Signals - Part V

Comprehensive Course on SIGNAL SYSTEM ECE/EE/IN

Vishal Soni • Lesson 5 • Feb 24, 2025

SIGNAL SYSTEM

Discrete Time Signal

Lecture 05

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ESE AIR 25

Q. Calculate zero crossover time instant of x(t)

$$x(t) = \frac{\sin 4t}{3t}$$

Soln

$$x(t) = \frac{4}{3}\operatorname{sinc}\left(\frac{4t}{\pi}\right)$$

ZERO CROSSOVER TIME INSTANT $\frac{4t}{\pi} = n \quad n \in I, \; n \neq 0$

$$\boxed{t = \frac{n\pi}{4} \quad n \in I, \; n \neq 0}$$

Q. Calculate zero crossover frequency of X(ω)

$$X(\omega) = \frac{\sin 3\omega}{\omega}$$

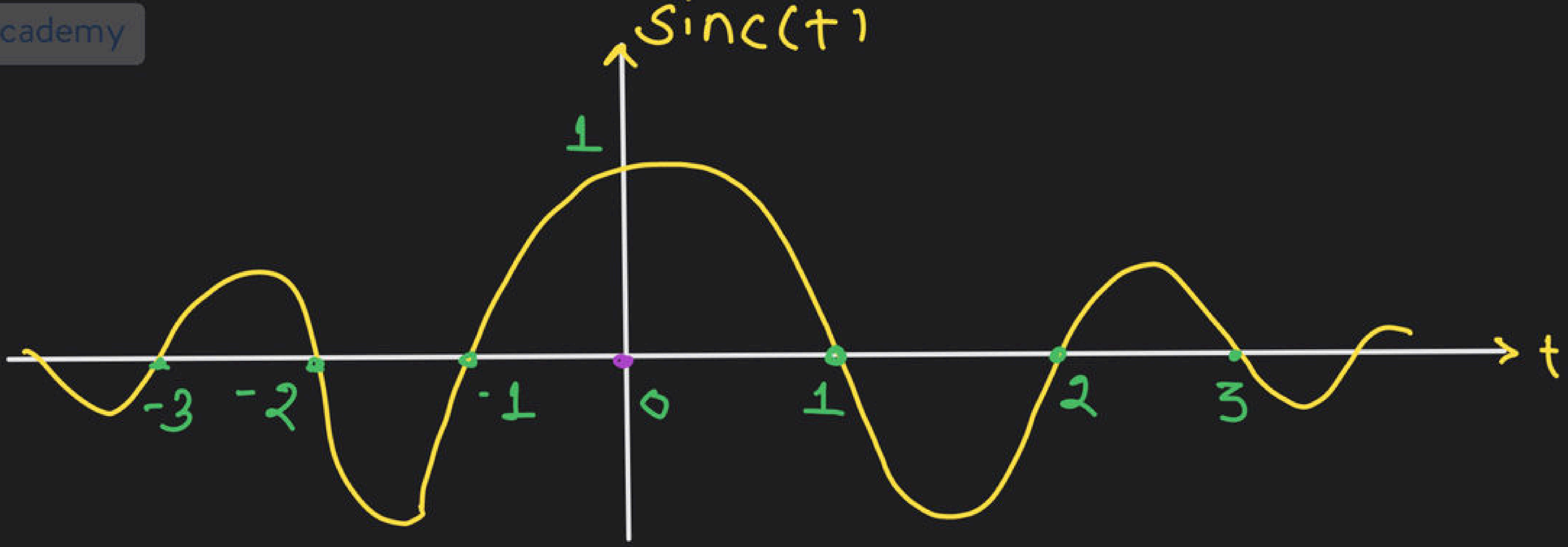
Soln $X(\omega) = 3\,\mathrm{sinc}\left(\frac{3\omega}{\pi}\right)$

ZERO CROSSOVER FREQ.

$$\boxed{\frac{3\omega}{\pi} = n : n \in I,\ n \neq 0}$$

$$\boxed{\omega = \frac{n\pi}{3}\ \frac{\text{RAD}}{\text{SEC}}\quad n \in I : n \neq 0}$$

$$\boxed{f = \frac{n}{6}\ \text{Hz} : n \in I,\ n \neq 0}$$


sinc(t)
1
t
-3
-2
-1
0
1
2
3

$\boxed{6}$ $$\int_{-\infty}^{\infty} \operatorname{sinc}(t)\,dt = 1$$

$\boxed{7}$ $$\int_{-\infty}^{\infty} \operatorname{sinc}(kt)\,dt = \frac{1}{K}$$

$\boxed{8}$ $$\int_{-\infty}^{\infty} \operatorname{sinc}^2(t)\,dt = 1$$

$\boxed{9}$ $$\int_{-\infty}^{\infty} \operatorname{sinc}^2(kt)\,dt = \frac{1}{K}$$

SAMPLING FUNCTION

$$\boxed{Sa(t) = \frac{\sin t}{t}}$$

$$\boxed{Sa(kt) = \frac{\sin kt}{kt}}$$

$$\frac{\sin at}{bt} = \frac{a}{b}\, Sa(at)$$

$$\frac{\sin 3t}{4t} = \frac{3}{4}\, Sa(3t)$$

$$\frac{\sin \pi t}{\pi t} = 1\, Sa(\pi t)$$

PROPERTIES

1. $Sa(-t) = Sa(t) \longrightarrow$ EVEN

2. $\{Sa(t)\}_{t=0} = 1$

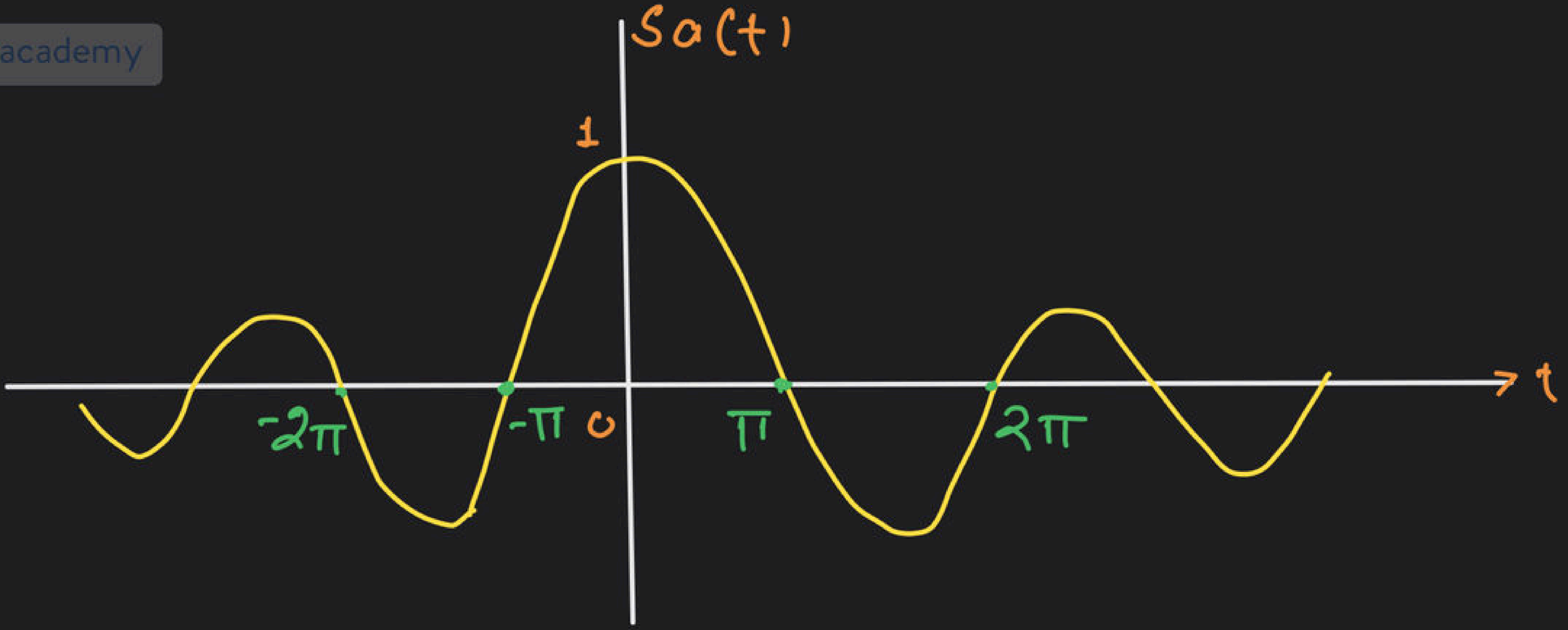
3. $(Sa(t))_{t=\pm\infty} = 0$

4 ZERO CROSSOVER TIME INSTANCES:

$$Sa(t) = \frac{\sin t}{t} = \operatorname{sinc}\left(\frac{t}{\pi}\right)$$

$$\frac{t}{\pi} = n \quad n \in I : n \neq 0$$

$$\boxed{t = n\pi : n \in I, \; n \neq 0}$$


Sa(t)
1
t
-2π
-π
0
π
2π

$\boxed{6}$ $$\int_{-\infty}^{\infty} Sa(t)\,dt = \int_{-\infty}^{\infty} \operatorname{sinc}\left(\frac{t}{\pi}\right) dt = \frac{1}{K} = \pi$$

$K = \frac{1}{\pi}$

$\boxed{7}$ $$\int_{-\infty}^{\infty} Sa^2(t)\,dt = \int_{-\infty}^{\infty} \operatorname{sinc}^2\left(\frac{t}{\pi}\right) dt = \frac{1}{K} = \pi$$

$K = \frac{1}{\pi}$

Q. $I = \int_0^{\infty} \underbrace{\frac{\sin 4t}{3t}}_{\text{EVEN}} \, dt$

$f(t) = \frac{\sin 4t}{3t}$

$f(-t) = \frac{\sin 4(-t)}{3(-t)} = \frac{\sin 4t}{3t}$

$f(-t) = f(t)$

$I = \frac{1}{2} \int_{-\infty}^{\infty} \frac{\sin 4t}{3t} \, dt$

$K = 4/\pi$

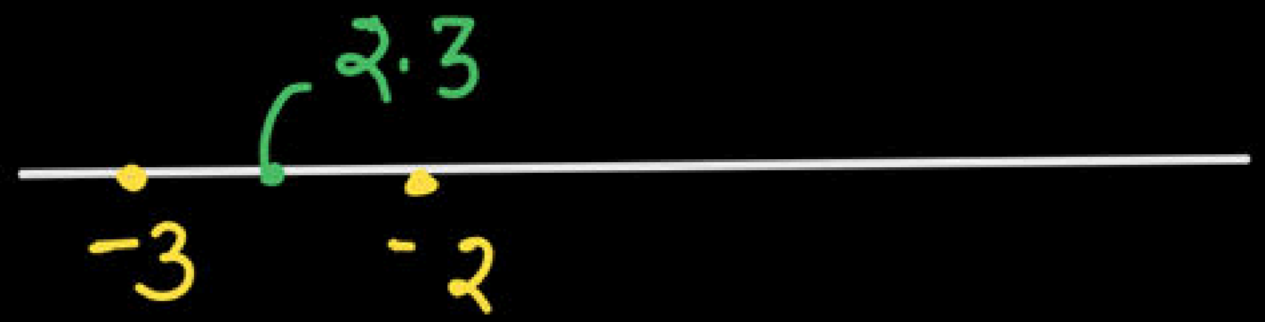
$I = \frac{1}{2} \times \frac{4}{3} \int_{-\infty}^{\infty} \mathrm{sinc}\left(\frac{4t}{\pi}\right) dt = \frac{4}{6} \times \frac{\pi}{4} = \frac{\pi}{6}$

GREATEST INTEGER FUNCTION (Floor Function)

SYMBOL $[\cdot]$ or $\lfloor \ \rfloor$

$$x(t) = [t] = \begin{cases} \text{Integer Itself} : t = \text{ Integer} \\ \text{Immediate Previous Integer} : t \neq \text{ Integer} \end{cases}$$

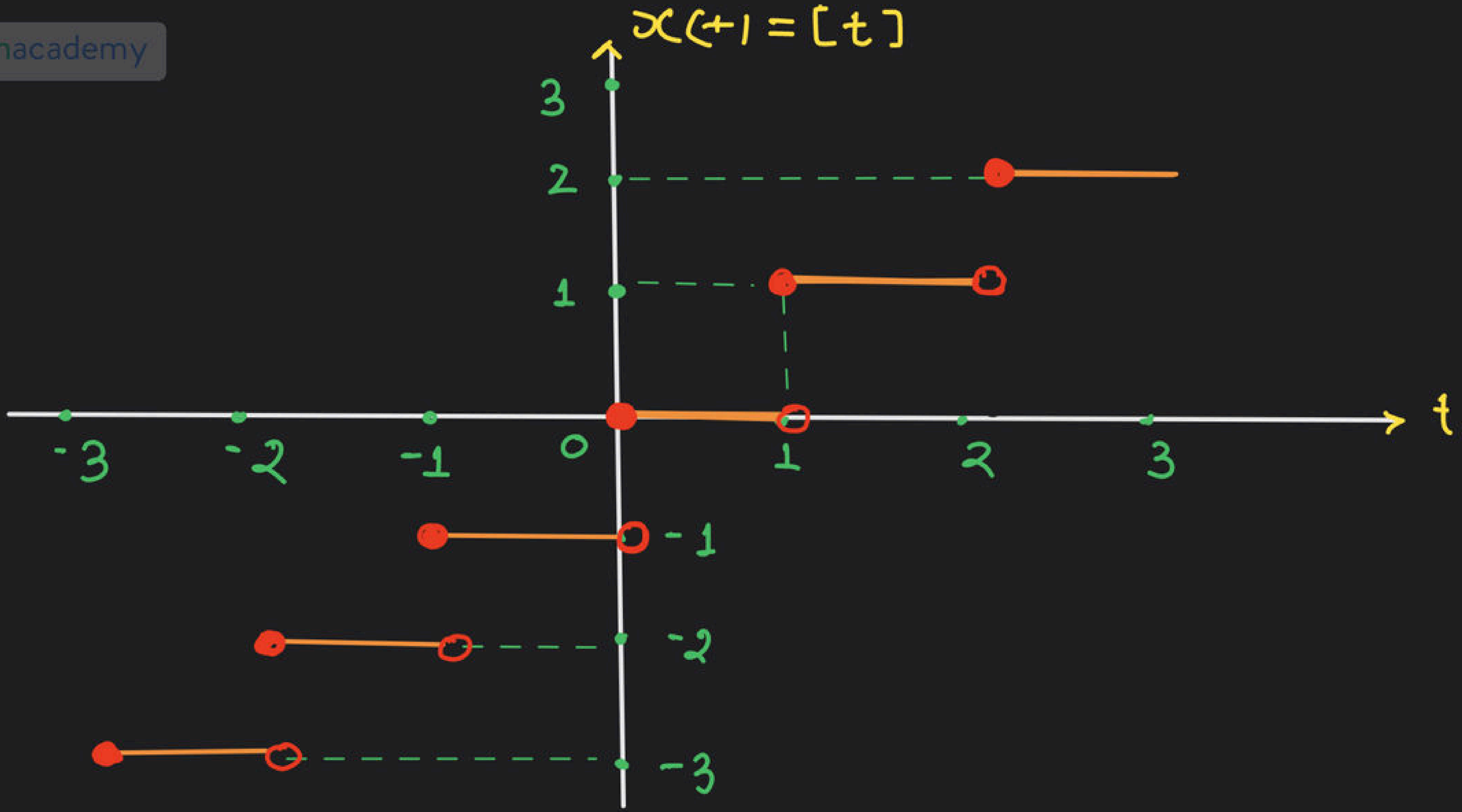
$[2] = 2$ $\quad$ $[2.3] = 2$ $\quad$ $[-2.3] = -3$



