Signals And Systems

Assignment -01

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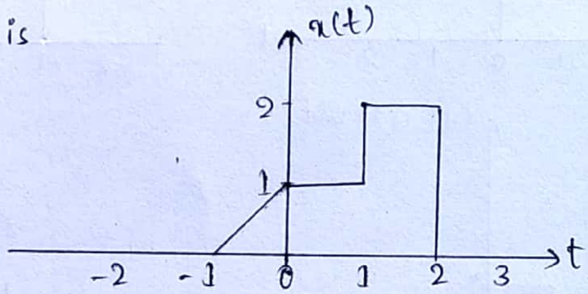
1) Sketch the following

a) A continuous signal $x(t) = \begin{cases} t+1 \; ; & -1 \le t \le 0 \\ 1 \; ; & 0 \le t \le 1 \\ 2 \; ; & 1 \le t \le 2 \\ 0 \; ; & \text{otherwise} \end{cases}$

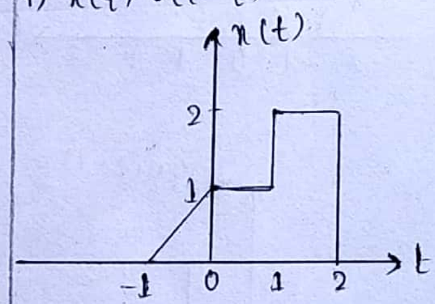
Sketch and label the following signals

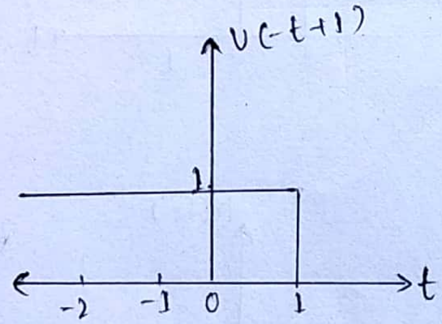
1) $x(t)u(1-t)$
2) $x(t)[u(t)-u(t-1)]$
3) $x(t)[\delta(t-3/2)]$
4) $x(t)[u(t+1)-u(t)]$
5) $x(t)u(t-1)$

