A discrete-time signal x(n) is defined as:

$$x(n) = \begin{cases} 1 + \frac{n}{3} & -3 \leq n \leq -1 \\ 1 & 0 \leq n \leq 3 \\ 0 & \text{elsewhere} \end{cases}$$

Determine its values and sketch it.

Sketch the signals that result if we,

(i) $x(n)$

(ii) $x(n-1)$

(iii) $x(n+1)$

(iv) $x(-n)$

(v) $x(-n+1)$

(vi) $x(-n-1)$

(vii) $x(2n)$

(viii) $x\left(\frac{n}{2}\right)$

(ix) $x(2n-2)$

(x) $x(n)\,u(n)$

(xi) $x(n)\,u(n-1)$

(xii) $x(n)\,u(n+1)$

(xiii) $x(n)\,u(-n)$

(xiv) $x(n)\,u(-n-1)$

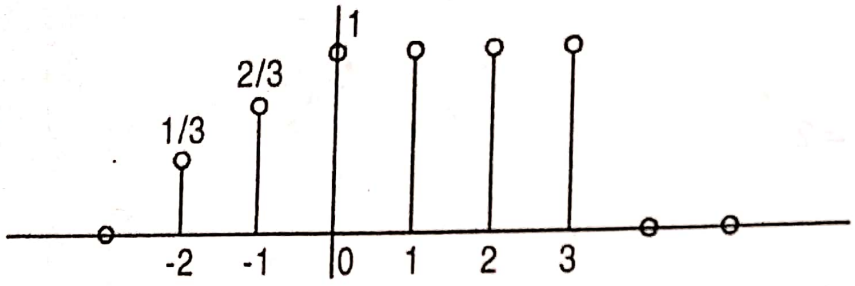
(xv) $x(n)\,\delta(n-2)$

(xvi) Express signal $x(n)$ in terms of signal $\delta(n)$.

(xvii) Express signal $x(n)$ in terms of $\delta(n)$ and $u(n)$.

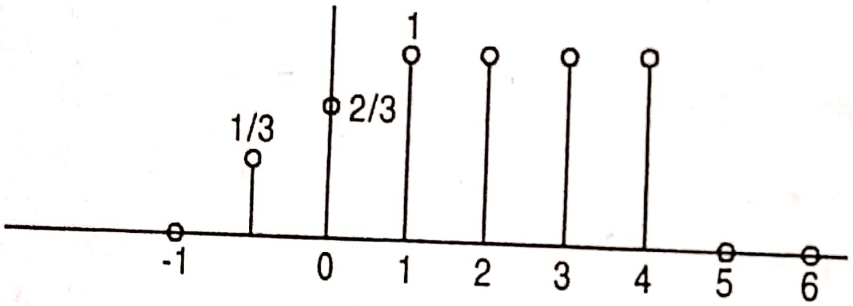
Solution:

(i) $x(n) = \left\{0, \frac{1}{3}, \frac{2}{3}, \underset{\uparrow}{1}, 1, 1, 1\right\}$