Definition

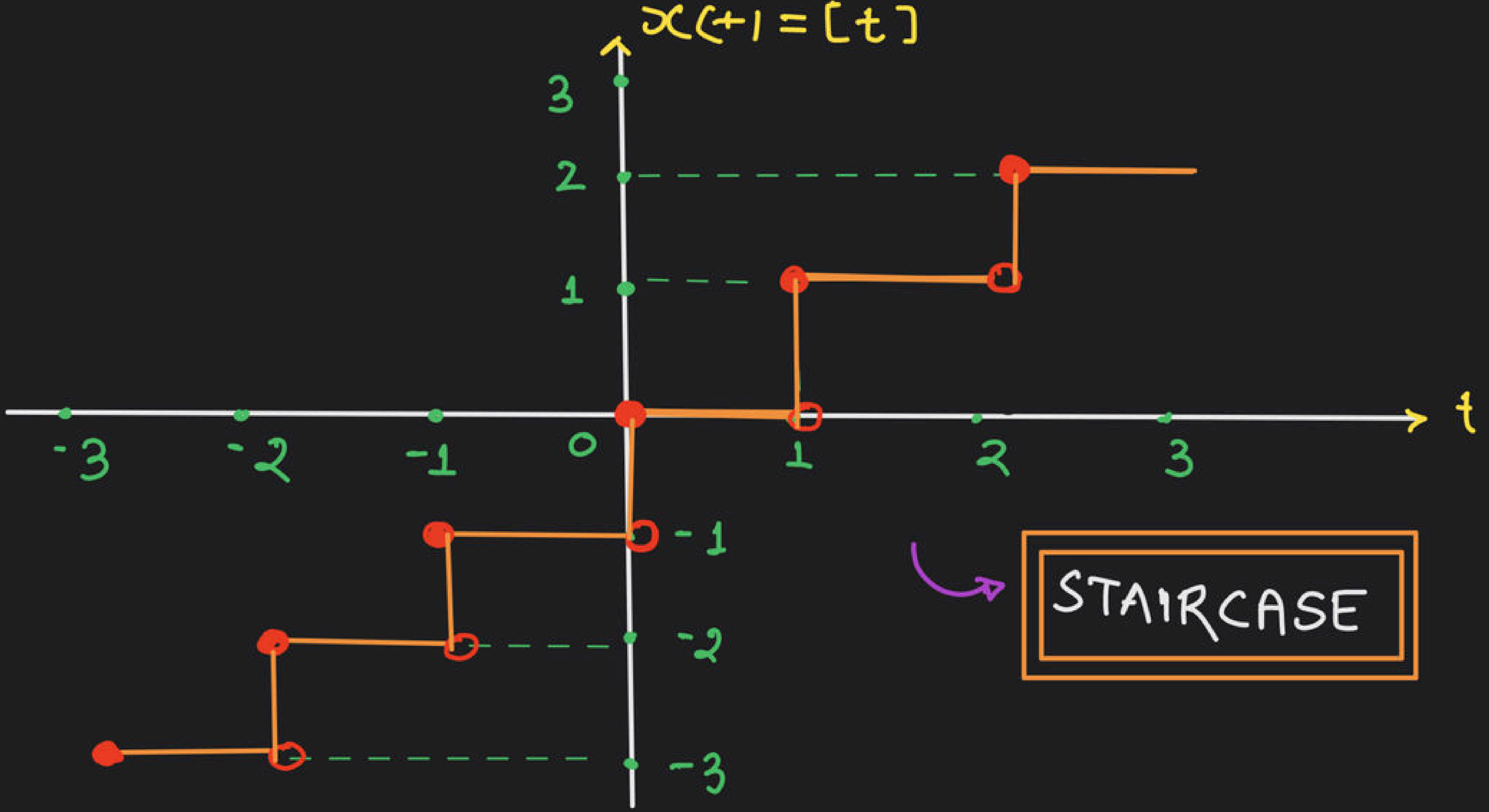
Piecewise Define in integer intervals

$$x(t) = [t] = \begin{cases} -2 & : -2 \le t < -1 \\ -1 & : -1 \le t < 0 \\ 0 & : 0 \le t < 1 \\ 1 & : 1 \le t < 2 \\ 2 & : 2 < t < 3 \end{cases}$$



x(t) = [t]
3
2
1
t
-3
-2
-1
0
1
2
3
-1
-2
-3

NOTE



FRACTIONAL PART OF t

[·] GIF

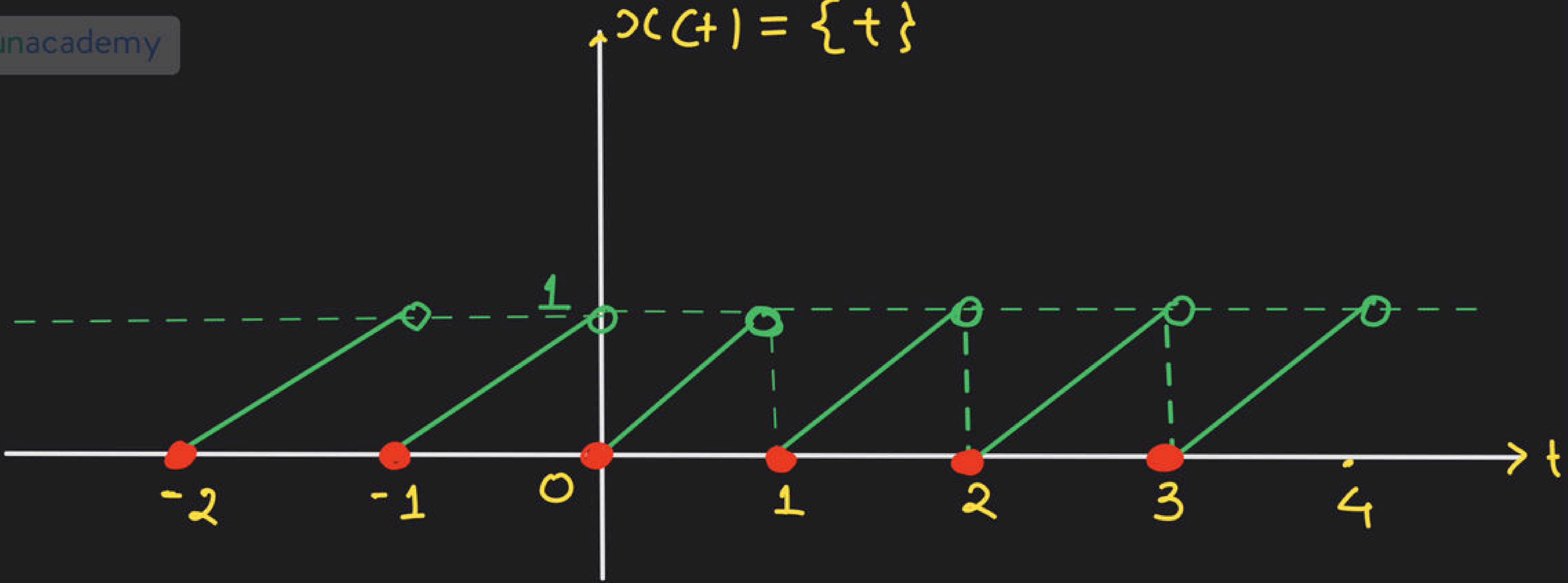
$x(t) = t - [t] = \{t\}$

$$x(t) = t - [t] = \begin{cases} t-(-2) & : -2 \leq t < -1 \\ t-(-1) & : -1 \leq t < 0 \\ t-0 & : 0 \leq t < 1 \\ t-1 & : 1 \leq t < 2 \\ t-2 & : 2 \leq t < 3 \end{cases}$$

AT

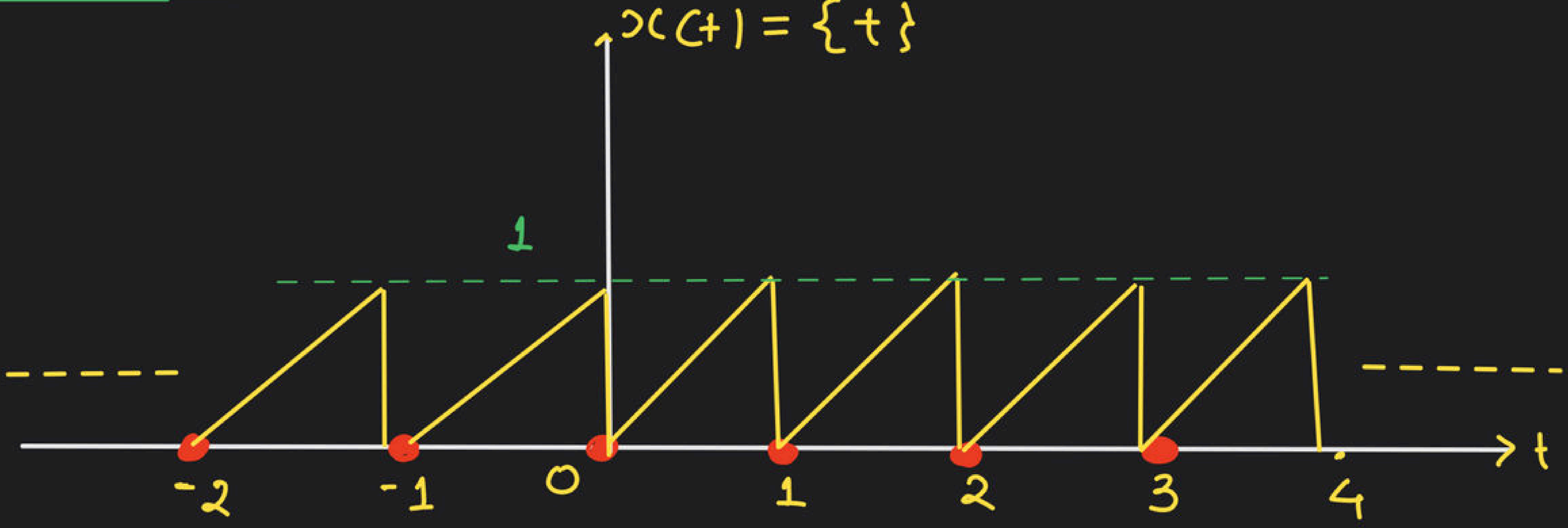
t = INTEGER

$\boxed{x(t) = 0}$



x(t) = {t}
1
t
-2
-1
0
1
2
3
4

NOTE



SAWTOOTH PULSE TRAIN

LEAST INTEGER FUNCTION (L.I.F.) [•] or CEILING FUNCTION

$$x(t) = [t] = \lceil t \rceil$$

$$= \begin{cases} \text{Integer Itself} : t = \text{Integer} \\ \text{Immediate Next Integer}: t \neq \text{non Integer} \end{cases}$$

let $[\cdot]$ LIF $\longrightarrow$ $[2.3] = 3$

$[2] = 2$

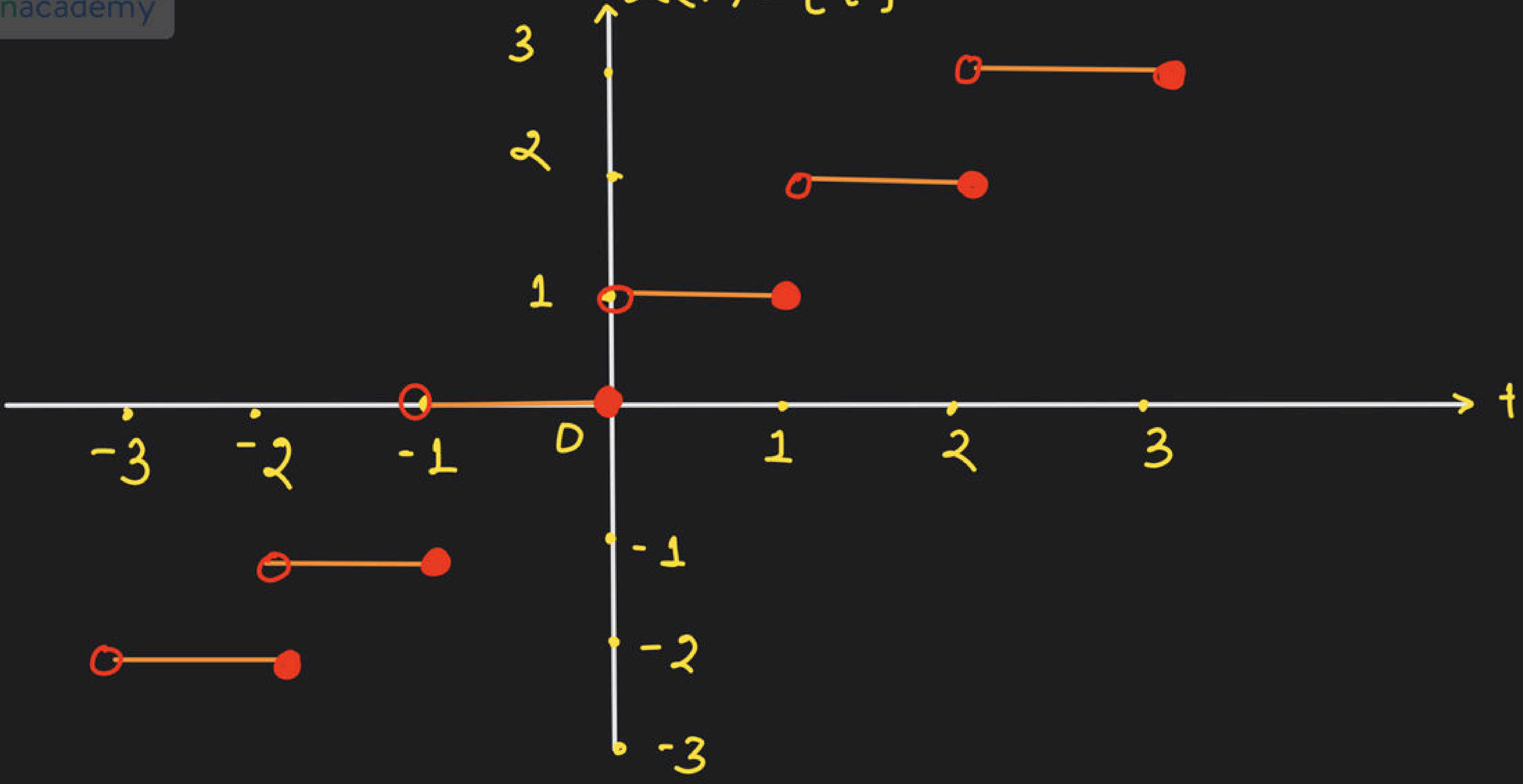
$[-2.3] = -2$

Definition

Piecewise Define in integer intervals

$$x(t) = [t] = \begin{cases} -1 & : -2 < t \leq -1 \\ 0 & : -1 < t \leq 0 \\ 1 & : 0 < t \leq 1 \\ 2 & : 1 < t \leq 2 \\ 3 & : 2 < t \leq 3 \end{cases}$$

$x(t) = [t]$



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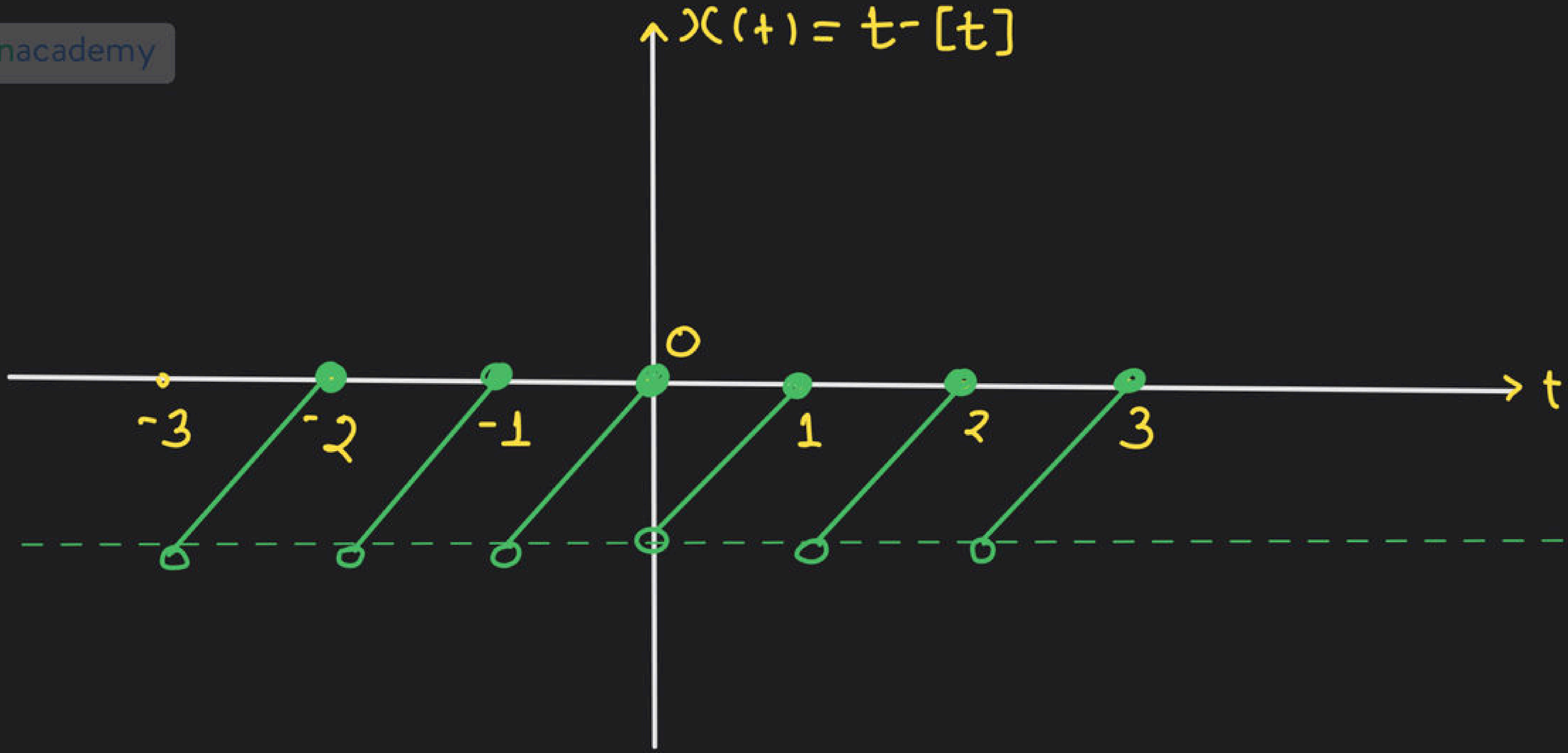
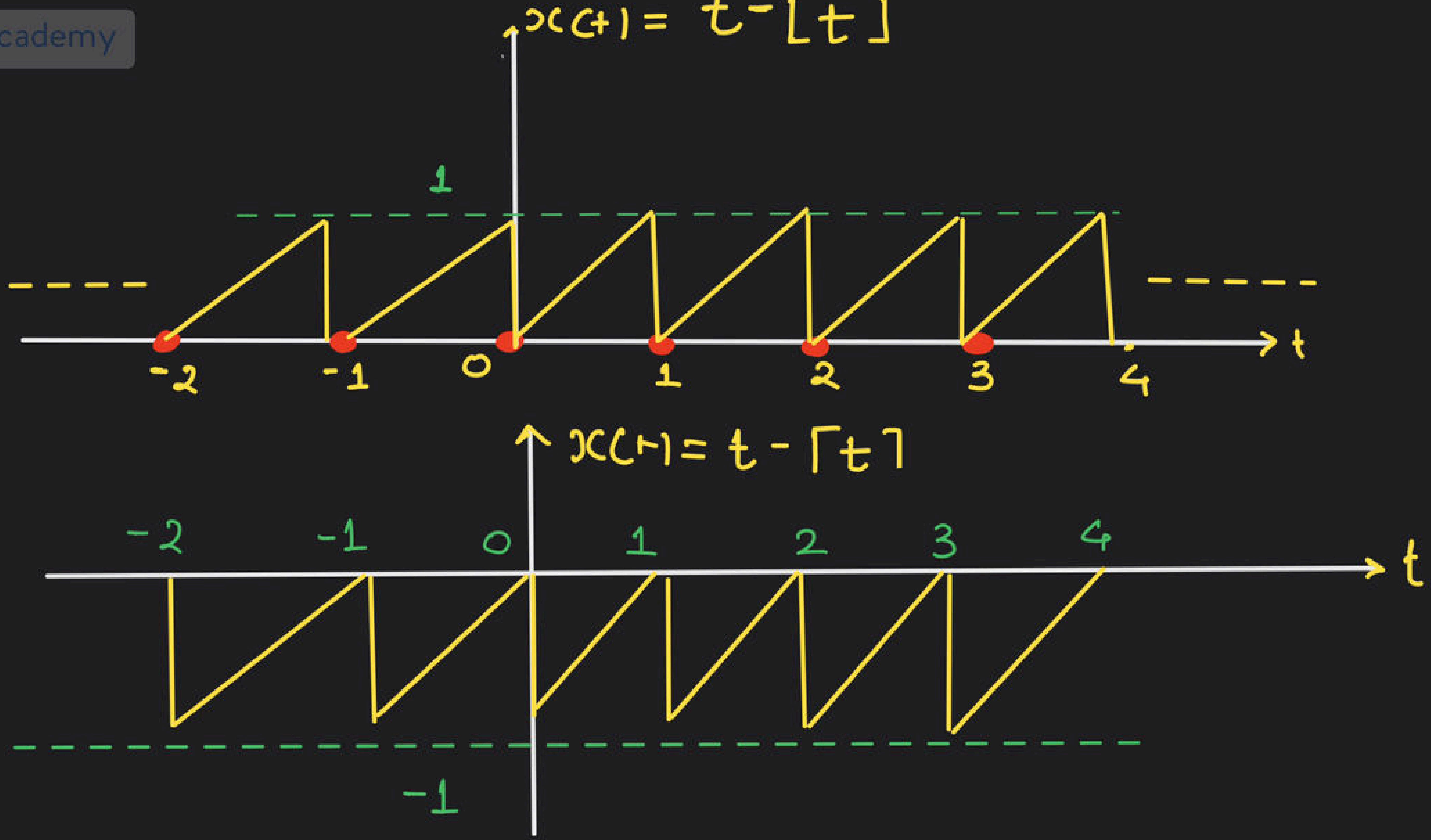
$x(t) = t - [t]$ $\qquad [\cdot] \to \text{L I F}$

$$x(t) = t - [t] = \begin{cases} t-(-1) & : -2 < t \leq -1 \\ t-0 & : -1 < t \leq 0 \\ t-1 & : 0 < t \leq 1 \\ t-2 & : 1 < t \leq 2 \\ t-3 & : 2 < t \leq 3 \end{cases}$$



x(t) = t - [t]
0
t
-3
-2
-1
1
2
3



$x(t) = t - \lfloor t \rfloor$
1
-2
-1
0
1
2
3
4
t
$x(t) = t - \lceil t \rceil$
-2
-1
0
1
2
3
4
t
-1