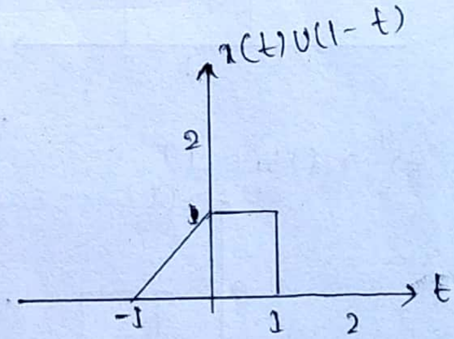
~> Given $x(t)$ is



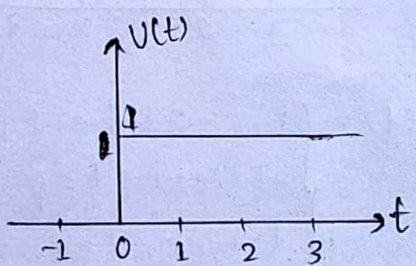
1) $x(t)\,u(1-t)$

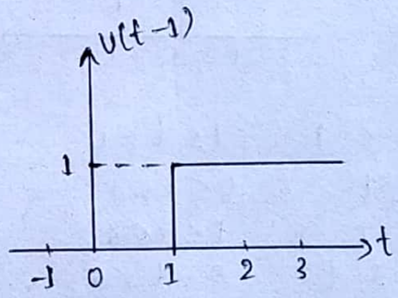


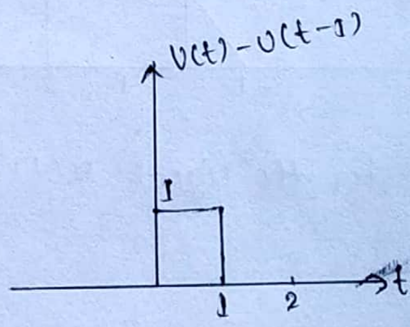


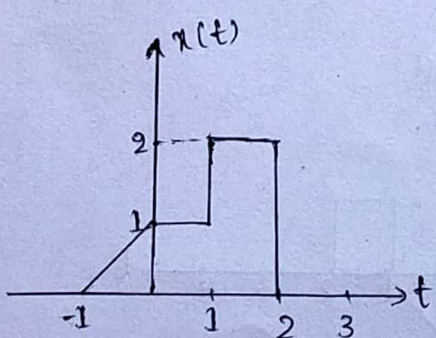


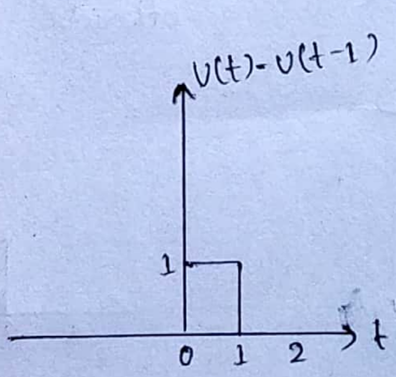
2) $x(t)[u(t)-u(t-1)]$

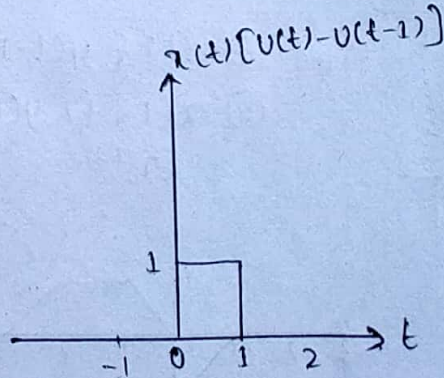




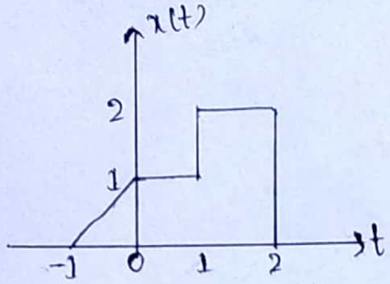


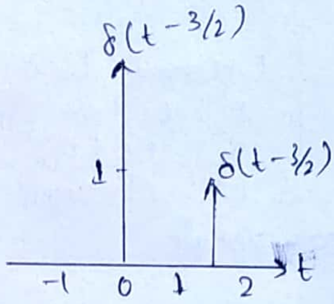


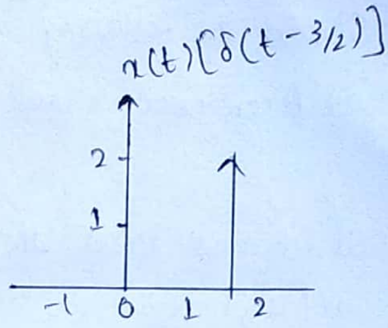




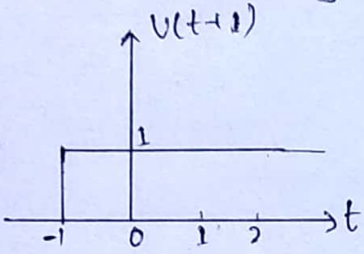
3) $x(t)[\delta(t-3/2)]$

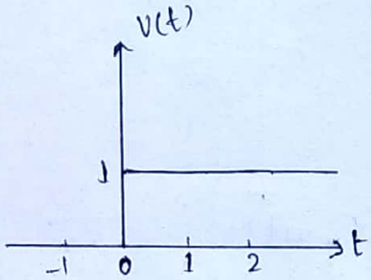


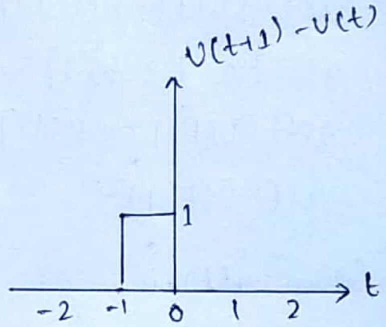


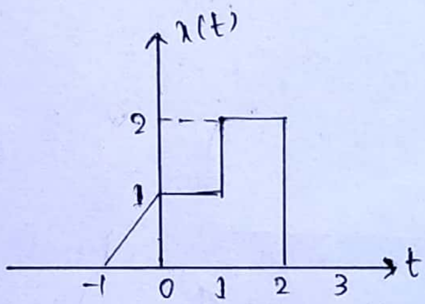