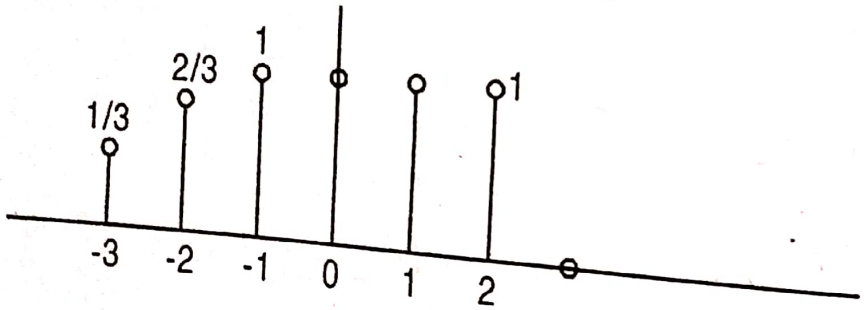


(ii) $x(n-1) = \left\{\frac{1}{3}, \frac{2}{3}, 1, 1, 1, 1\right\}$

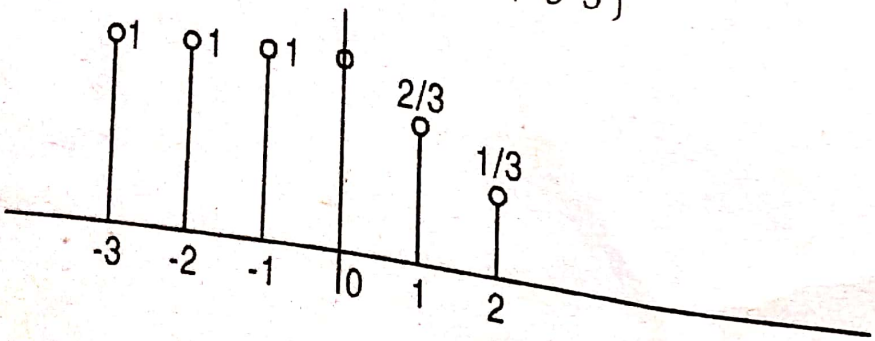
$\uparrow$



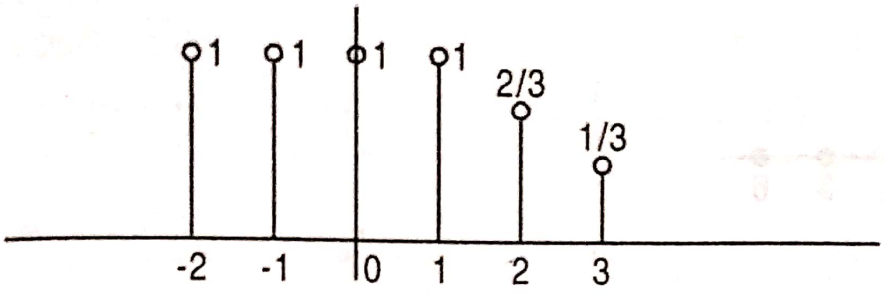
(iii) $x(n+1) = \left\{\frac{1}{3}, \frac{2}{3}, 1, \underset{\uparrow}{1}, 1, 1\right\}$



(iv) $x(-n) = \left\{1, 1, 1, \underset{\uparrow}{1}, \frac{2}{3}, \frac{1}{3}\right\}$

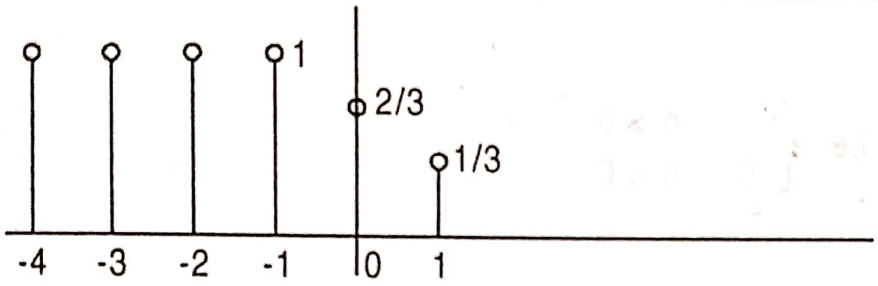


(v) $x(-n+1) = \left\{1, 1, \underset{\uparrow}{1}, 1, \frac{2}{3}, \frac{1}{3}\right\}$