NOTE

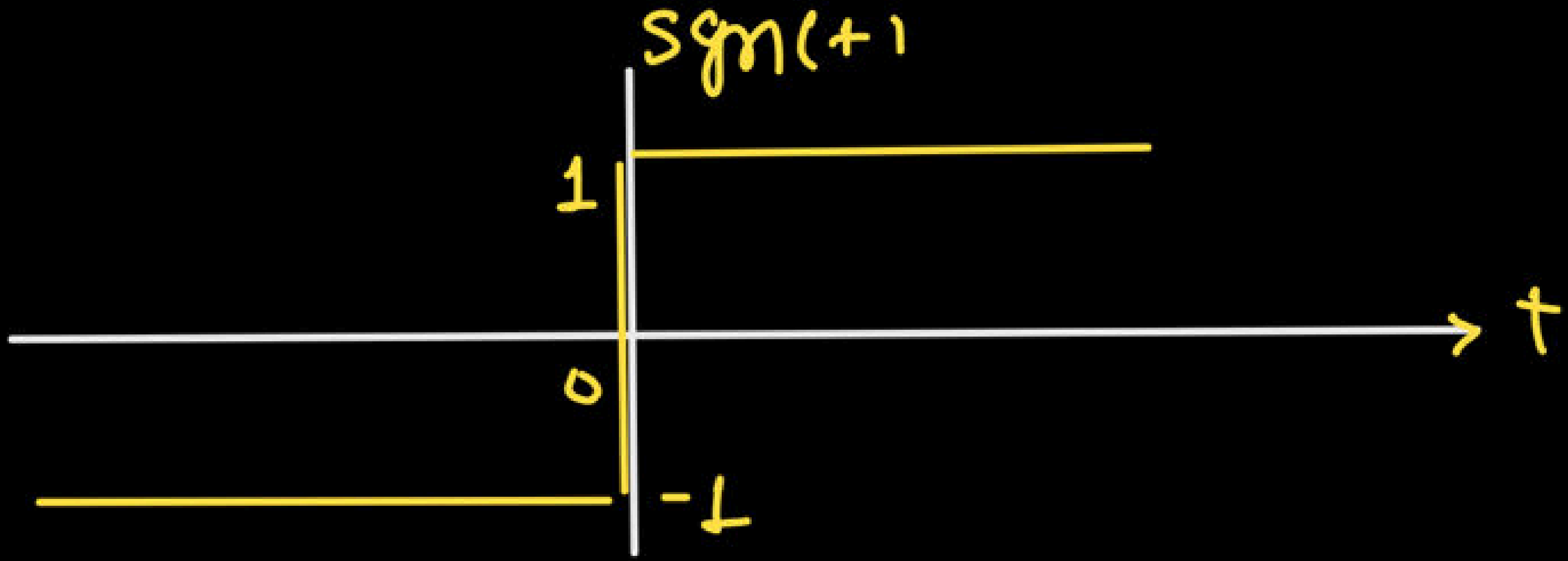
GIF = Floor Function = $\lfloor t \rfloor$

LIF = Ceiling Function = $\lceil t \rceil$

$$\boxed{(t - \lceil t \rceil) + 1 = t - \lfloor t \rfloor}$$

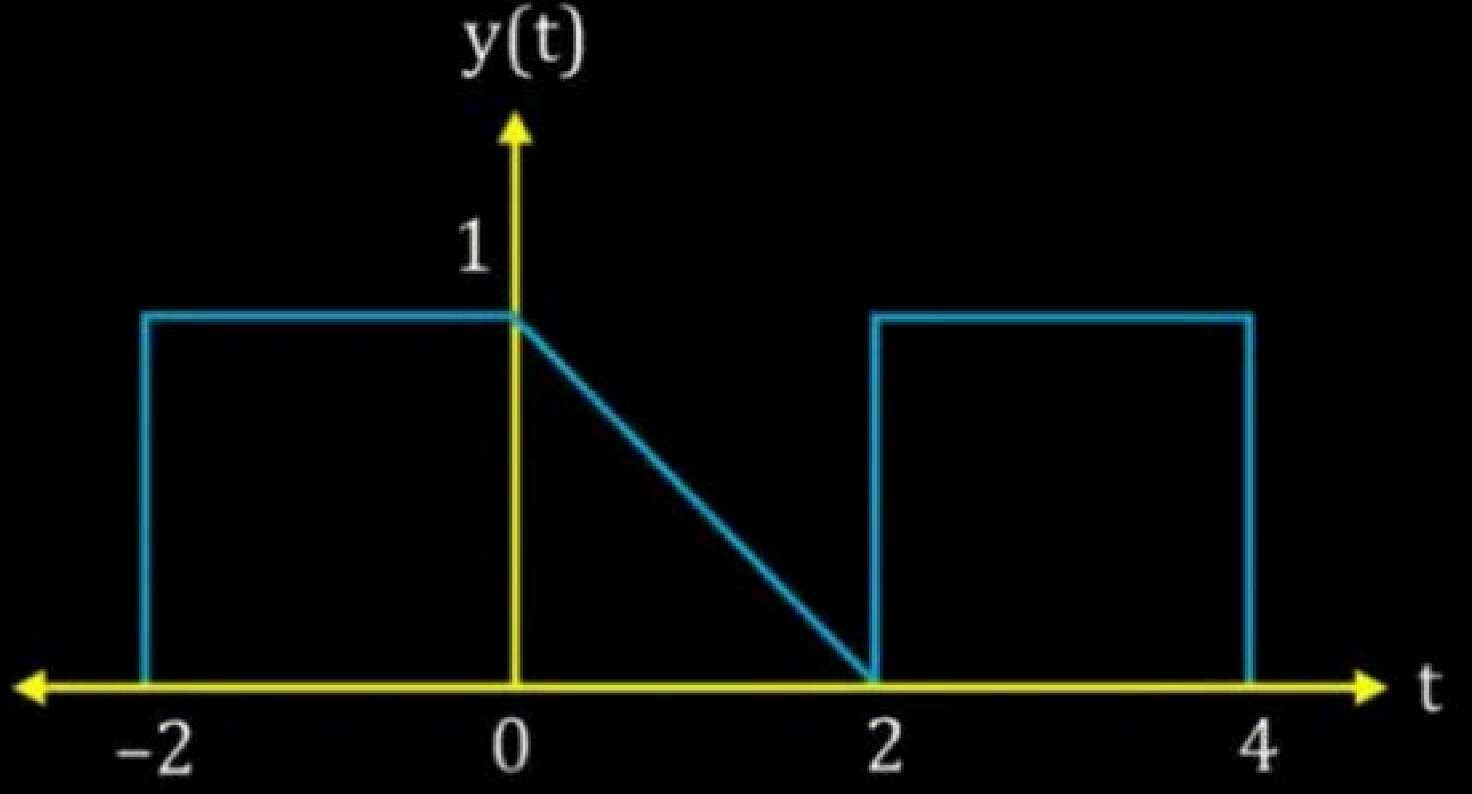
SIGNUM FUNCTION

$$\mathrm{sgn}(t) = \begin{cases} -1 & : t < 0 \\ 0 & : t = 0 \\ 1 & : t > 0 \end{cases}$$

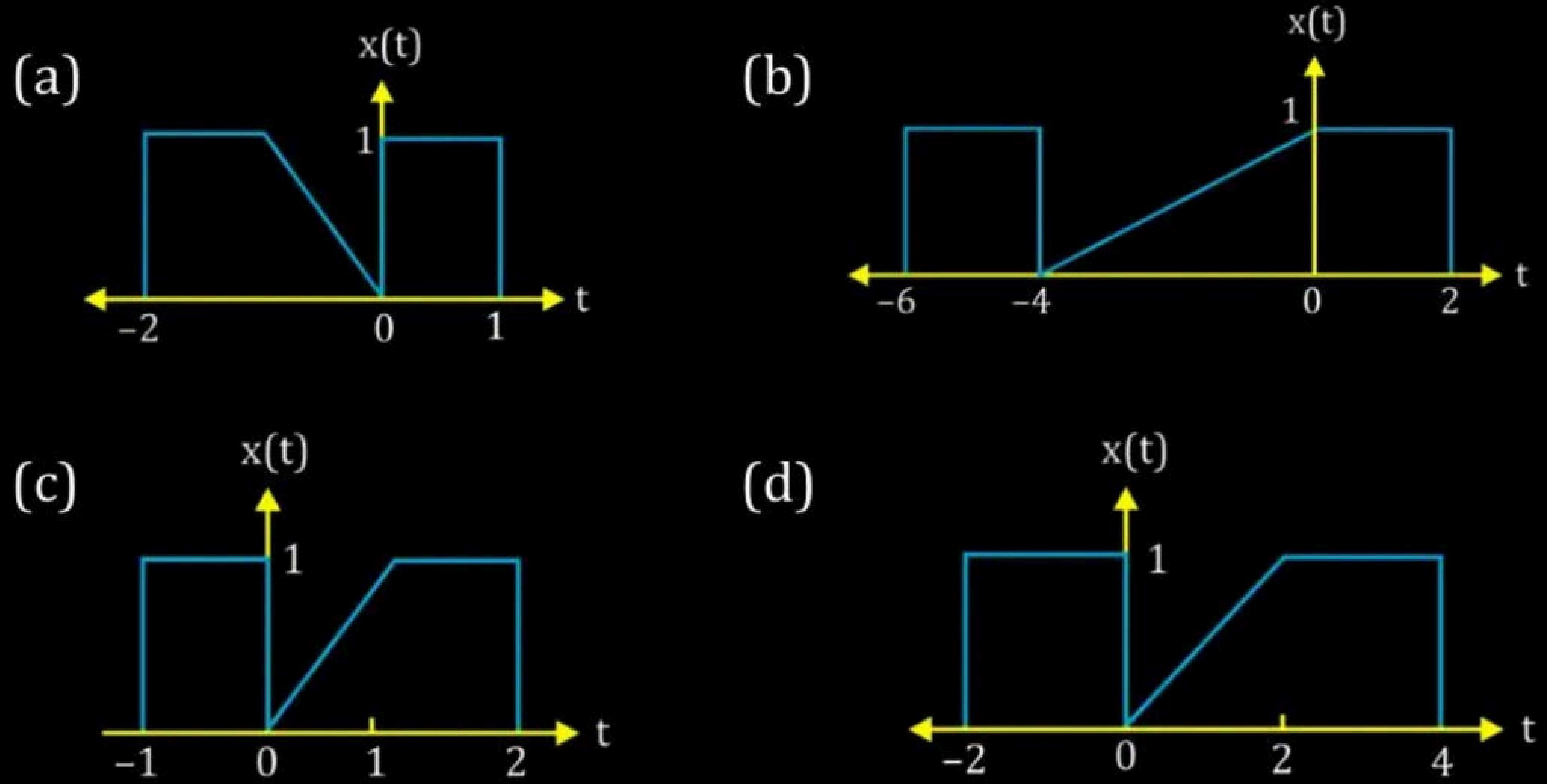


Q. A signal $x(t)$ is transformed into another signal $y(t)$ given as

TRY $y(t) = x\left(1 - \frac{t}{2}\right)$



The waveform of the original signal $x(t)$ is



(a)
x(t)
1
t
−2
0
1
(b)
x(t)
1
t
−6
−4
0
2
(c)
x(t)
1
t
−1
0
1
2
(d)
x(t)
1
t
−2
0
2
4

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$$y(t) = x(-at + b) \longrightarrow x(t)$$

Discrete Time Signal

Natural D.T.S.

(not the sampled
Version C.T.S.)

Converted D.T.S.

(sampled version
of C.T.S.)

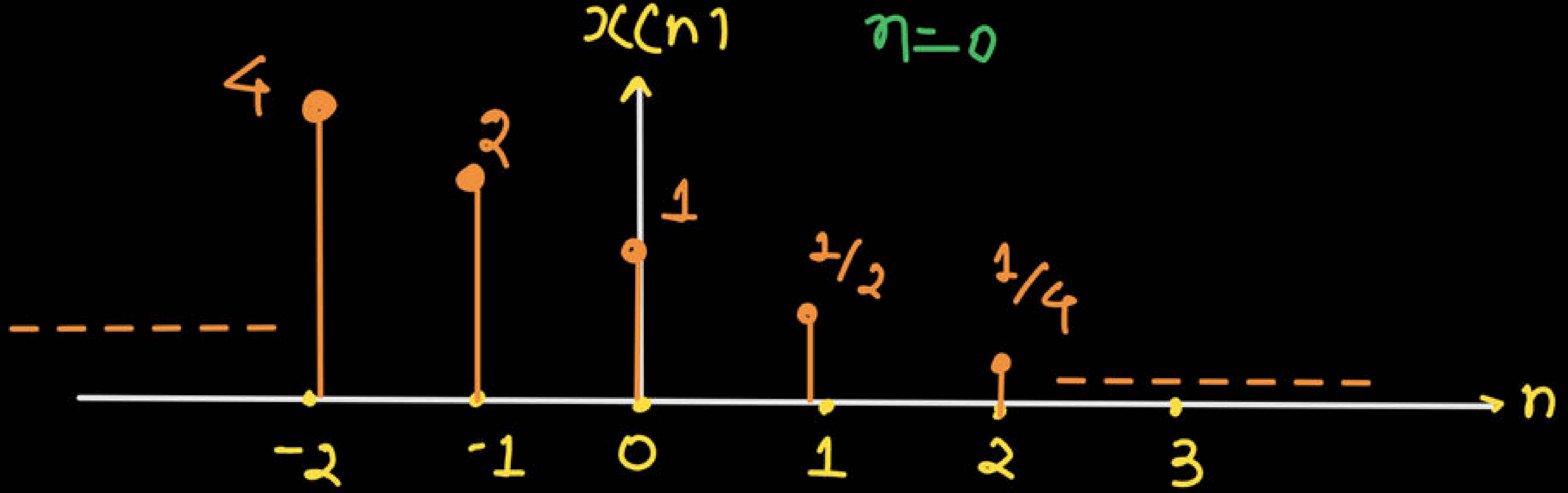
SYMBOL $X(n)$ vs n $n \in I$

Representation:

Mathematical $x(n) = \left(\frac{1}{2}\right)^n \qquad n \in I$

Sequence $x(n) = \{ - - - 4, 2, \underset{\substack{\uparrow \\ n=0}}{1}, \frac{1}{2}, \frac{1}{4} - - - - \}$

GRAPH

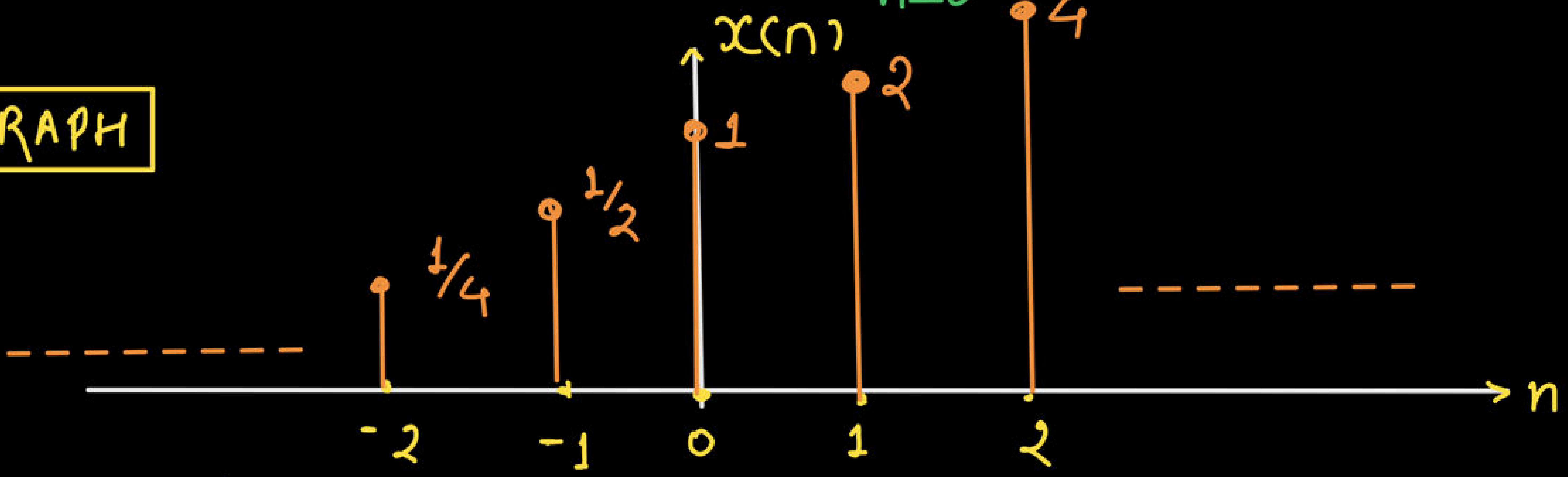


Q. $x(n) = 2^n$

SEQ $\quad x(n) = \left\{ \cdots\cdots \frac{1}{4}, \frac{1}{2}, \underset{\uparrow}{1}, 2, 4 \cdots\cdots \right\}$