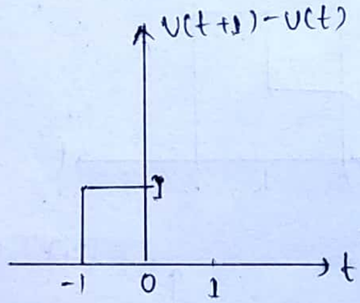
4) $x(t)[u(t+1)-u(t)]$

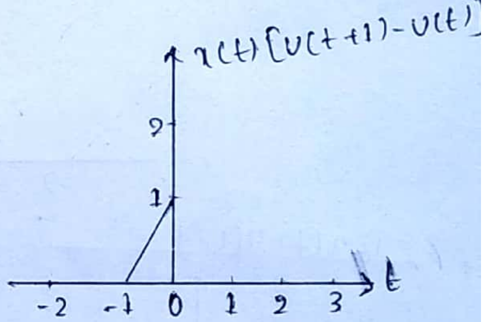




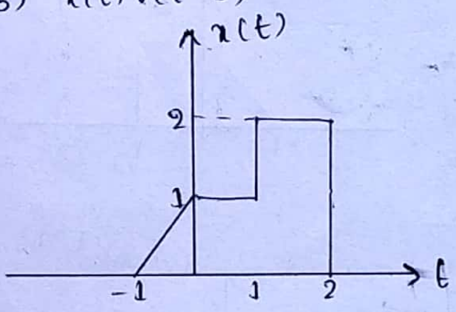


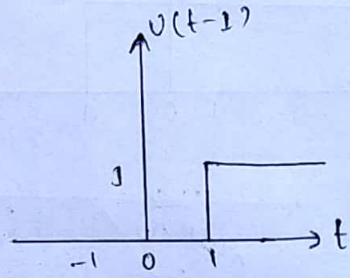


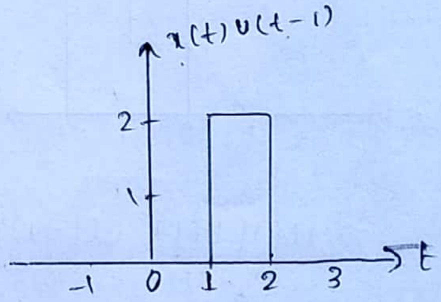




5) $x(t)\,u(t-1)$







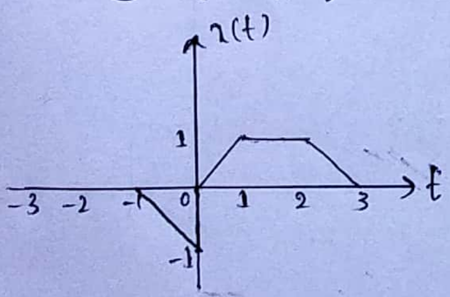
b) For the signal
$$x(t)=\begin{cases}-t-1 & ; -1\le t\le 0\\ t & ; 0\le t\le 1\\ 1 & ; 1\le t\le 2\\ 3-t & ; 2\le t\le 3\\ 0 & ; \text{otherwise}\end{cases}$$

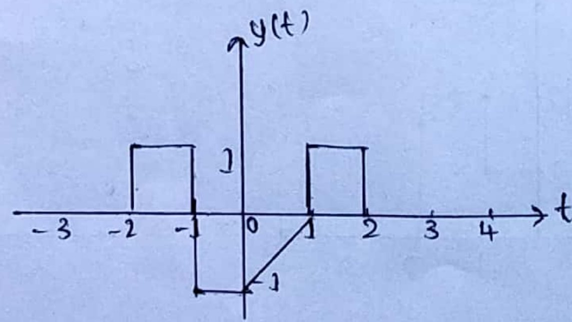
$$y(t)=\begin{cases}1 & ; -2\le t\le 1 \ \& \ 1\le t\le 2\\ -1 & ; -1\le t\le 0\\ t-1 & ; 0\le t\le 1\\ 0 & ; \text{otherwise}\end{cases}$$