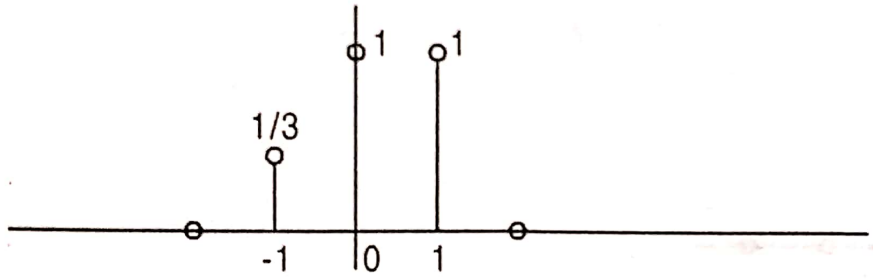


(vi) $x(-n-1) = \left\{1, 1, 1, 1, \frac{2}{3}, \frac{1}{3}\right\}$

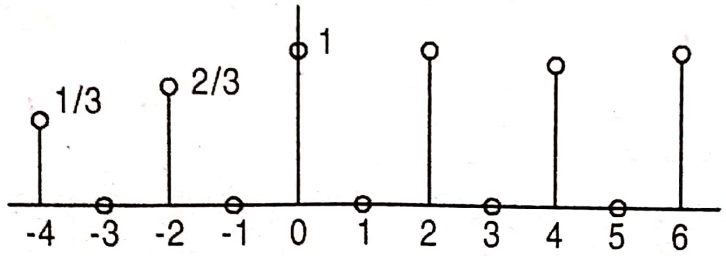
$\uparrow$



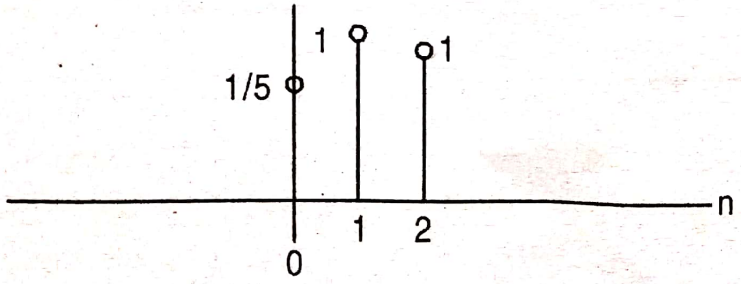
(vii) $x(2n) = \left\{\frac{1}{3}, \underset{\uparrow}{1}, 1\right\}$



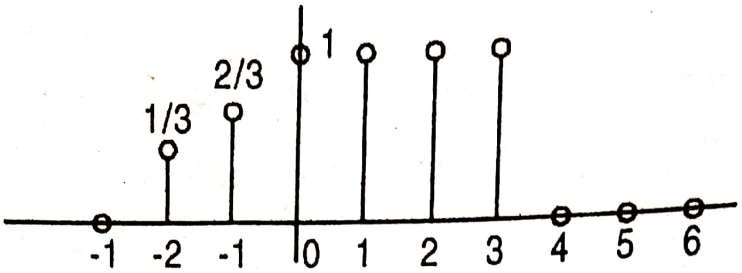
(viii) $x\left(\frac{n}{2}\right) = \left\{\frac{1}{3}, 0, \frac{2}{3}, 0, \underset{\uparrow}{1}, 0, 1, 0, 1, 0, 1, 0\right\}$

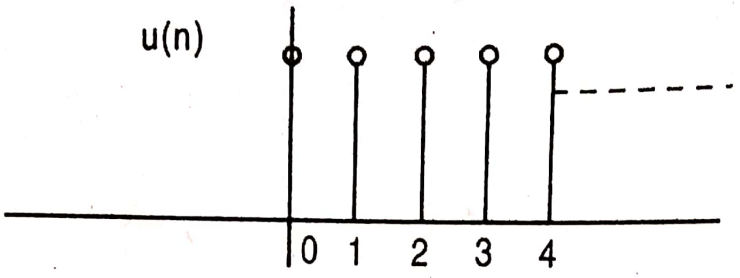


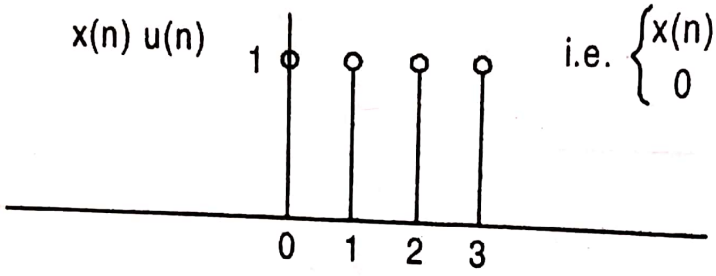
(ix) $x(2n-2) = \left\{\frac{1}{3}, 1, 1\right\}$