$n=0$

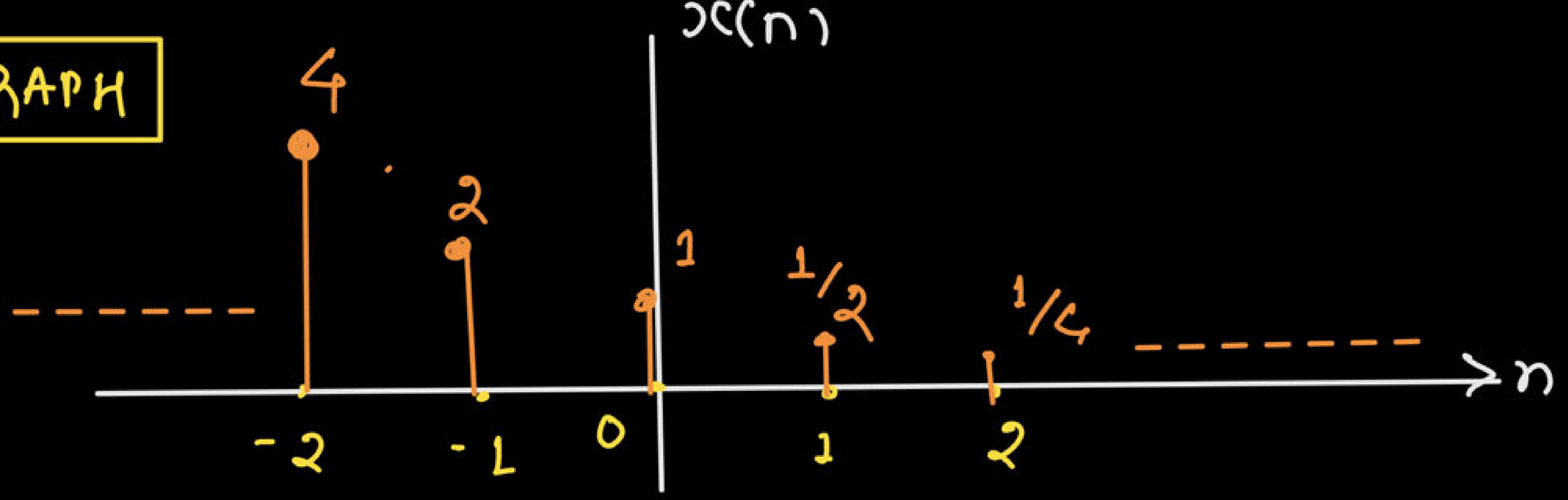
GRAPH



Q. $x(n) = \left(\frac{1}{2}\right)^n$

SEQ $x(n) = \{ \cdots 4, 2, \underset{\substack{\uparrow \\ n=0}}{1}, \frac{1}{2}, \frac{1}{4} \}$

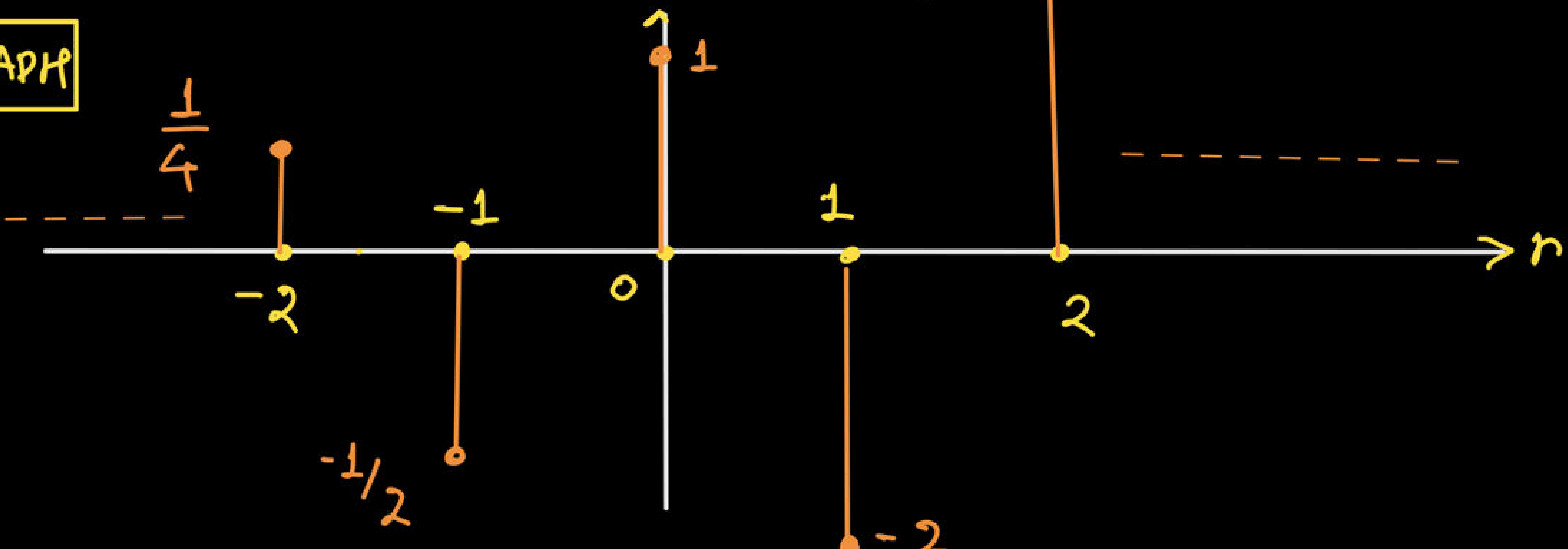
GRAPH



Q. $x(n) = (-2)^n$

SEQ. $x(n) = \left\{ \ldots\ldots \frac{1}{4}, -\frac{1}{2}, \underset{\substack{\uparrow \\ n=0}}{1}, -2, 4 \ \ldots \right\}$

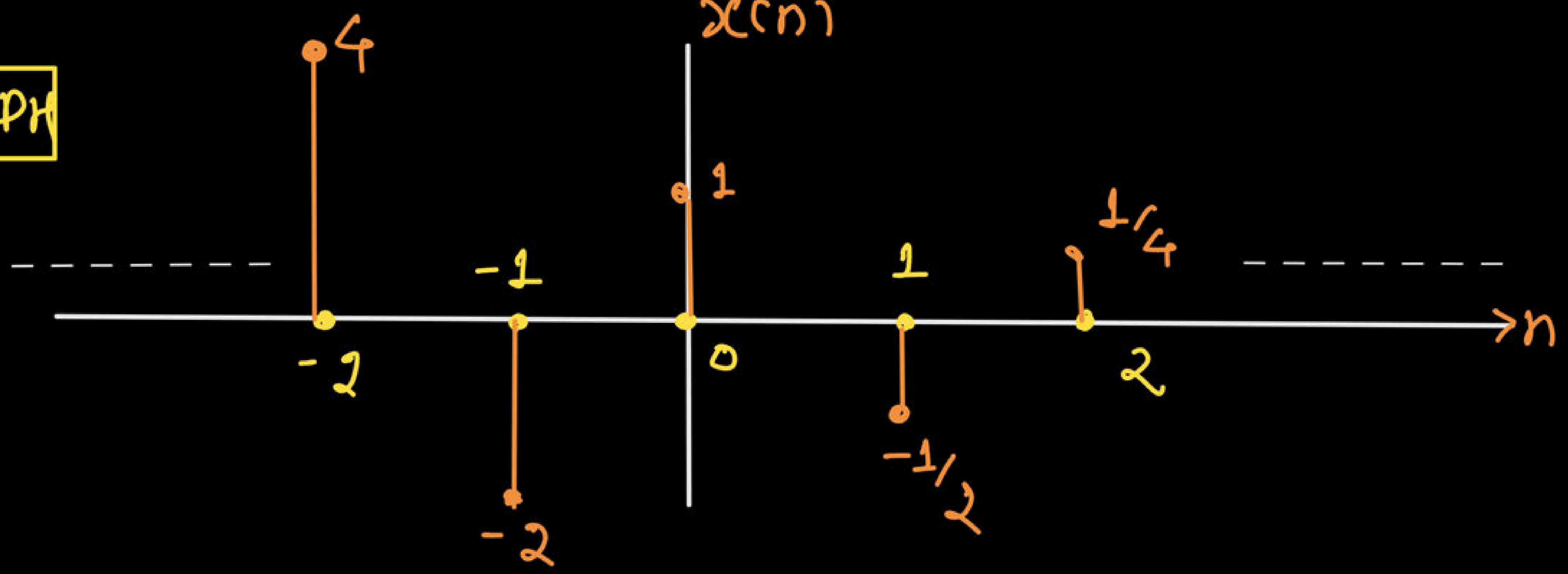
GRAPH



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

SEQ $x(n) = \left\{ \text{----} 4, -2, 1, -\frac{1}{2}, \frac{1}{4} \cdots\cdots \right\}$

GRAPH



Note $\boxed{x(n) = a^n}$

1. $0 < a < 1$
2. $-1 < a < 0$
3. $a > 1$
4. $a < -1$

Operations on D.T.S.

Operations on D.V.:

1. Amplitude Scaling:

Given : x(n) vs n

Plot : Ax(n) vs n

Ex

$$x(n) = \{1, \underset{\uparrow}{2}, 3\}$$

$$y(n) = 2x(n) = \{2, \underset{\uparrow}{4}, 6\}$$

2. Amplitude Reversal

Given : x(n) vs n

Plot : –x(n) vs n

Ex

$$x(n) = \{1, \underset{\uparrow}{2}, 3\}$$

$$y(n) = -x(n) = \{-1, \underset{\uparrow}{-2}, -3\}$$

3. Addition and subtraction of D.T.S.

$$x_1(n) = \{1, 3, \underset{\uparrow}{-2}, 4\}$$

$$x_2(n) = \{1, \underset{\uparrow}{-1}, 3, 1\}$$

$$\begin{array}{ccccc} & & \downarrow & & \\ 1 & 3 & -2 & 4 & 0 \\ 0 & 1 & -1 & 3 & 1 \\ \hline \end{array}$$

$$x_1(n) + x_2(n) = \{1, 4, \underset{\uparrow}{-3}, 7, 1\}$$

$$x_1(n) - x_2(n) = \{1 \quad 2 \quad \underset{\uparrow}{-1} \quad 1 \quad -1\}$$

Operations on I.D.V.

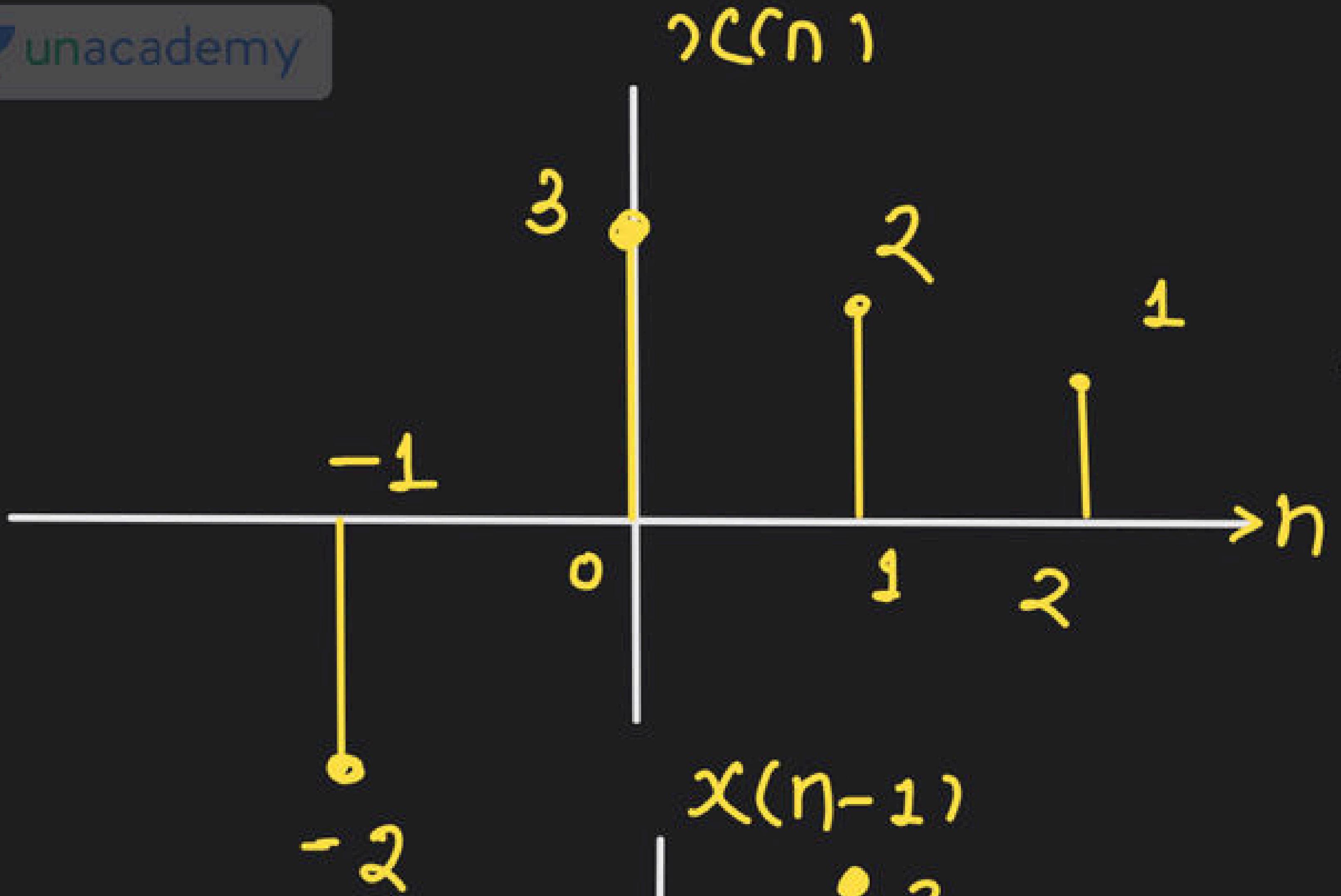
Time Shifting

Given $x(n)$ vs n

Plot $x(n - n_0)$ vs n $\longrightarrow$ Arrow Left shift by n_0

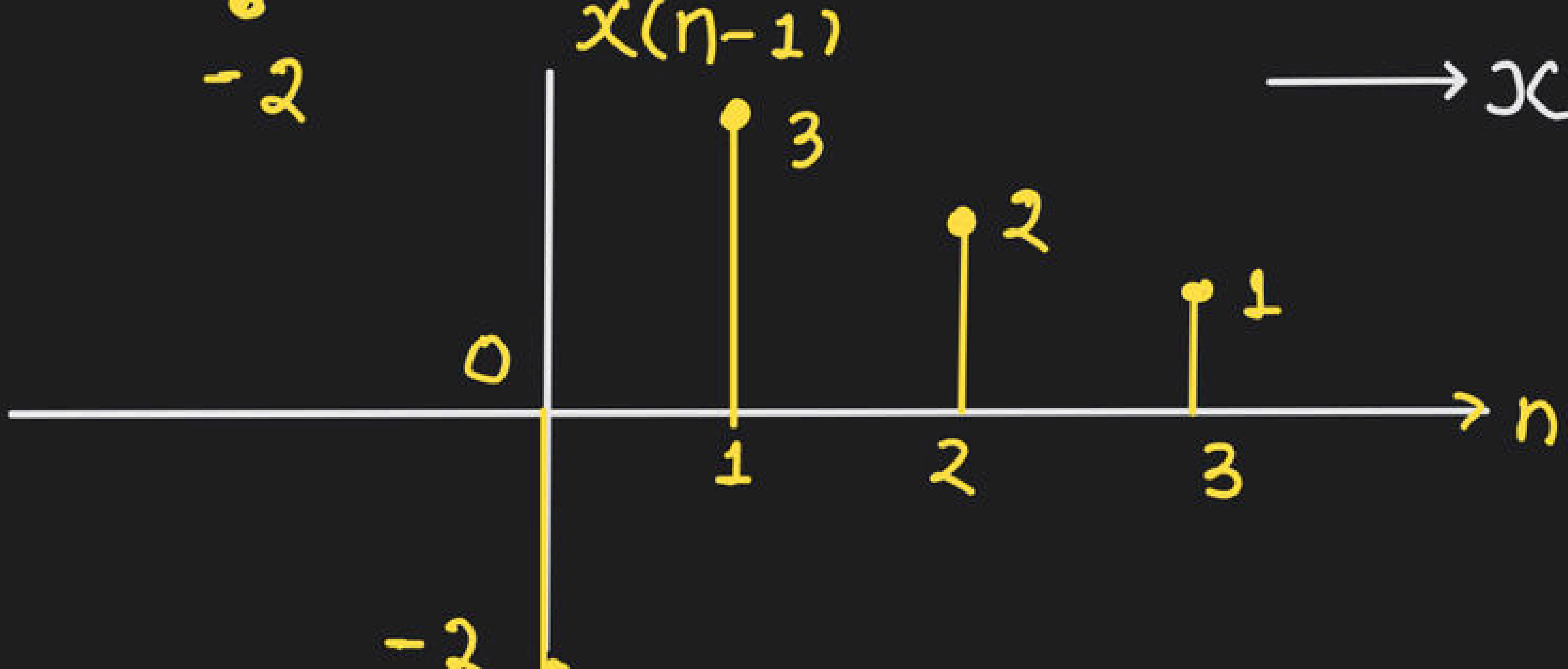
$x(n + n_0)$ vs n $\longrightarrow$ Arrow Right shift by n_0