find ① $x(t)\ \&\ y(t-1)$

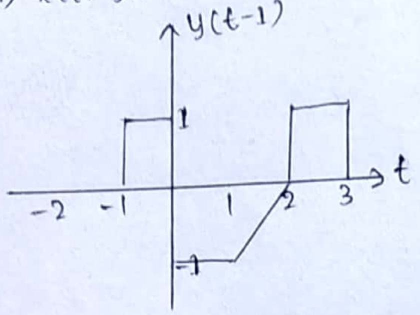
② $x(1-t)\,y(t)$

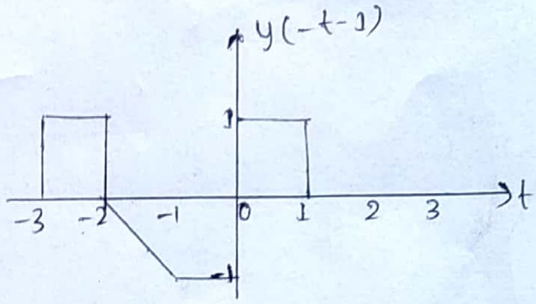
→

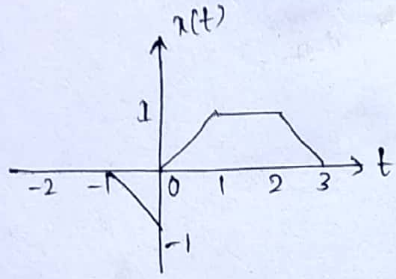


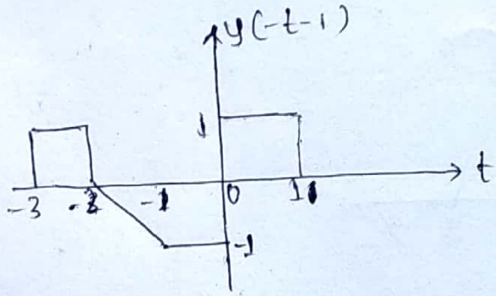


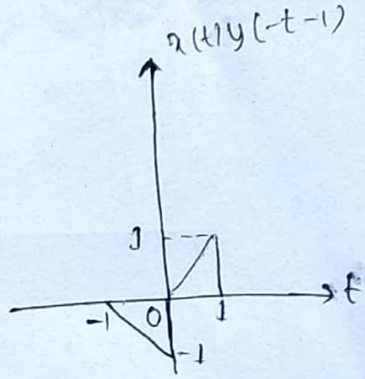
1) $x(t)\,y(-t-1)$



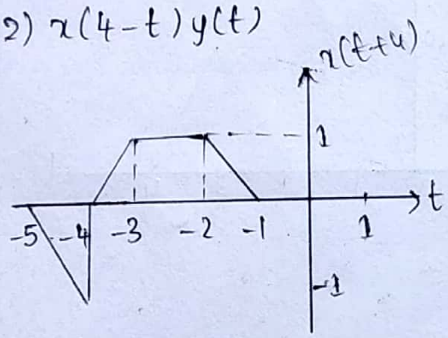


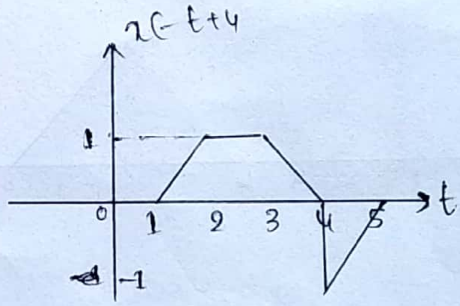


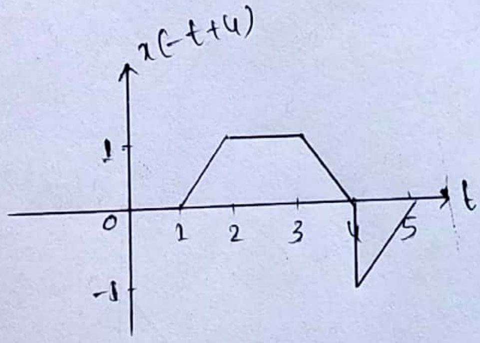


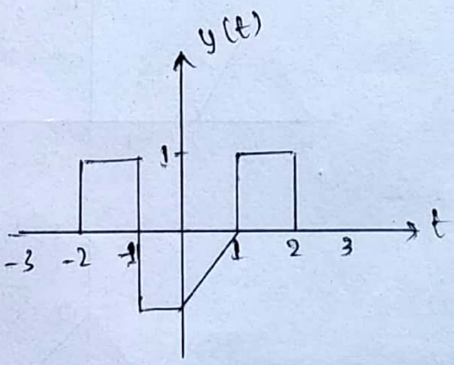


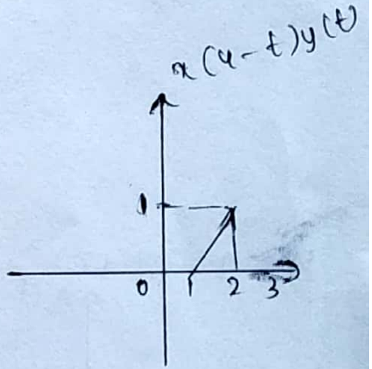
2) $x(4-t)\,y(t)$











c) For the signal $x(t) = \begin{cases} 5t & 0 \le t \le 2 \\ 20-5t & 2 \le t \le 4 \end{cases}$ Find and plot

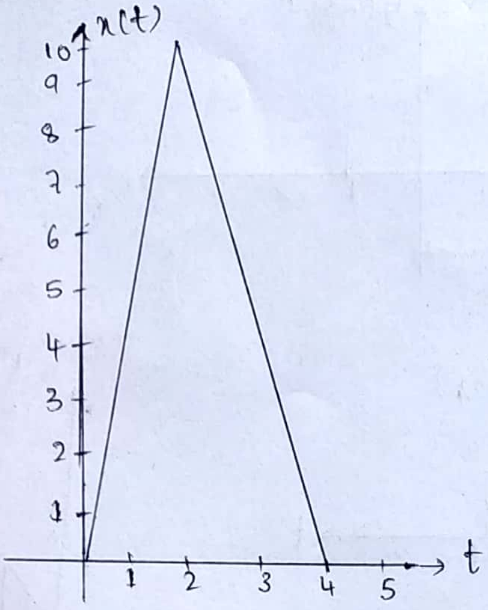
1) $x(-2t-4)$

2) $x(-3t+2)$

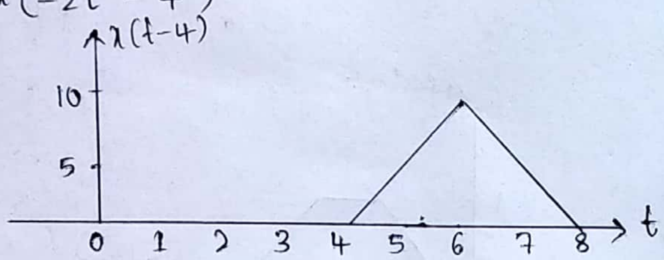
3) $x(2(-t-1))$

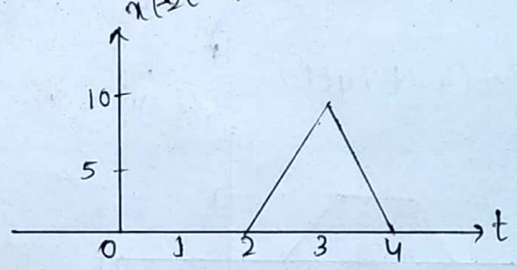
(a)