(x) x(n) u(n)

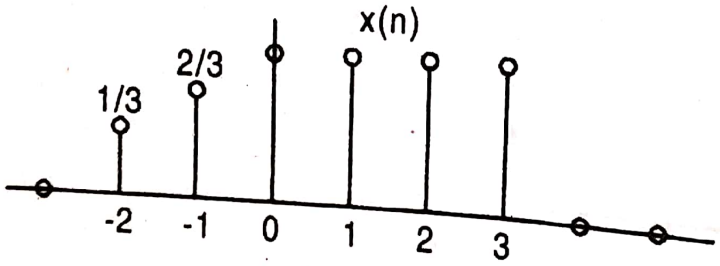


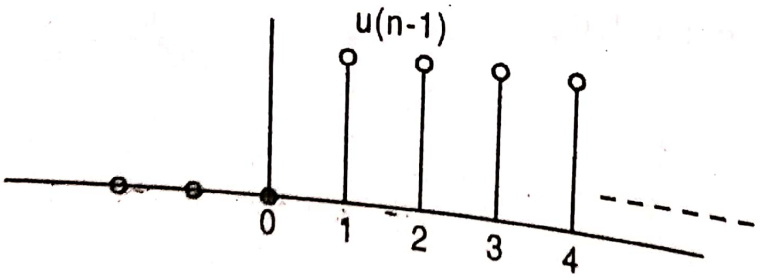


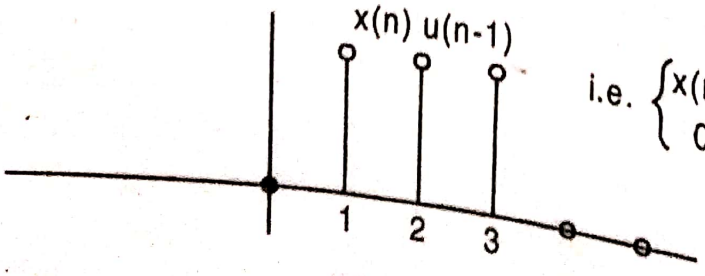


i.e. $\begin{cases} x(n) & n \geq 0 \\ 0 & n < 0 \end{cases}$

(xi) x(n) u(n – 1)