NOTE: $n_0 \in I$



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

$n = 0$



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

$n = 0$

Q. $x(n) = \{1, 2, 3, 1, -1, -2, 3\}$

$$\underset{n=0}{\uparrow}$$

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

Q. $x(n) = \{1, 2, 3, 1, -1, -2, 3\}$

$n = 0$

$x(n-2) = \{1, 2, 3, 1, -1, -2, 3\}$

Q. $x(n) = \{1, 2, 3, 1, -1, -2, 3\}$

$\uparrow$

$n = 0$

$x(n-4) = \{0, 1, 2, 3, 1, -1, -2, 3\}$

$\uparrow$

$n = 0$

Q. $x(n) = \{1, 2, 3, \underset{\uparrow}{1}, -1, -2, 3\}$

$x(n+5) = \{1, 2, 3, 1, -1, -2, 3, 0, \underset{\uparrow}{0}\}$

TIME SCALING

Given : x(n) vs n

Plot : x(an) vs n

NOTE: $a \rightarrow \text{Rational} \rightarrow \dfrac{\text{Integer}}{\text{Integer}}$

$a \rightarrow \text{Irrational} \rightarrow \sqrt{2}, \pi$

In x(an) → Should not be irrational

CASE 1:

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

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

-2   -1   n = 0   1   2   3

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

$\frac{-2}{2}$ ✓ $\quad \frac{-1}{2}$ ✗ $\quad n = \frac{0}{2}$ ✓ $\quad \frac{1}{2}$ ✗ $\quad \frac{2}{2}$ ✓ $\quad \frac{3}{2}$ ✗

$$\boxed{y(n) = x(2n) = \{1,\ \underset{\uparrow}{3},\ -2\}}$$

$n=-1 \quad n=0 \quad n=1$

SCALING FACTOR $(a>1) \longrightarrow$ DECIMATION in Time

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Q. $x(n) = \{-4, -2, -1, \underset{\uparrow}{0}, 7, 3, 4, 1, -7, 2\}$

$$x(n) = \{-4,\ -2,\ -1,\ \underset{\uparrow}{0},\ 7,\ 3,\ 4,\ 1,\ -7,\ 2\}$$

-3 -2 -1 $n=0$ 1 2 3 4 5 6

$$x(n) = \{-4,\ -2,\ -1,\ \underset{\uparrow}{0},\ 7,\ 3,\ 4,\ 1,\ -7,\ 2\}$$

$$\frac{-3}{3}\ \checkmark \quad \frac{-2}{3}\ \times \quad \frac{-1}{3}\ \times \quad n=\frac{0}{3}\ \checkmark \quad \frac{1}{3}\ \times \quad \frac{2}{3}\ \times \quad \frac{3}{3}\ \checkmark \quad \frac{4}{3}\ \times \quad \frac{5}{3}\ \times \quad \frac{6}{3}\ \checkmark$$

$$\boxed{y(n) = x(3n) = \{-4,\ \underset{\uparrow}{0},\ 4,\ 2\}}$$

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CASE 2: $x(n) = \{1, \underset{\uparrow}{2}, 3, -3\}$

$$x(n) = \{1, \underset{\underset{n=0}{\uparrow}}{2}, 3, -3\}$$

$$x(n) = \{1,\ 2,\ 3,\ -3\}$$

$$\begin{matrix} -1 & n=0 & 1 & 2 \end{matrix}$$

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

$$\begin{matrix} -2 & -1 & n=0 & 1 & 2 & 3 & 4 \end{matrix}$$

Default Interpolation value

SCALING FACTOR $a < 1$: Interpolation in Time

Q. $x(n) = \{1 \quad \underset{\uparrow}{2} \quad 3\}$

$-1 \quad n=0 \quad 1$

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

$n=-3 \quad -2 \quad -1 \quad n=0 \quad 1, \quad 2 \quad n=3$

Q. $x(n) = \{1,\ 2,\ \underset{\uparrow}{-1},\ 3,\ 7,\ 5,\ 2\}$

$$x(n) = \{1,\ 2,\ \underset{\uparrow}{-1},\ 3,\ 7,\ 5,\ 2\}$$

$-2 \quad -1 \quad n=0 \quad 1 \quad 2 \quad 3 \quad 4$

$$x(n) = \{1,\ 2,\ \underset{\uparrow}{-1},\ 3,\ 7,\ 5,\ 2\}$$

$\frac{4}{3} \times$	-2	-1	$n=0$	1	2	3	4
	$-8/3$	$-4/3$	0	$4/3$	$8/3$	4	$16/3$
	×	×	✓	×	×	✓	×

$$x\left(\frac{3n}{4}\right) = \{\underset{\uparrow}{-1},\ 0,\ 0,\ 0,\ 5\}$$

$n=0 \quad 1 \quad 2 \quad 3 \quad n=4$

$$\boxed{a = \frac{3}{4}}$$

CASE 1

$$x(n) \xrightarrow{\text{DECIMATE}} x(3n) \xrightarrow{\text{Interpolate}} x\left(\frac{3n}{4}\right)$$

$$x(n) = \{1,\ 2,\ -1,\ 3,\ 7,\ 5,\ 2\}$$

$-2 \quad -1 \quad n=0 \quad 1 \quad 2 \quad 3 \quad 4$

$$x(3n) = \{-1,\ 5\}$$

$n=0 \quad 1$

$$x\left(\frac{3n}{4}\right) = \{-1,\ 0,\ 0,\ 0,\ 5\}$$

$n=0 \qquad n=4$

CASE 2

$$x(n) \xrightarrow{\text{Interpolate}} x\left(\frac{n}{4}\right) \xrightarrow{\text{Decimate}} x\left(3\left(\frac{n}{4}\right)\right)$$

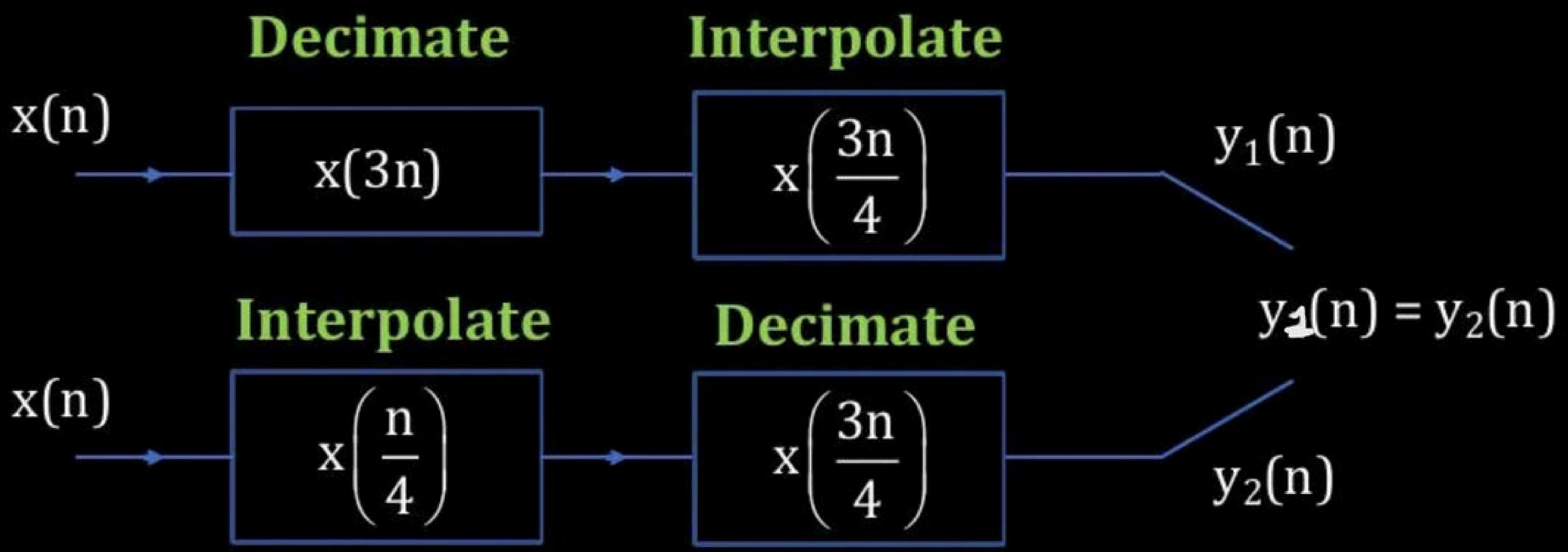
$$x(n) = \{1,\ 2,\ \underset{\uparrow}{-1},\ 3,\ 7,\ 5,\ 2\}$$

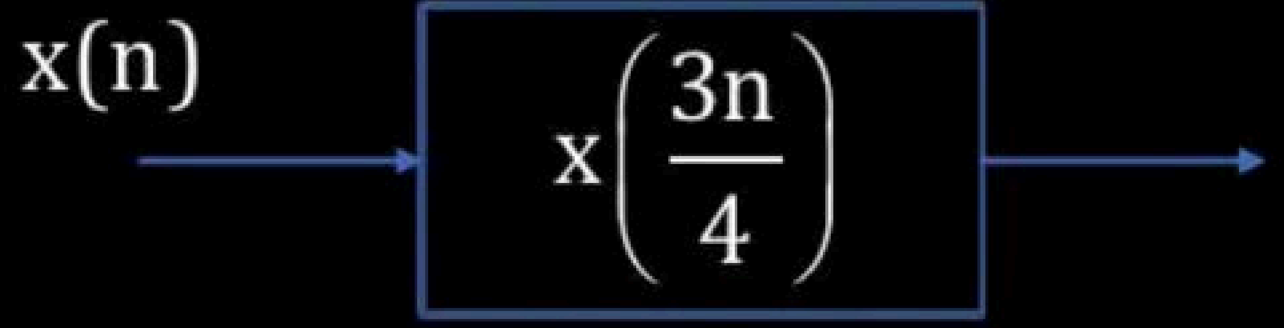
$-2 \quad -1 \quad n=0 \quad 1 \quad 2 \quad 3 \quad 4$

$$x\left(\frac{n}{4}\right) = \{1,0,0,0,2,0,0,0,\underset{\substack{\uparrow \\ n=0}}{-1},0,0,0,3,0,0,0,7,0,0,0,5,0,0,0,2\}$$

$$x\left(\frac{3n}{4}\right) = \{0,\ 0,\ \underset{\uparrow}{-1},\ 0,\ 0,\ 0,\ 5\} = \{\underset{\uparrow}{-1},\ 0,\ 0,\ 0,\ 5\}$$

NOTE





"divide Horizontal axis by $\frac{3}{4}$ or multiply by 4/3."

Q. $x(n) = \{1,\ 2,\ 1,\ 1\}$

$$\begin{array}{cccc} -1 & n = 0 & 1 & 2 \end{array}$$

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Time Reversal:

Given : x(n) vs n

Plot : x(−n) vs n

$$x(n) = \{1 \quad 1 \quad -2 \quad -3 \quad 4\}$$

Mixed operation:

Given : $x(n)$ vs n

Plot : $x(-an + b)$ vs n

Ex: $x(-3n + 2)$

Natural order:

Other order:

Q. $x(n) = \{1 \quad 1 \quad 2 \quad 3 \quad -1 \quad 4 \quad 5\}$ $\boxed{x(-2n+3) = ?}$

STANDARD D.T. SIGNALS

1. Unit Impulse Sequence

1. Symbol

2. Definition

Q. $\delta[-2n + 4]$

$\delta(t)$ vs $\delta[n]$

1. $\delta(n)$ is not sampled version of $\delta(t)$

2.

PARAMETER	$\delta(t)$	$\delta[n]$
Duration	Finite	Finite
Amplitude at B.P.	Infinite	Finite

PROPERTIES

Q.

$$\sum_{K=-\infty}^{3} \delta(2K-6)$$

Q. $\sum_{K=-5}^{-1} \delta(-K-1)$

Q. $$S=\sum_{n=3}^{-1} n^2\delta(n-1)$$

Q. $$S=\sum_{n=-\infty}^{-1}\sin\left(\frac{n\pi}{2}\right)\delta(-n-1)$$

SYNTHESIS & ANALYSIS

Analysis

Synthesis

UNIT STEP SEQUENCE

Symbol:

Definition:

GRAPH u[n] is sampled version of u(t)

NOTE

RELATION BETWEEN u[n] and δ[n]

Logical understanding

Conclusion

Q. $x(n) = 1 - \sum_{k=1}^{\infty} \delta(n-k-1) = u[Mn - N]$ Calculate

$M = ?$ and $N = ?$

Q. $$1-\sum_{k=-\infty}^{n+2}\delta(k)=u(Mn+N)$$

$M = ?$

$N = ?$

Synthesis and Analysis

Synthesis

CASE 1: Finite Duration signal:

- STUFF/PAD   0 at the start and end of seq.

unacademy

CASE 2: Infinite Duration signal

unacademy

Analysis:

Q. $x(n) = 3u(n + 3) - 4u(n - 1) + 6u(n - 3) - 5u(n - 5)$

UNIT RAMP SEQUENCE

1. SYMBOL

2. Definition

3. Graph

4. SEQUENCE:

SIGNAL SYSTEM

DPP -03

Vishal Soni Sir
ESE AIR 25

Q. For a signal $x(t) = u(t + 2) - 2u(t) + u(t - 2)$ the waveform is

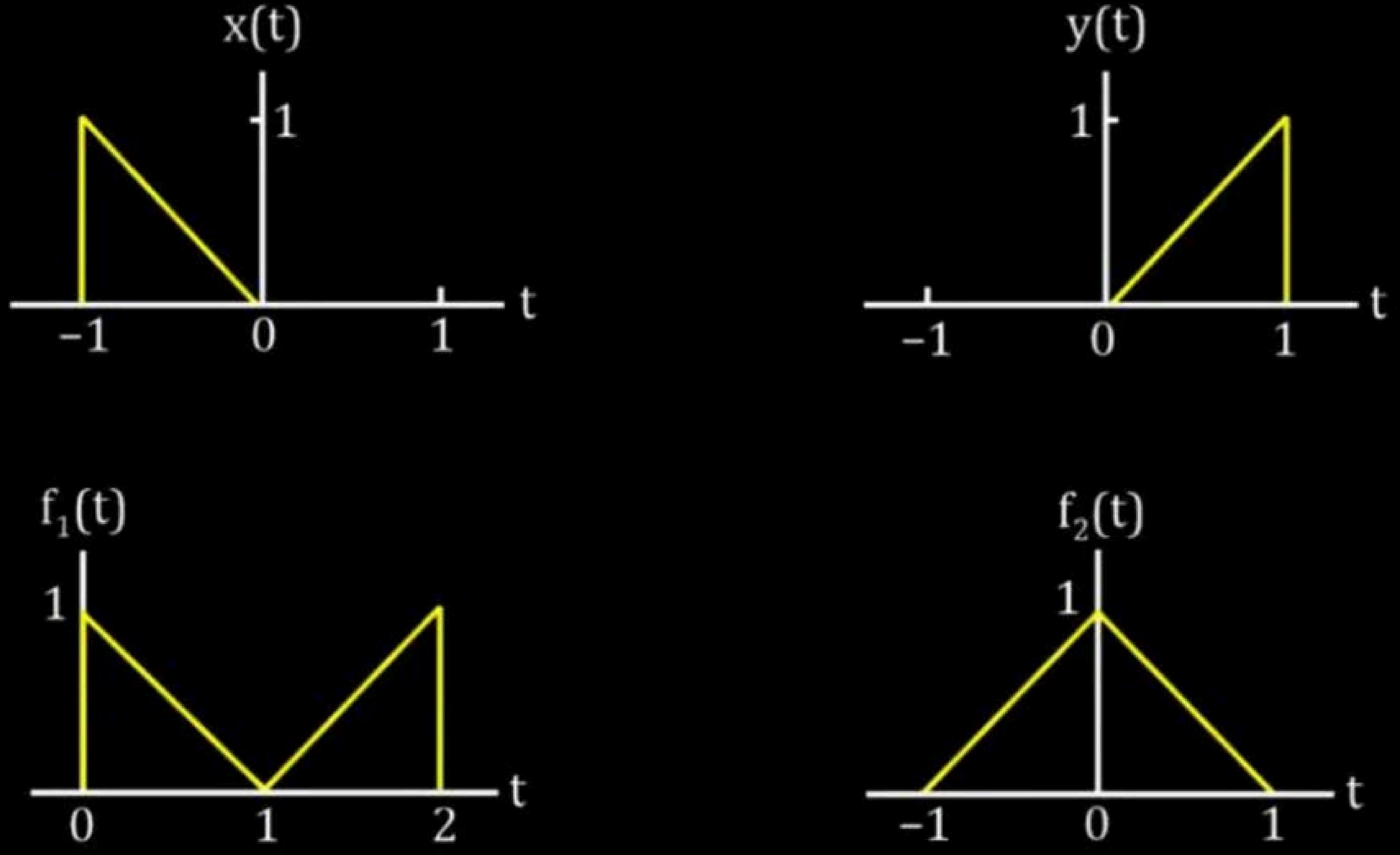
Q. Which of the following is correct waveform of a signal x(t) given as below

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

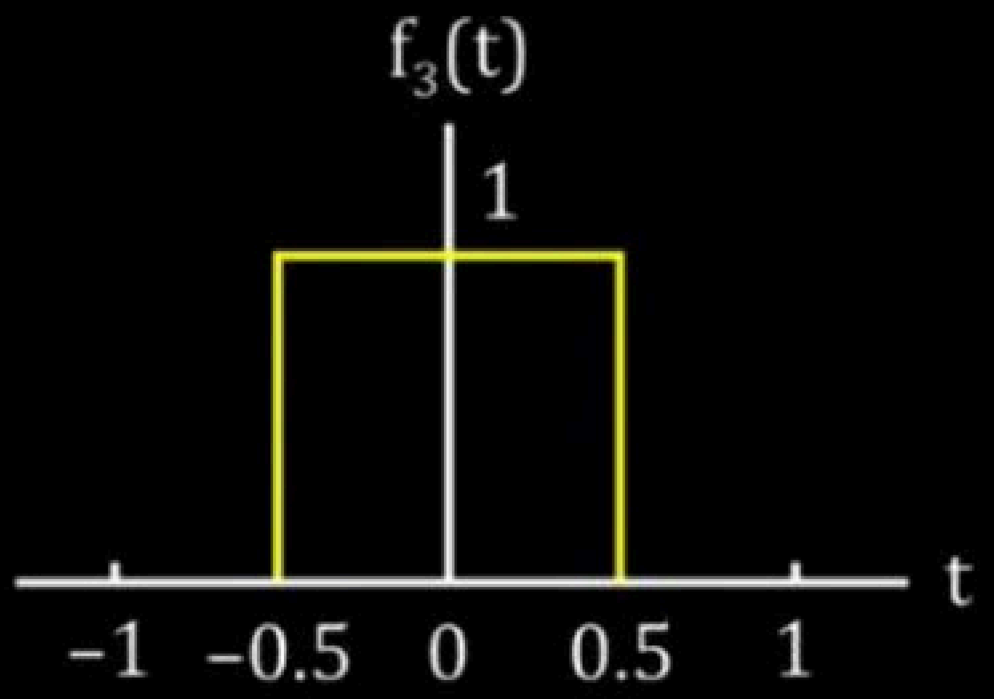
Q. Consider a signal x(t) which is a linear combination of ramp signals given as