→ x(t) is given, sketch is

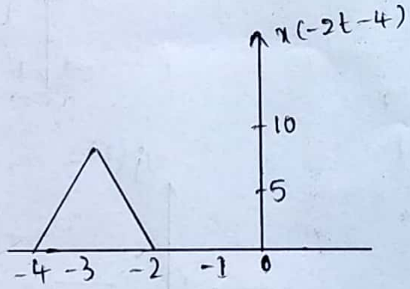


1) $x(-2t-4)$

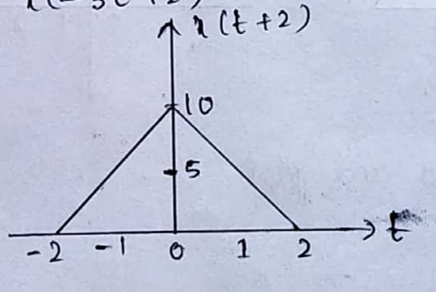


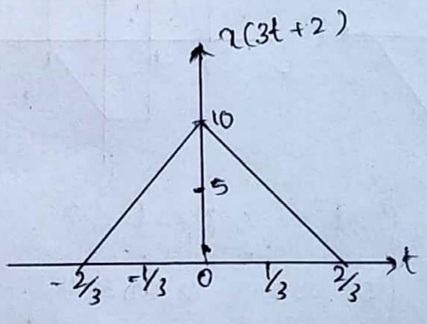


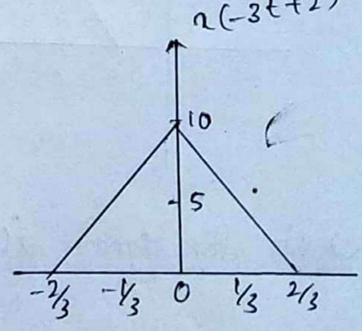
⟹



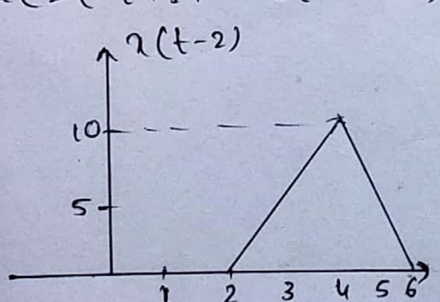
2) $x(-3t+2)$

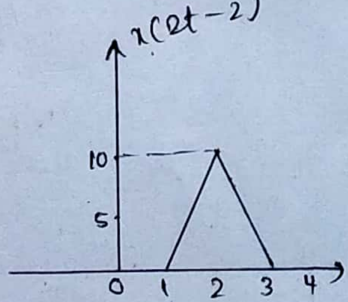


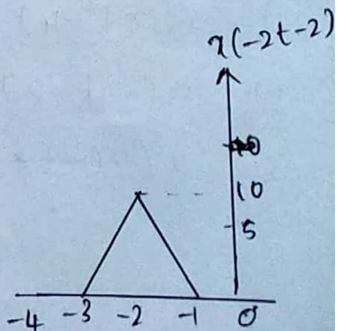




3) $x(2(-t+1)) = x(-2t-2)$







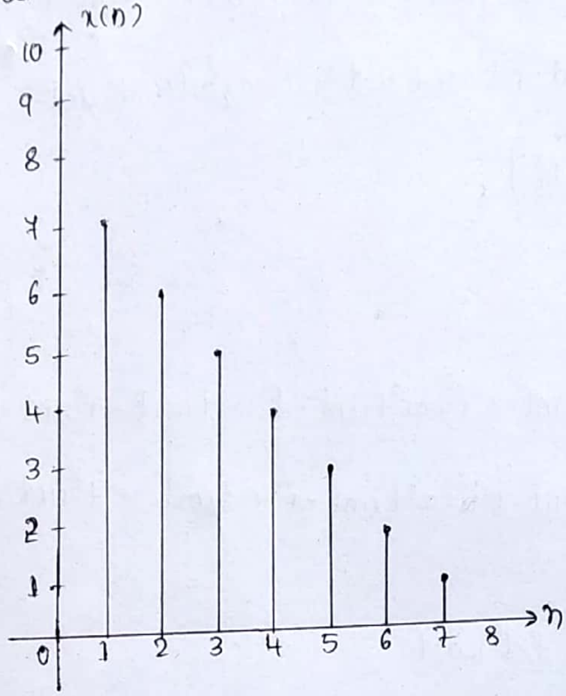
⑤

d) For the signal $x(n) = (8-n)[u(n) - u(n-8)]$ find & sketch

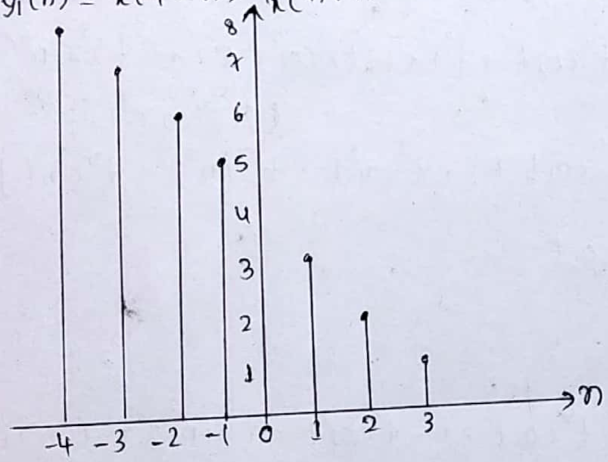
i) $y_1(n) = x(4-n)$

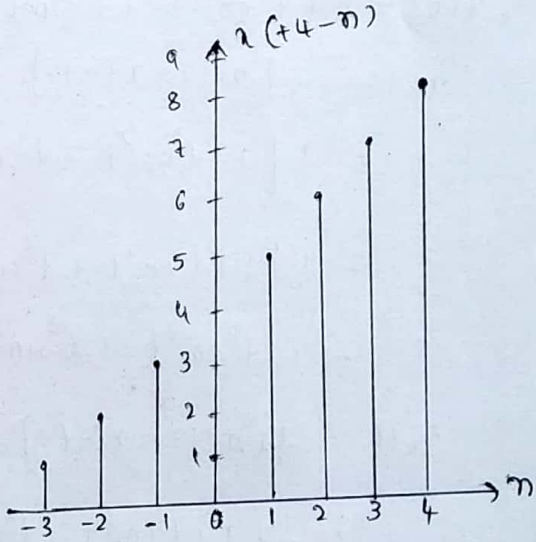
ii) $y_2(n) = x(2n-3)$

→ $x(n)$ signal is sketch as

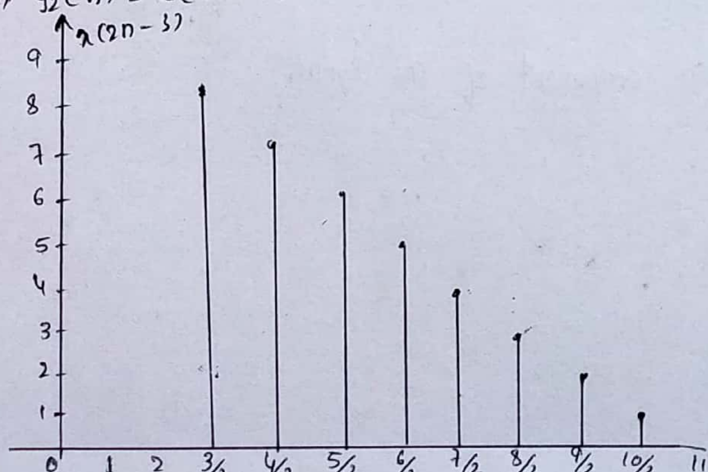


1) $y_1(n) = x(4-n)$





2) $y_2(n) = x(2n-3)$



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2) Solve the following

a) Find the odd & even components of the signal

1) $x(t) = 1 + t\cos t + t^2\sin t + t^3\cos^2(t)\sin t$