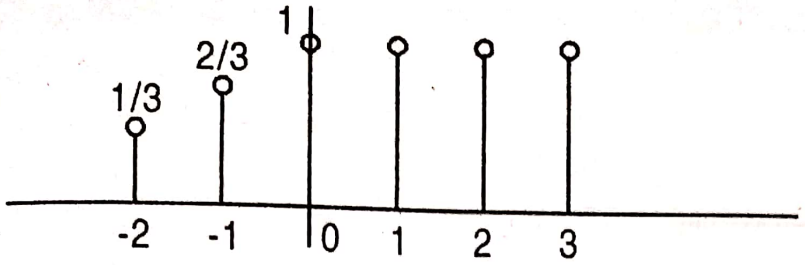


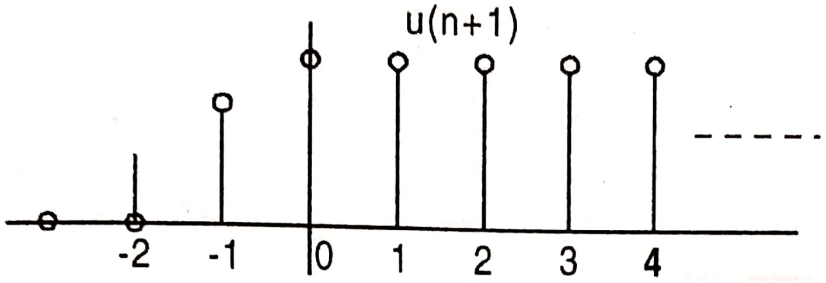


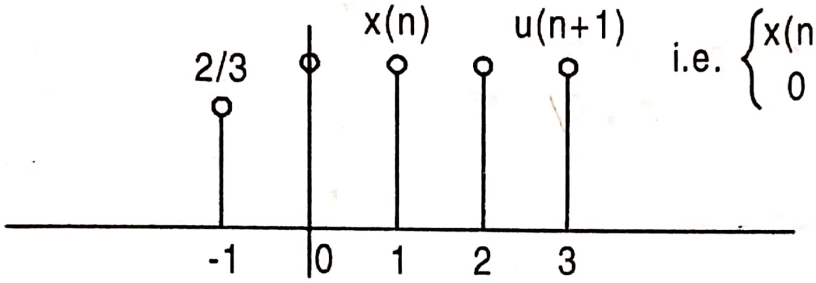


i.e. $\begin{cases} x(n) & n > 0 \\ 0 & n < 0 \end{cases}$

(xii) x(n) u(n + 1)

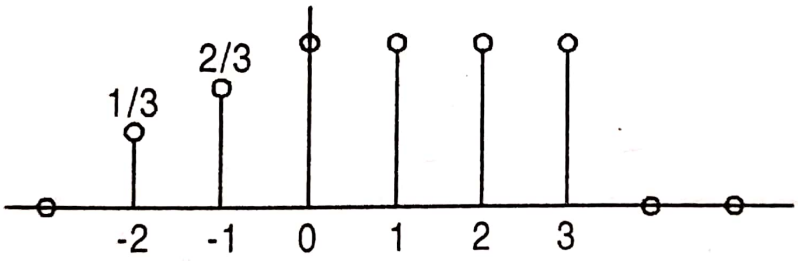


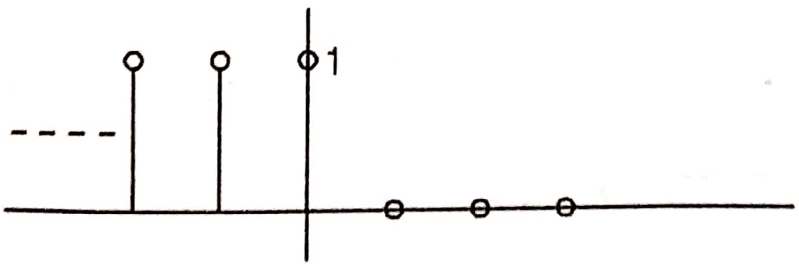


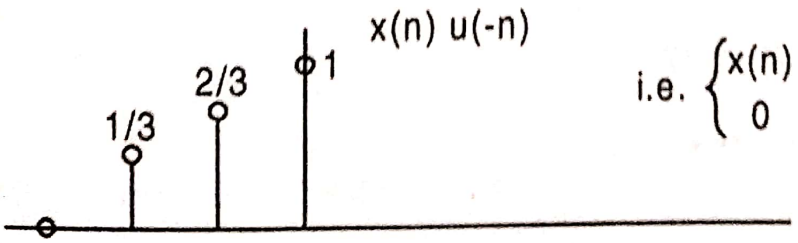


i.e. $\begin{cases} x(n) & n \geq -1 \\ 0 & n < -1 \end{cases}$

(xiii) x(n) u(–n)