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

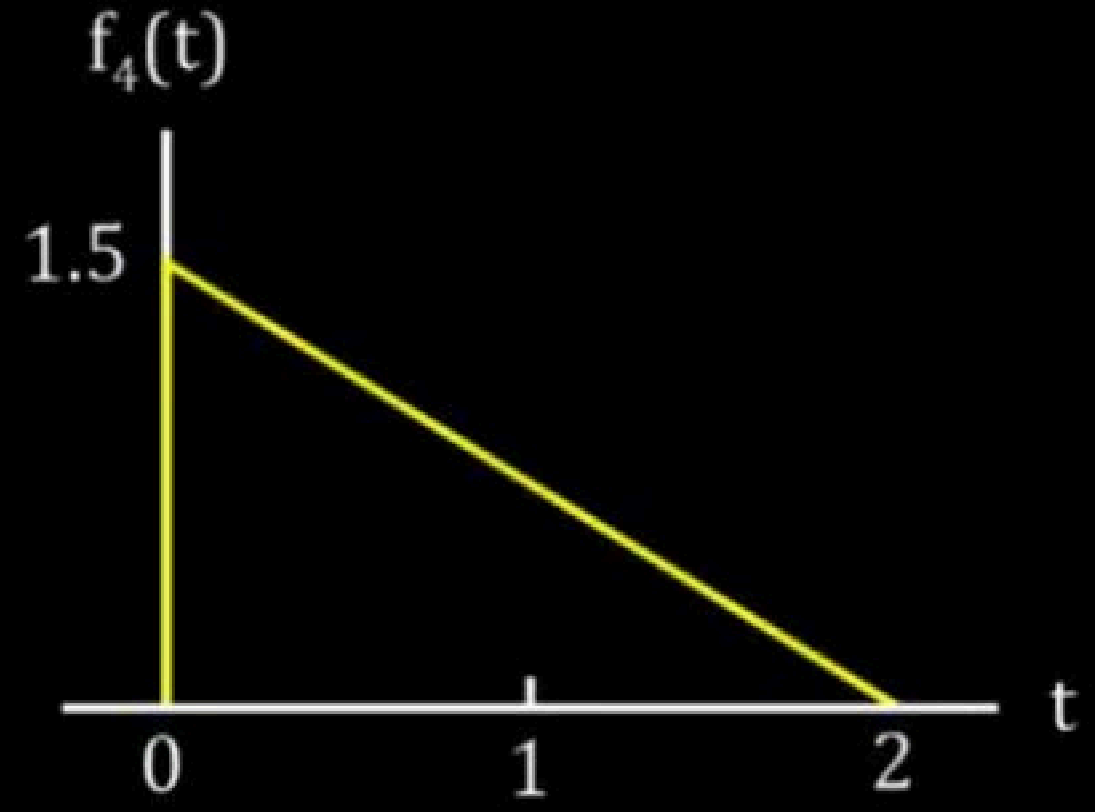
The correct waveform of x(t) is



x(t)
1
t
−1
0
1
y(t)
1
t
−1
0
1
f1(t)
1
t
0
1
2
f2(t)
1
t
−1
0
1



$f_3(t)$
1
t
−1
−0.5
0
0.5
1



$f_4(t)$
1.5
t
0
1
2

Q. The signal $f_1(t)$ can be expressed as

A. $x(t-1)+y(t+1)$

B. $x(t-1)+y(t-1)$

C. $x(t+1)+y(t+1)$

D. $x(t+1)+y(t-1)$

Q. The signal $f_2(t)$ can be expressed as

A. $x(t-1)+y(t+1)$

B. $x(t-1)+y(t-1)$

C. $x(t+1)+y(t+1)$

D. $x(t+1)+y(t-1)$

Q. The signal $f_3(t)$ can be expressed as

A. $x(t-0.5)+y(t+0.5)$

B. $x(t+0.5)+y(t+0.5)$

C. $x(t-0.5)+y(t-0.5)$

D. $x(t+0.5)+y(t-0.5)$

Q. The signal $f_4(t)$ can be expressed as

A. $1.5x(2t-2)$

B. $1.5x\left(\frac{t-1}{2}\right)$

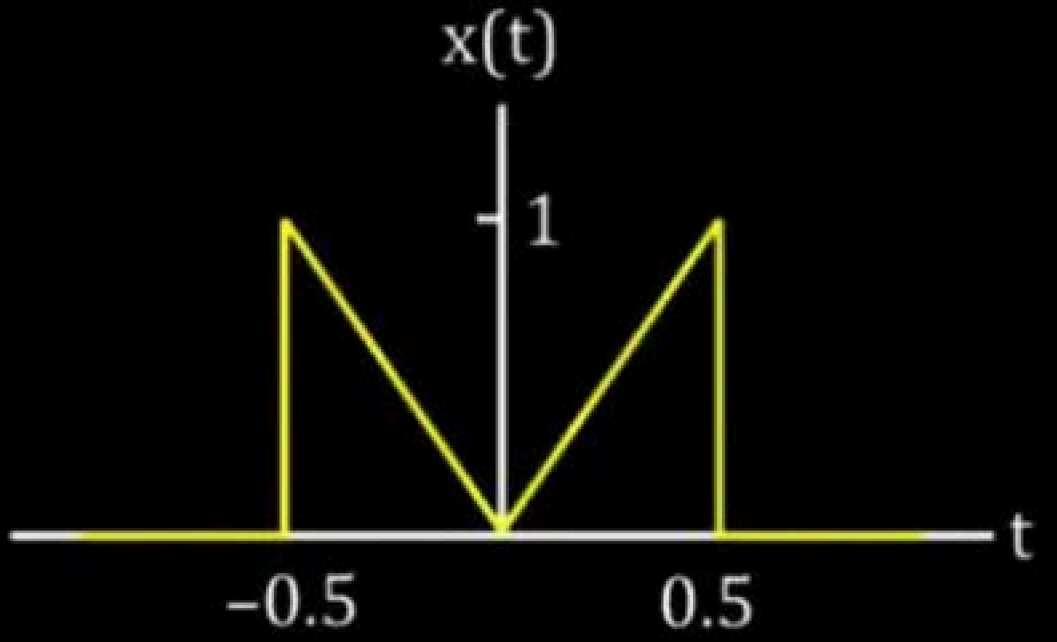
C. $1.5x(2t-1)$

D. $1.5x\left(\frac{t}{2}-1\right)$

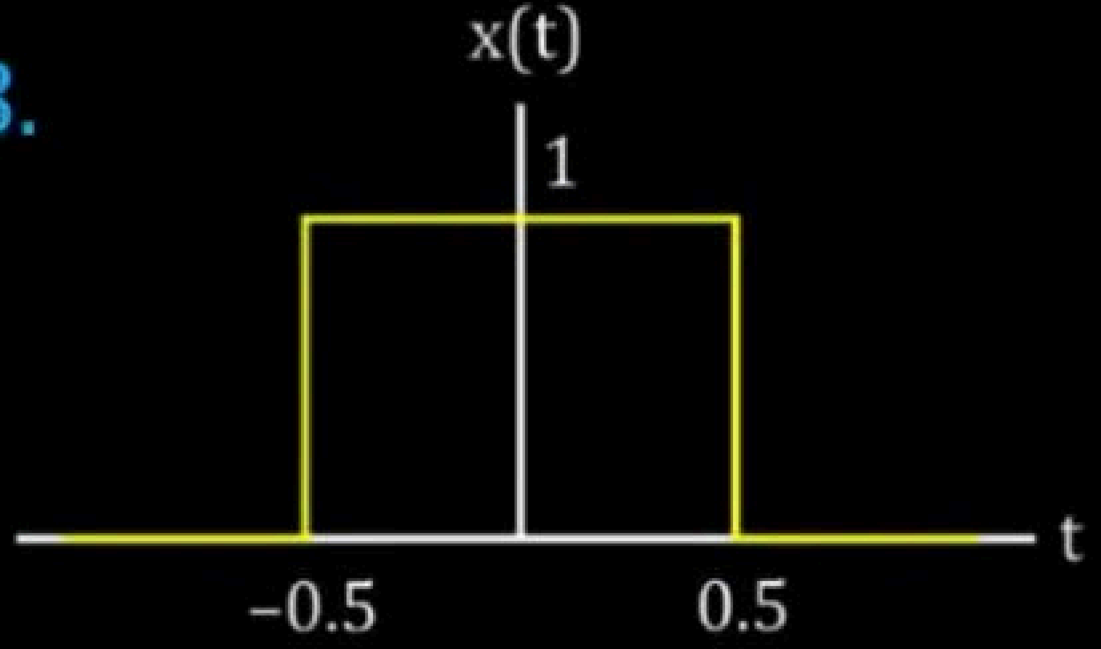
Q. Consider the function $x(t) = u\left(t+\frac{1}{2}\right) \text{ramp}\left(\frac{1}{2}-t\right)$.

The graph of x(t) is

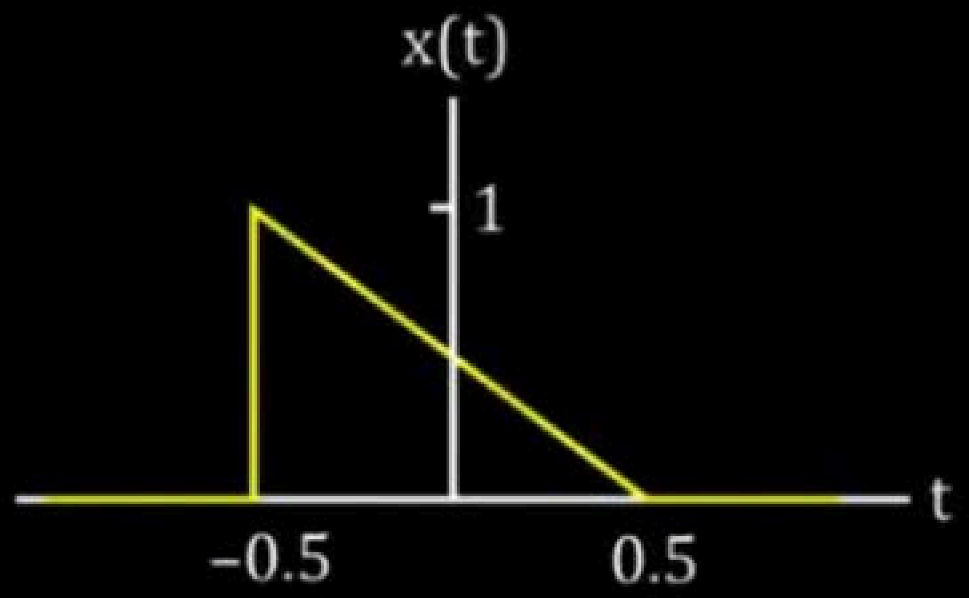
A.



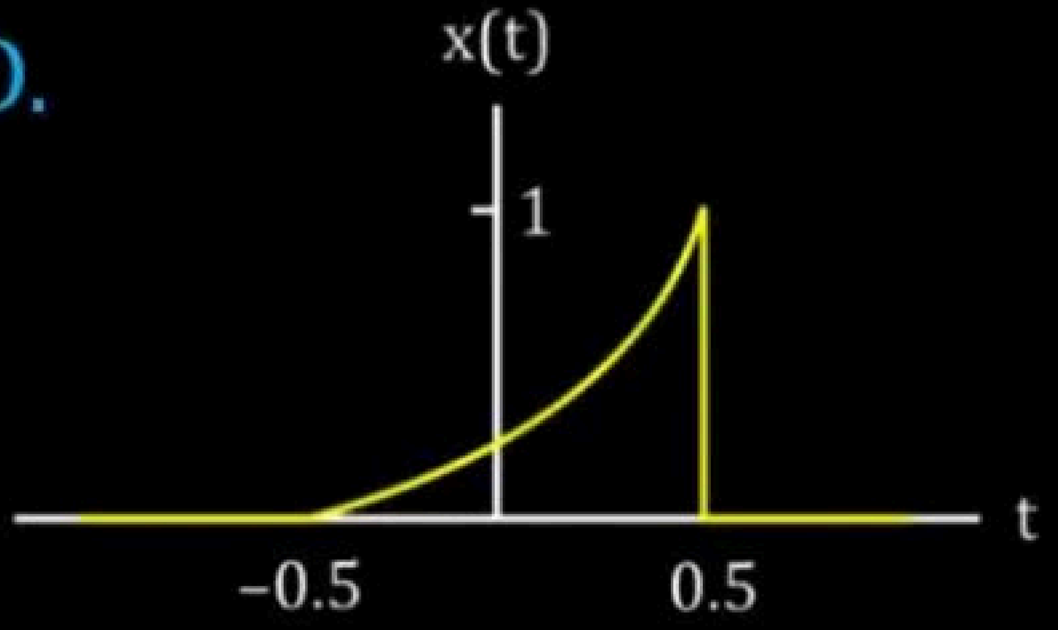
B.



C.

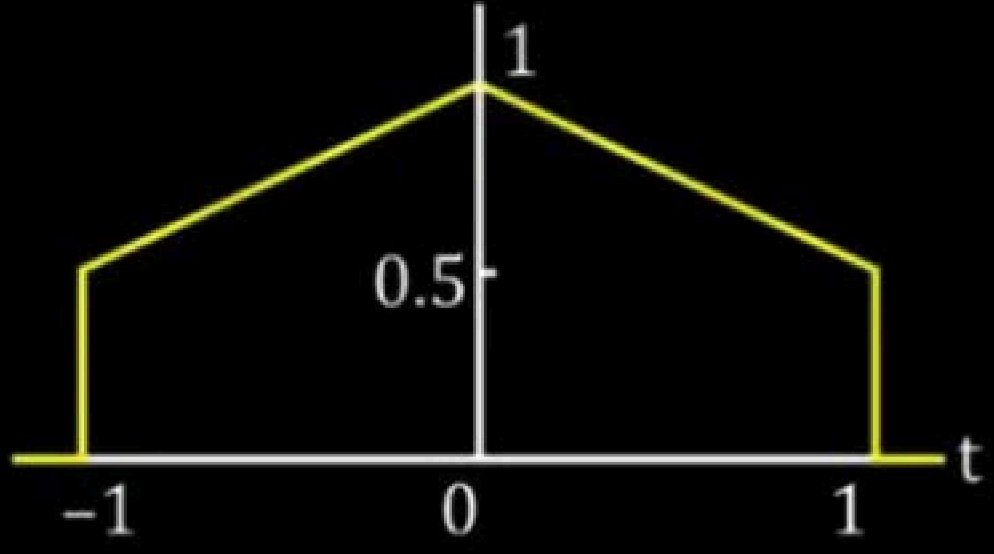


D.

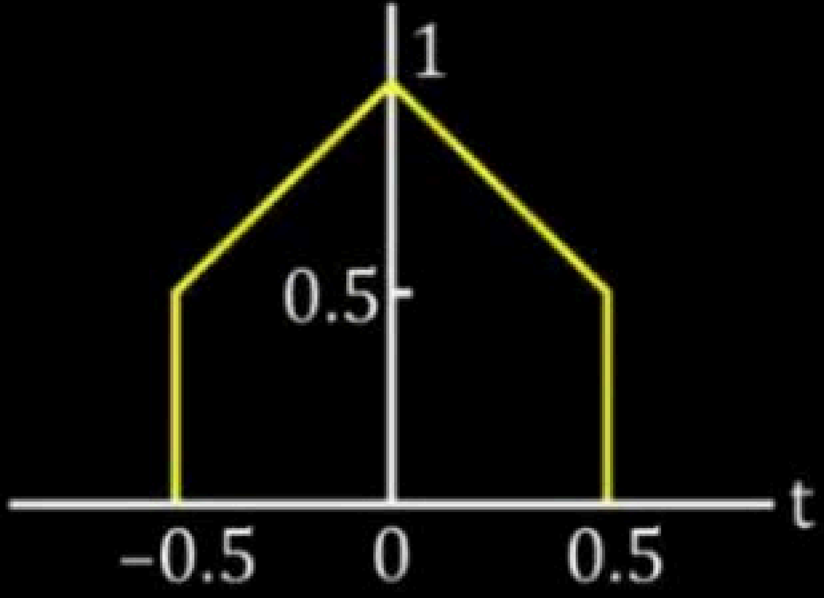


Q. Consider the signal $x(t) = \text{rect}(t)\text{tri}(t)$. The graph of $x(t)$ is

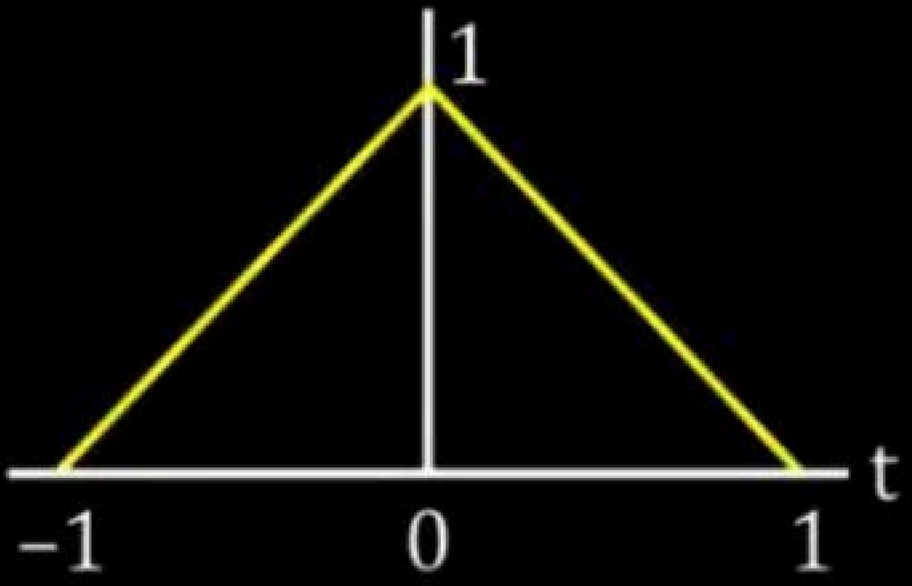
A.