$x_e(t) = \frac{1}{2}[x(t) + x(-t)]$

$= \frac{1}{2}[1 + t\cos t + t^2\sin t + t^3\cos^2 t \sin t + [1 + (-t)\cos(-t) + (-t)^2\sin(-t) + (-t)^3\cos^2(-t)\sin(-t)]$

$= \frac{1}{2}[1 + t\cancel{\cos t} + t^2\cancel{\sin t} + t^3\cos^2 t\sin t + 1 - t\cancel{\cos t} - t^2\cancel{\sin t} + t^3\cos^2 t\sin t]$

$= \frac{2}{2}[1 + t^3\cos^2 t\sin t]$

$= 1 + t^3\cos^2 t\sin t$

$x_o(t) = \frac{1}{2}[x(t) - x(-t)]$

$= \frac{1}{2}[1 + t\cos t + t^2\sin t + t^3\cos^2 t\sin t - [1 - t\cos t - t^2\sin t + t^3\cos^2 t\sin t]$

$= \frac{1}{2}[\cancel{1} + t\cos t + t^2\sin t + t^3\cancel{\cos^2 t\sin t} - \cancel{1} + t\cos t + t^2\sin t - t^3\cancel{\cos^2 t\sin t}]$

$= t\cos t + t^2\sin t$

2) $x(t) = 1 + t^2\cos^2 t + t^3\sin^3 t + t^4\cos t$

$x_e(t) = \frac{1}{2}[x(t) + x(-t)]$

$= \frac{1}{2}[1 + t^2\cos^2 t + t^3\sin^3 t + t^4\cos t + [1 + (-t)^2\cos^2(-t) + (-t)^3\sin^3(-t) + (-t)^4\cos(-t)]$

