Express given rectangular function in terms of the orthogonal set of function sin nt, orthogonal over (0, π2) and also find minimum MSE by considering one, two, and three terms. 12