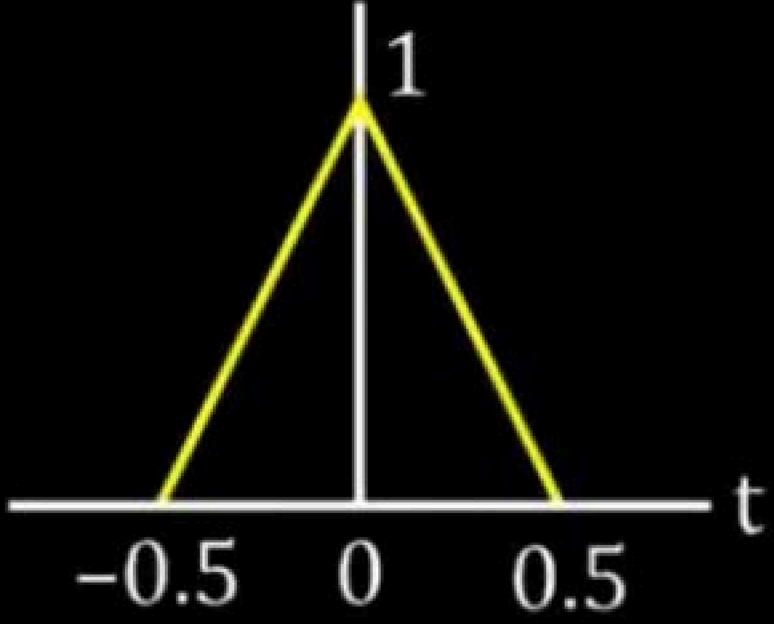
B.



C.

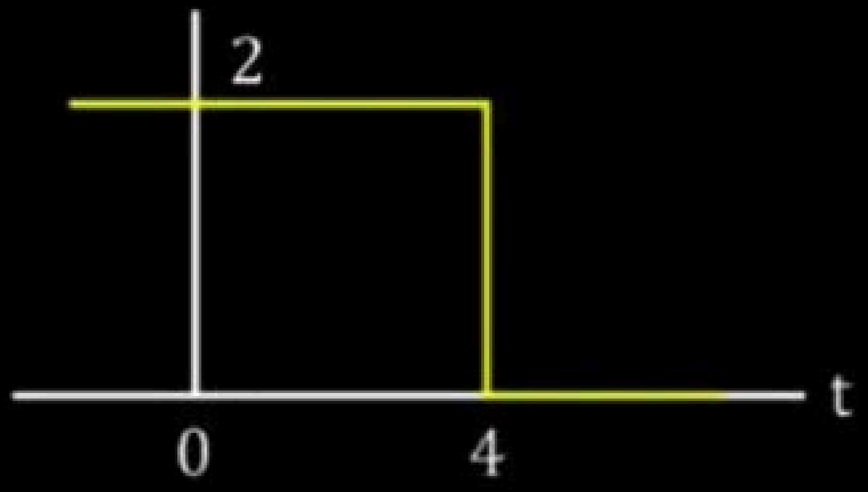


D.

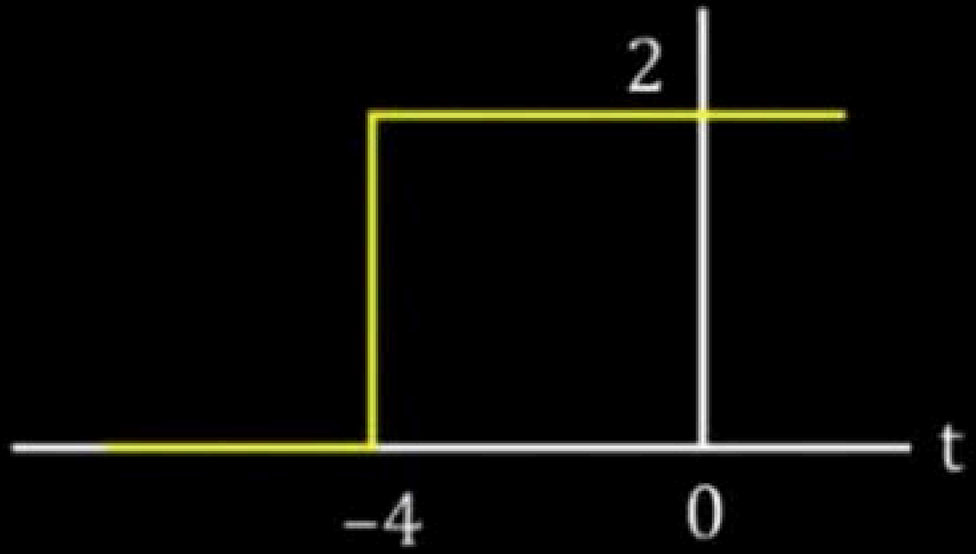


Q. A function is defined as $x(t) = 1 + \text{sgn}(4 - t)$. The graph of $x(t)$ is

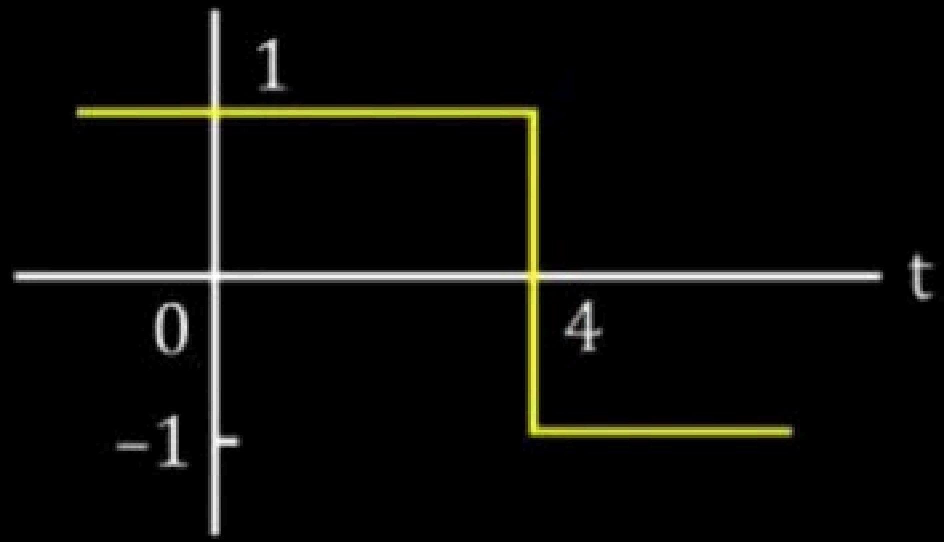
A.



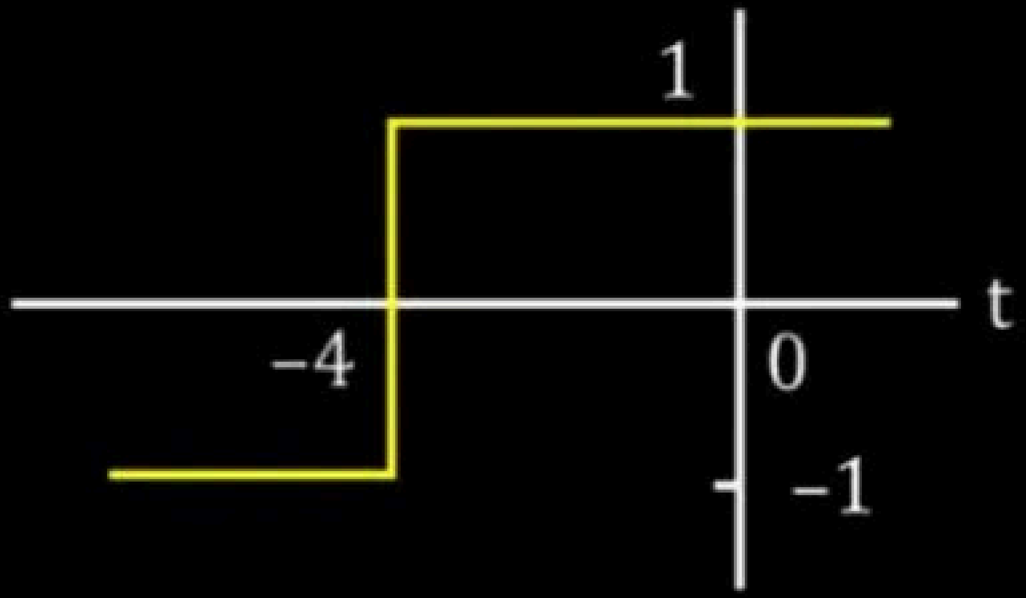
B.



C.



D.



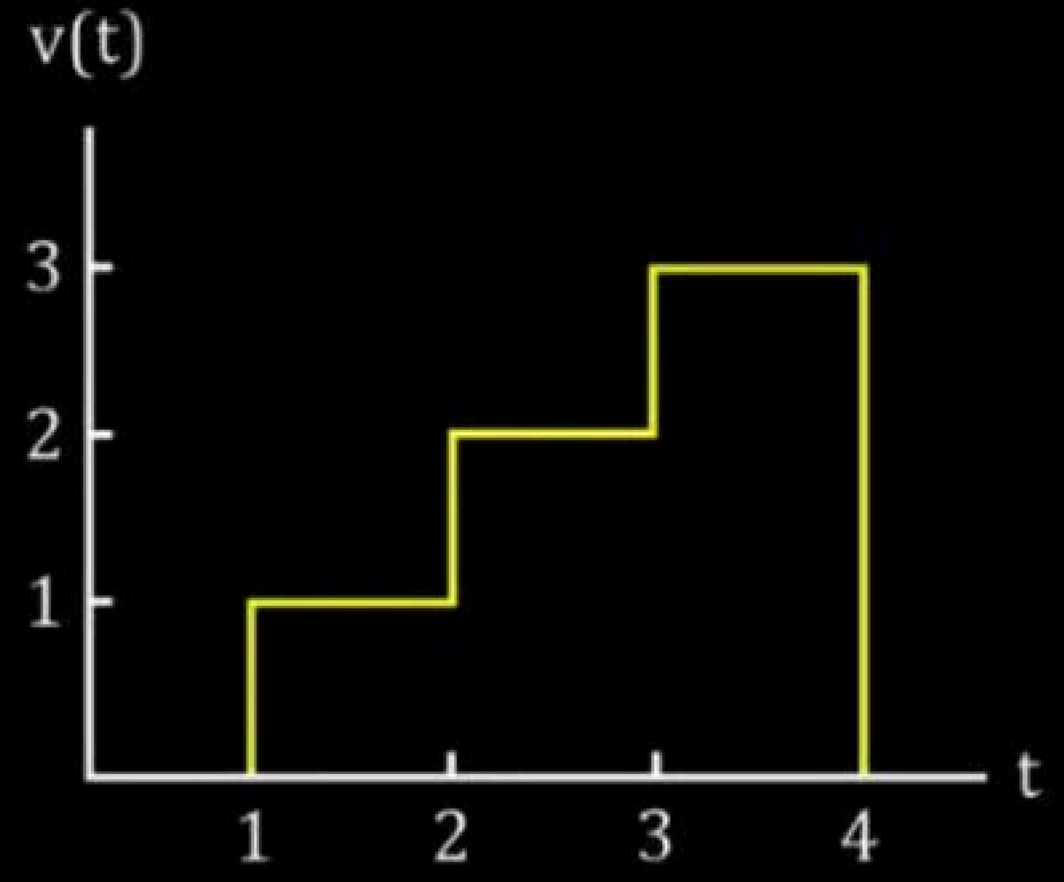
Q. Consider the voltage waveform shown below. The equation for v(t) is

A. $u(t-1)+u(t-2)+u(t-3)$

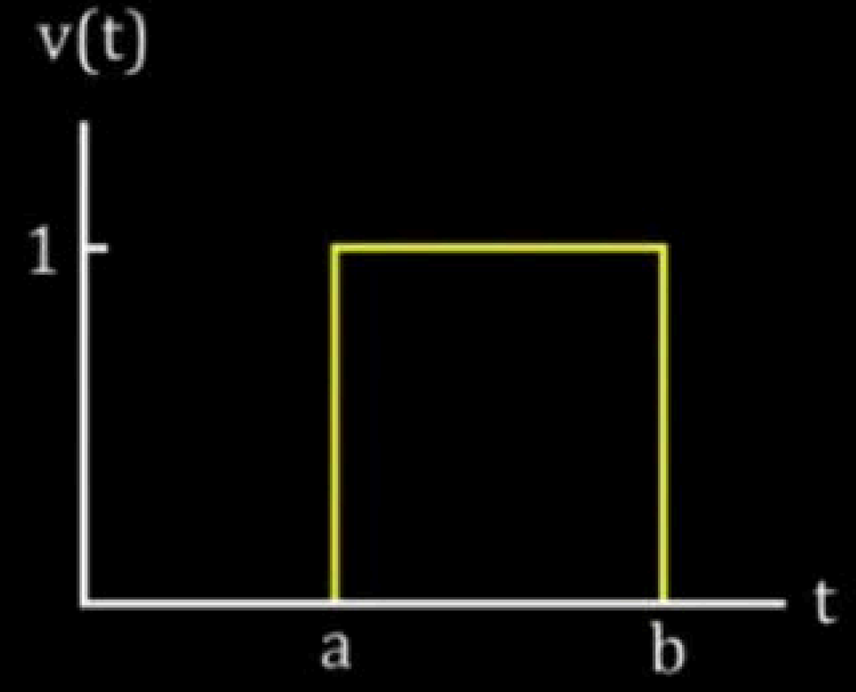
B. $u(t-1)+2u(t-2)+3u(t-3)$

C. $u(t-1)+u(t-2)+u(t-2)$

D. $u(t-1)+u(t-2)+u(t-3)-3u(t-4)$



Q. Consider the following function for the rectangular voltage pulse shown below



(1) $v(t) = u(a - t) \times u(t - b)$

(2) $v(t) = u(b - t) \times u(t - a)$

(3) $v(t) = u(t - a) - u(t - b)$

The function that describe the pulse are

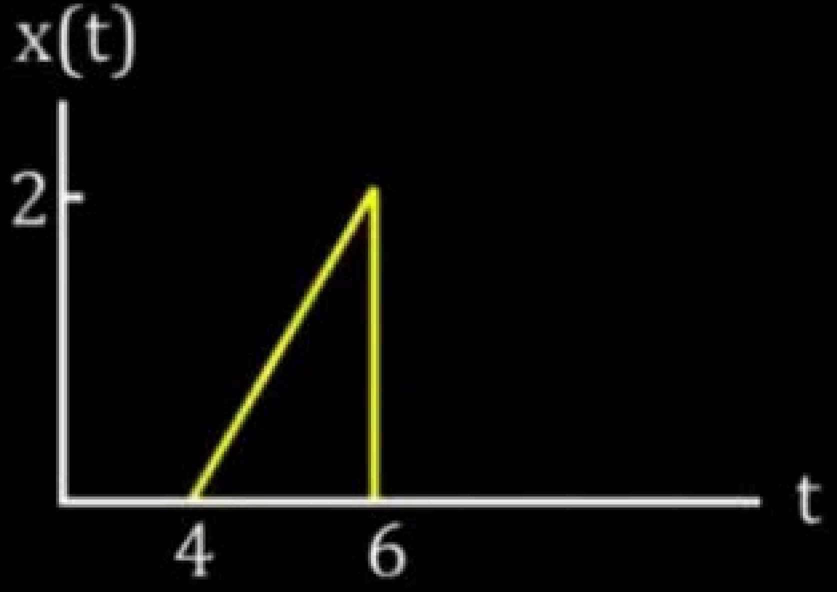
A. 1 and 2

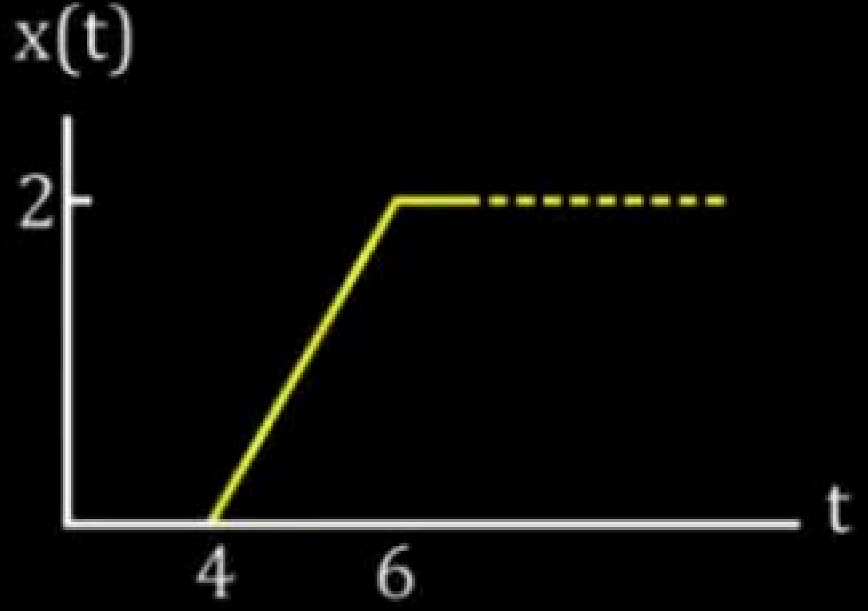
B. 2 and 3

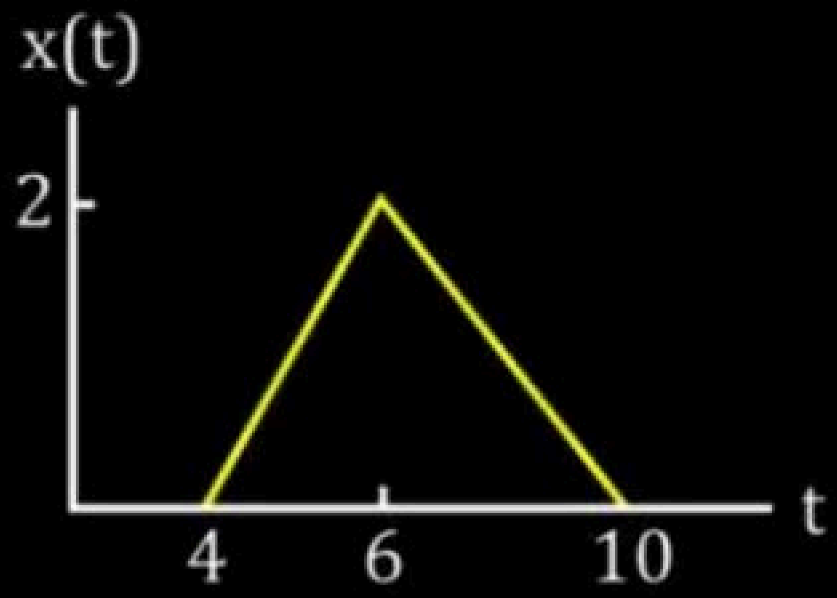
B. 1 and 3

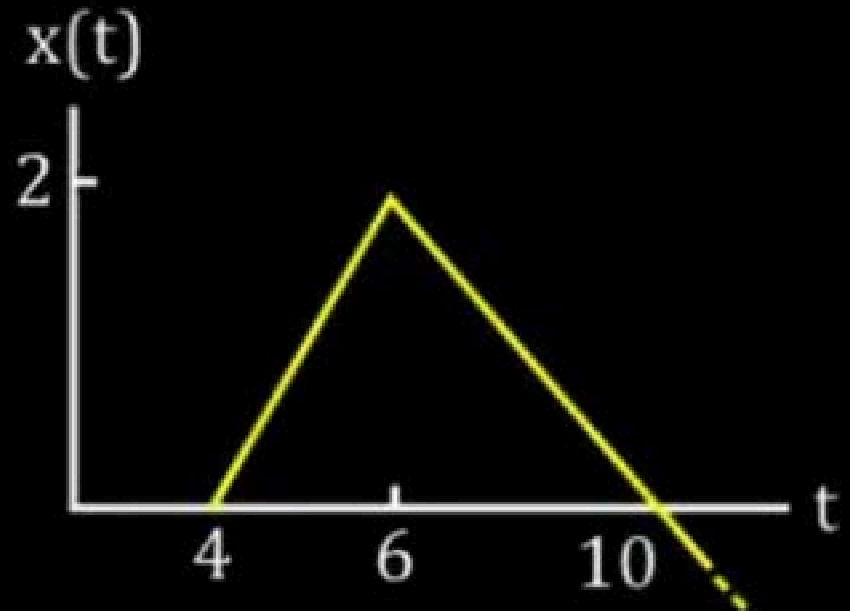
D. all

Q. A signal is described by $x(t) = r(t-4) - r(t-6)$, where $r(t)$ is a ramp function starting at $t = 0$. The signal $x(t)$ is represented as