$= \frac{1}{2}[1 + t^2\cos^2 t + t^3\sin^3 t + t^4\cos t + 1 + t^2\cos^2 t + t^3\sin^3 t + t^4\cos t]$

$= 1 + t^2\cos^2 t + t^3\sin^3 t + t^4\cos t$

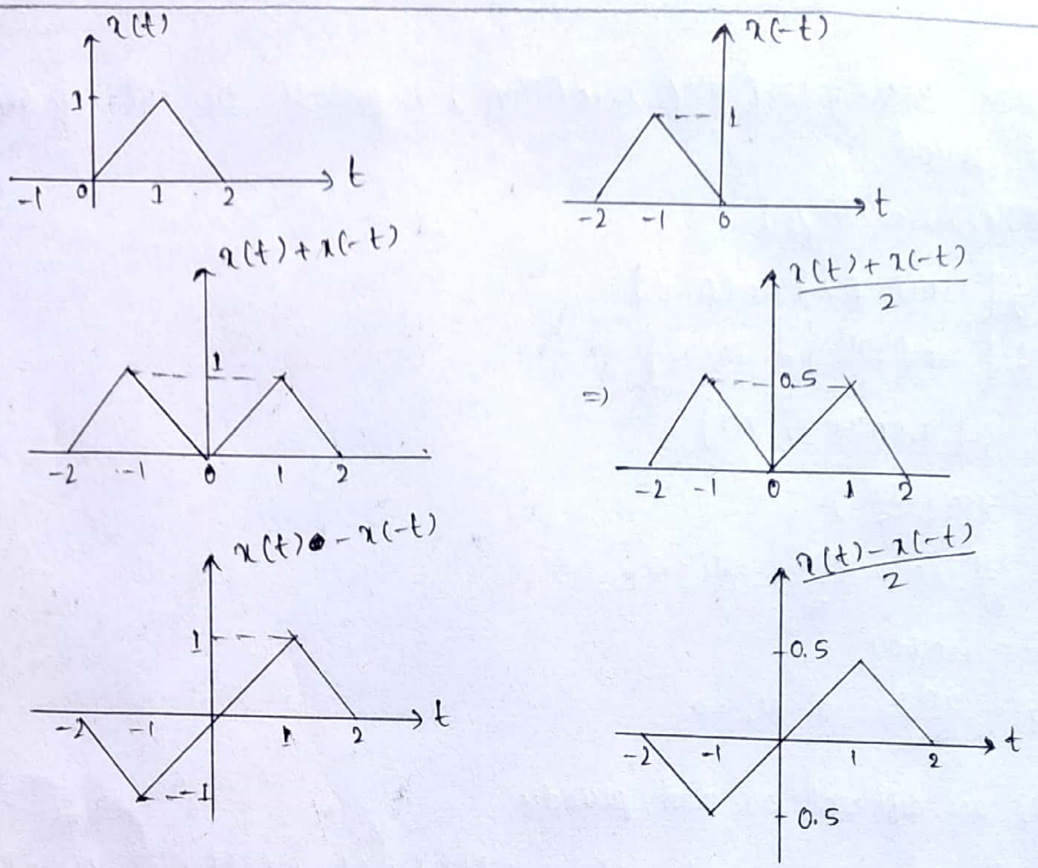
$x_o(t) = \frac{1}{2}[x(t) - x(-t)]$

$= \frac{1}{2}[1 + t^2\cos^2 t + t^3\sin^3 t + t^4\cos t - 1 - t^2\cos^2 t - t^3\sin^3 t - t^4\cos t]$