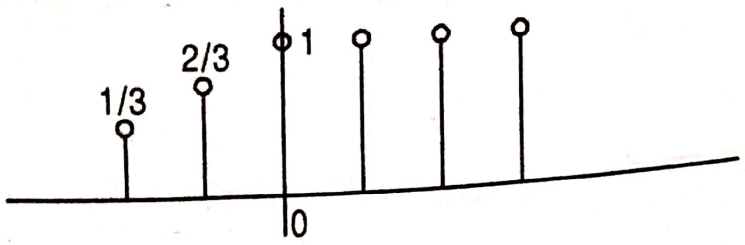


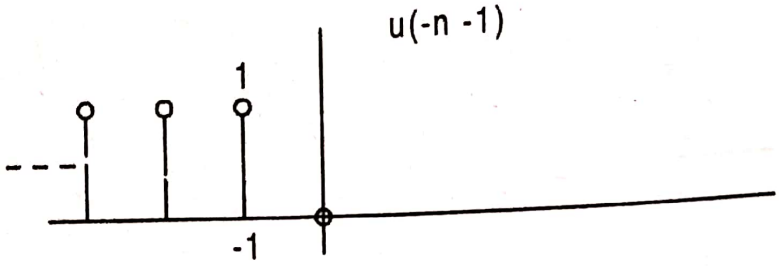


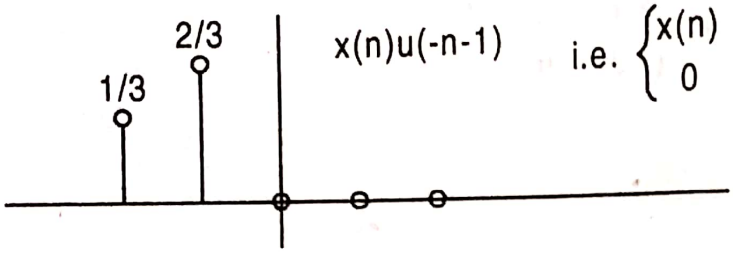


i.e. $\begin{cases} x(n) & n < 0 \\ 0 & \text{otherwise} \end{cases}$

(xiv) x(n) u(–n –1)

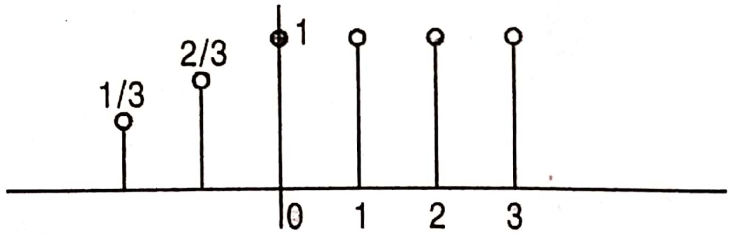


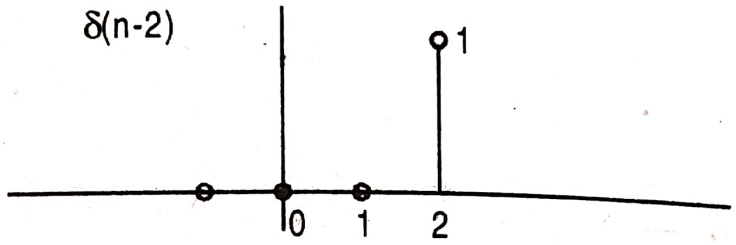


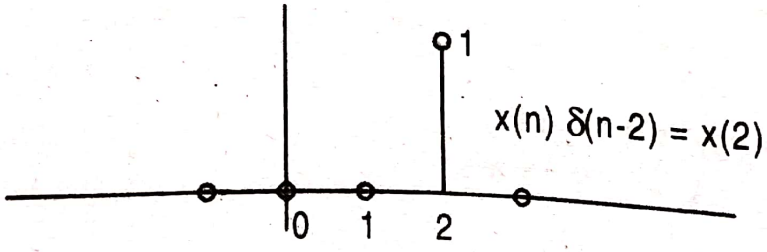


$$\text{i.e.} \begin{cases} x(n) & n < 0 \\ 0 & n \geq 0 \end{cases}$$

(xv) x(n) δ(n – 2)







(xvi) $x(n) = \frac{1}{3}\delta(n+2) + \frac{2}{3}\delta(n+1) + \delta(n) + \delta(n-1) + \delta(n-2) + \delta(n-3)$

(xvii) $x(n) = \frac{1}{3}\delta(n+2) + \frac{2}{3}\delta(n+1) + u(n) - u(n-4)$