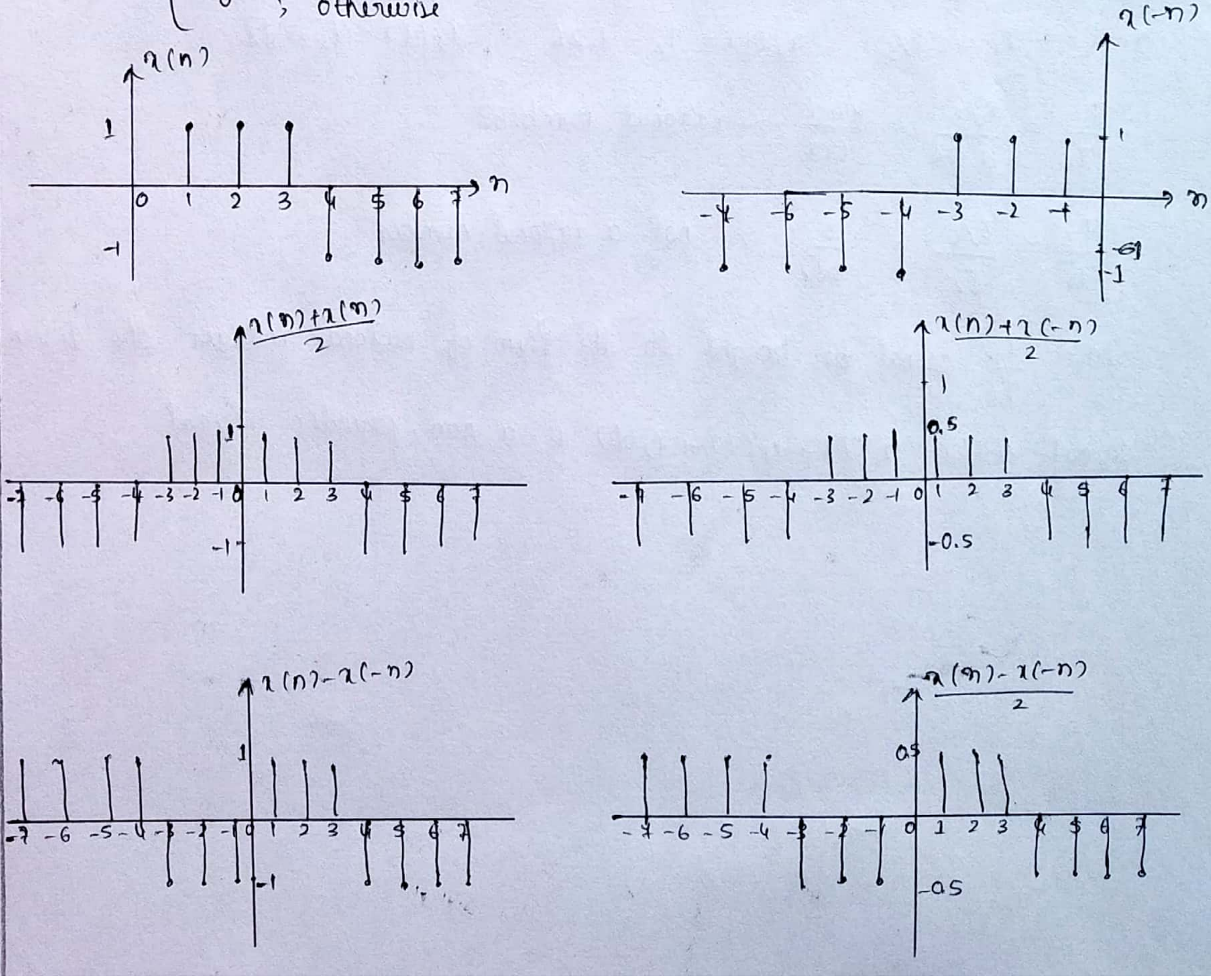
$= 0$

b) Find and sketch the odd & even component of the signal

1) $x(t) = \begin{cases} t & ; 0 \le t \le 1 \\ 2-t & ; 1 \le t \le 2 \\ 0 & ; \text{otherwise} \end{cases}$



2) $x(n) = \begin{cases} 1 & ; 0 \le n \le 3 \\ -1 & ; 4 \le n \le 7 \\ 0 & ; \text{otherwise} \end{cases}$



3) Determine

a) Whether the signal $x(n) = \cos(n\pi/5)\sin(n\pi/5)$ is periodic or not. if periodic Find fundamental period.

→ $x(n) = \cos(n\pi/5)\sin(n\pi/5)$

$$\sin A \cos B = \frac{1}{2}\left[\sin(A+B) + \sin(A-B)\right]$$

$$x(n) = \frac{1}{2}\left[\sin\left(\frac{2n\pi}{5}\right) + \sin(0)\right]$$

$$= \frac{1}{2}\left[x_1(n) + x_2(n)\right]$$

$$x_1(n) = \sin\left(\frac{2n\pi}{5}\right)$$

$$\Omega = \frac{2\pi}{N} \times n = \frac{2\pi n}{5} \quad N_1 = 5$$

$$x_2(n) = \sin(0)$$

$$\Omega_2 = \frac{2\pi n}{N_2} = 0 \quad N_2 = 0$$

N_1 & N_2 are different so non-periodic

b) Whether the continuous time signal $x(t) = x_1(t) + x_2(t) + x_3(t)$ is periodic or not. If periodic. Find the fundamental period where $x_1(t)$ $x_2(t)$ & $x_3(t)$ have periods of $8/3$, 1.26 & $\sqrt{2}$ respectively.

→ $x_1(t) = T_1 = 8/3$ $\quad x_2(t) = T_2 = 1.26$ $\quad x_3(t) = T_3 = \sqrt{2}$

$$\frac{T_1}{T_2} = \frac{8/3}{1.26} = \frac{400}{189} \Rightarrow \text{rational number}$$

$$\frac{T_1}{T_3} = \frac{8/3}{\sqrt{2}} = \frac{8}{3\sqrt{2}} \Rightarrow \text{not a rational number}$$

Since $\frac{T_1}{T_3}$ cannot be bought to the form of rational integer the given signal $x(t) = x_1(t) + x_2(t) + x_3(t)$ is a non-periodic signal.