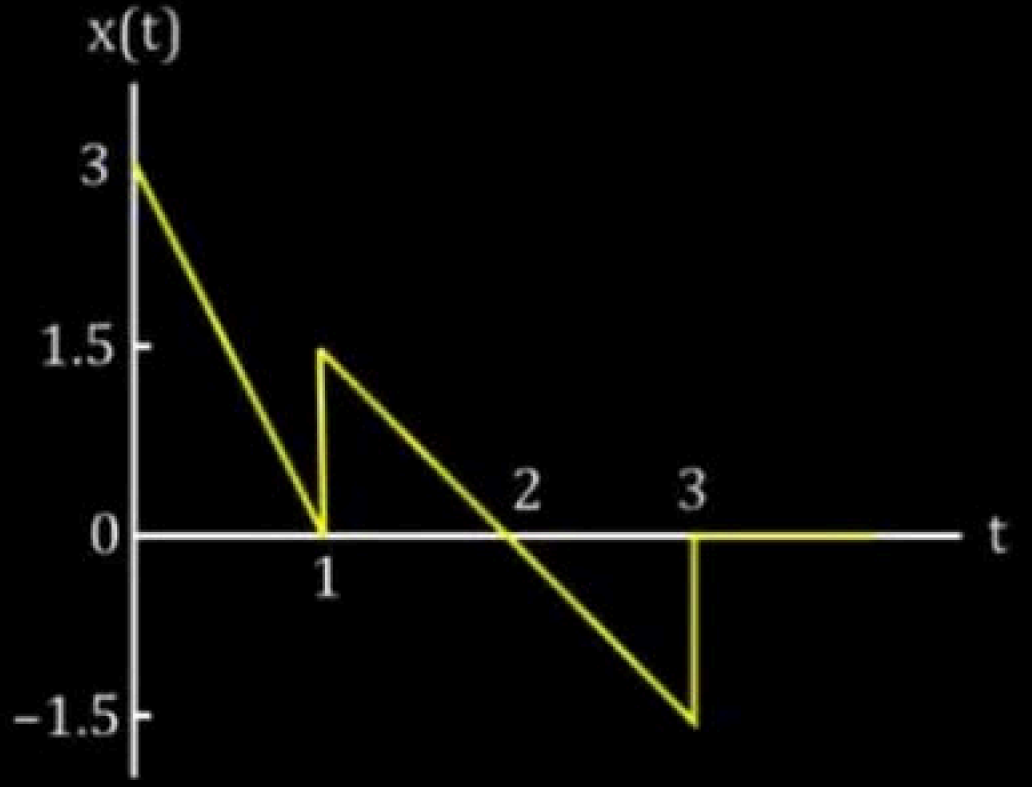
A.


B.


C.


D.


Q. For the waveform shown in figure the equation is



A. $-3tu(t) + 1.5(t-2)u(t-1) + 1.5(t-3)u(t-3)$

B. $3(2-t)u(t) + 1.5(t-2)u(t-1) + 1.5(t-3)u(t-3)$

C. $3(1-t)u(t) + 1.5tu(t-1) + 1.5(t-2)u(t-3)$

D. None of these

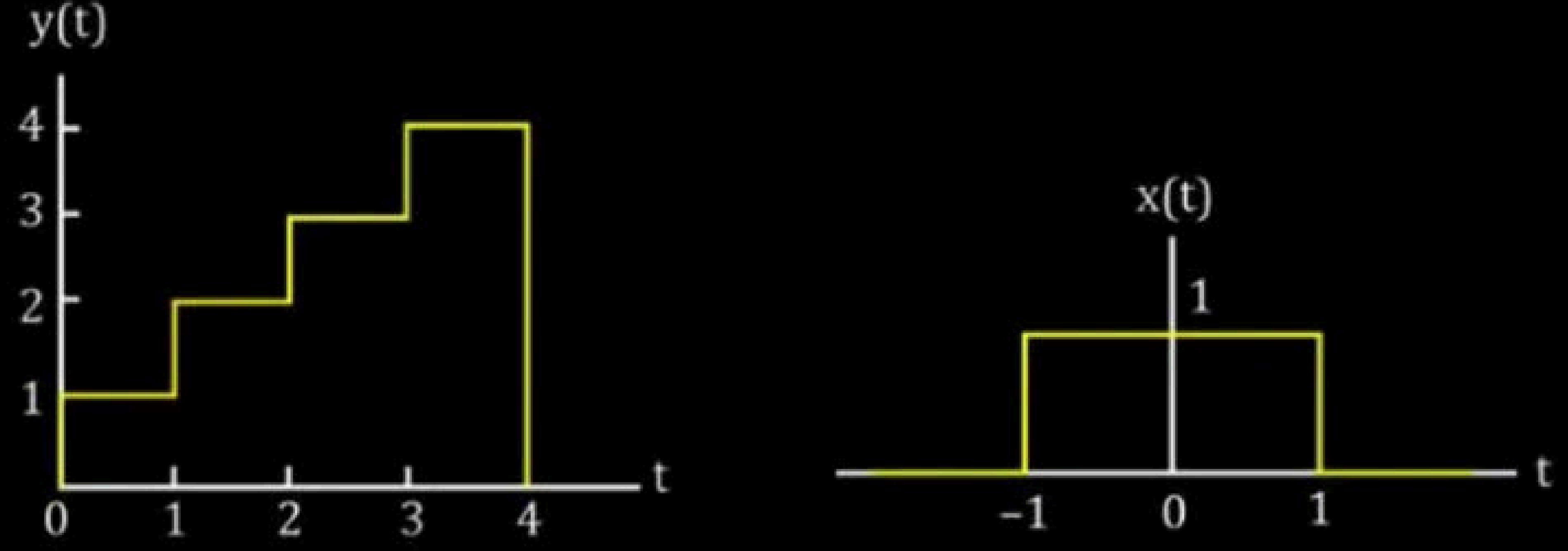
Q. For the signal $x(t) = u(t+1) - 2u(t-1) + u(t-3)$, the correct wave form is

Q. For the signal $x(t) = u(t) + u(t+1) - 2u(t+2)$, the correct waveform is

Q. For the signal $x(t) = 2(t-1)u(t-1) - 2(t-2)u(t-2) + 2(t-3)u(t-3)$ the correct waveform is

Q. For the signal $x(t) = (t+1)u(t-1) - tu(t) - u(t-2)$ the correct waveform is

Q. Consider the two signal shown in figure



The signal y(t) can be explained as

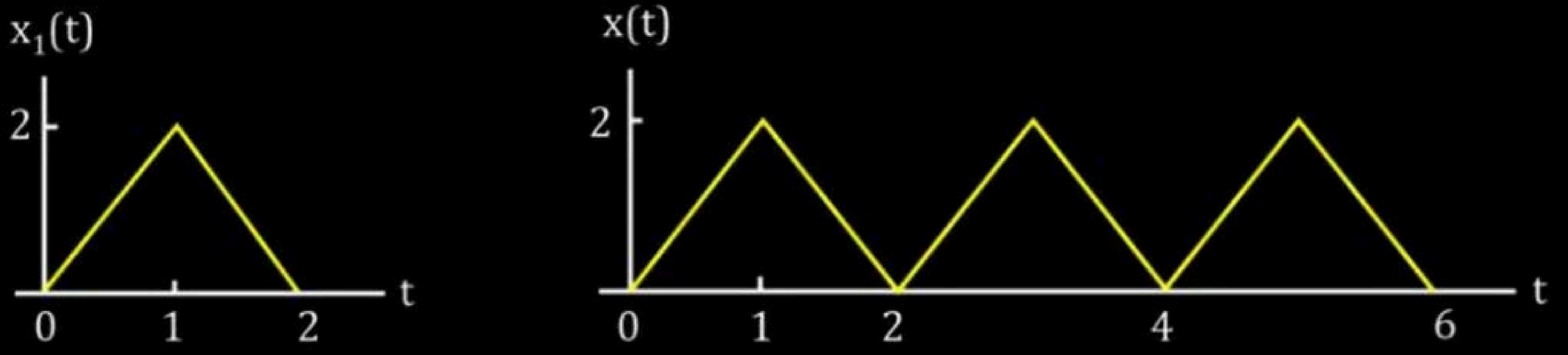
A. $x\left(\frac{1}{2}t-1\right)+x\left(\frac{2}{3}t-\frac{5}{3}\right)+x(t-3)+x(2t-7)$

B. $x(2t+1)+x\left(\frac{3}{2}t+\frac{5}{3}\right)+x(t+3)+x(2t+7)$

C. $x\left(\frac{1}{2}t+1\right)+x\left(\frac{2}{3}t+\frac{5}{3}\right)+(t+3)+x(2t+7)$

D. $x(2t-1)+x\left(\frac{3}{2}t-\frac{5}{3}\right)+x(t-3)+x(2t-7)$

Q. Consider the triangular pulses and the triangular wave of figure



The mathematical function for $x_1(t)$ is

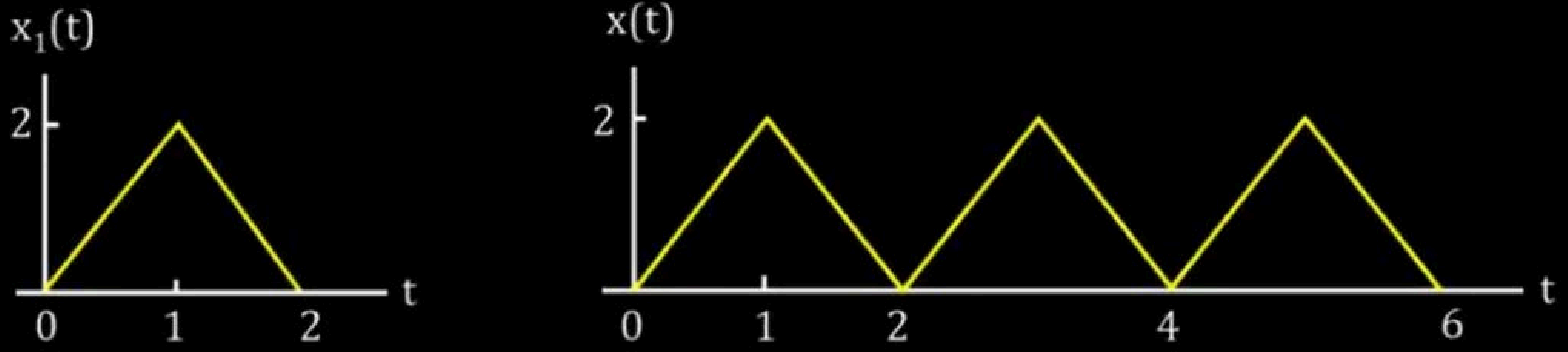
A. $2tu(t) - 4(t+1)u(t-1) + 2(t+2)u(t-2)$

B. $2tu(t) - 4(t-1)u(t-1) + 2(t-2)u(t-2)$

C. $2tu(t) - 4(t-1)u(t+1) + 2(t-2)u(t+2)$

D. None of the above

Q. Consider the triangular pulses and the triangular wave of figure



The mathematical function for waveform $x(t)$ is

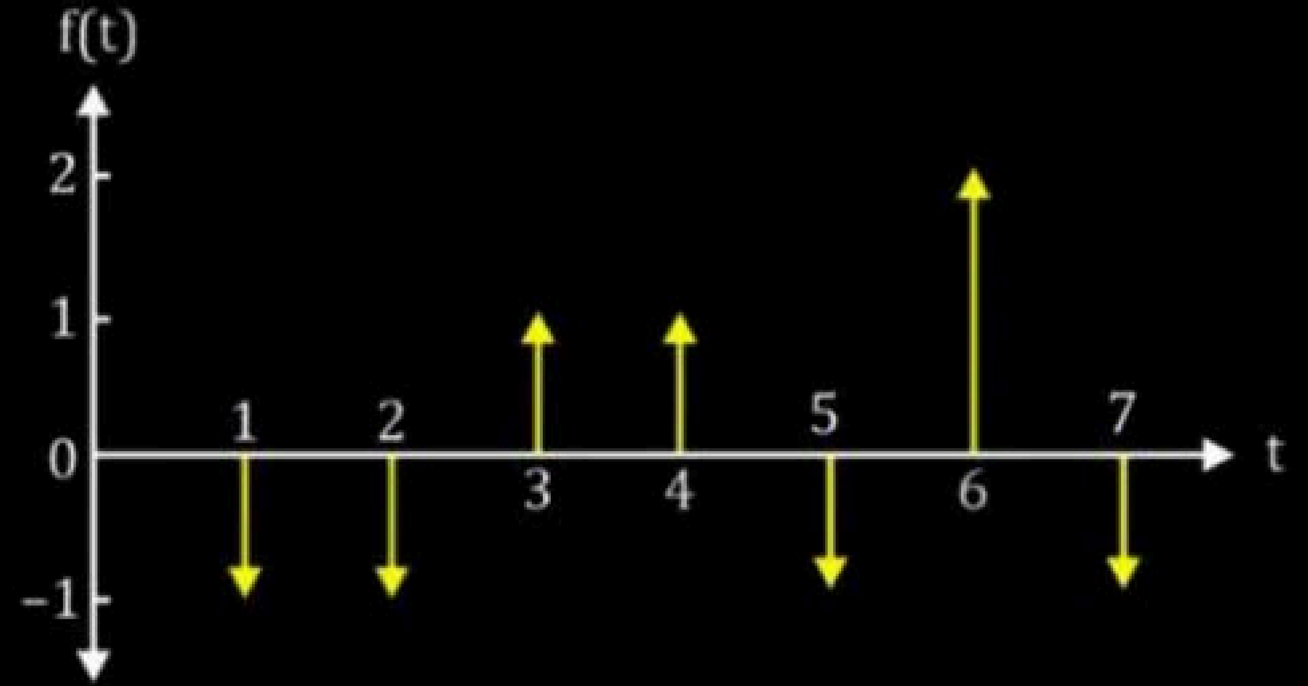
A. $\sum_{k=0}^{\infty} x_1(t+2k)$ B. $\sum_{k=-\infty}^{\infty} x_1(t-2k)$

C. $\sum_{k=0}^{\infty} x_1(t-2k)$ D. $\sum_{k=-\infty}^{\infty} x_1(t+2k)$

Here, $T_0 = 2$, therefore

$$x(t) = \sum_{k=-\infty} x_1(t-2k)$$

Q. The impulse train shown in the figure represents the second derivative of a function f(t). The value of f(t) is



A. $-tu(t-1) - tu(t-2) + tu(t-3) + tu(t-4) - tu(t-5) + 2tu(t-6) - tu(t-7)$

B. $-tu(t-1) - tu(t-2) - tu(t-3) - tu(t-4) + tu(t-5)$

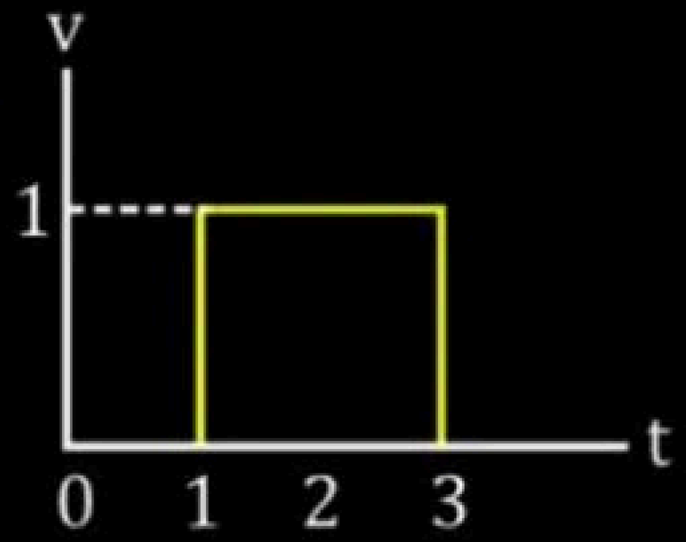
C. $tu(t-3) + tu(t-4) + 2tu(t-6)$

D. $tu(t+1) + tu(t+2) + tu(t+3) + tu(t+4) + tu(t+5) + 2tu(t+6) + tu(t+7)$

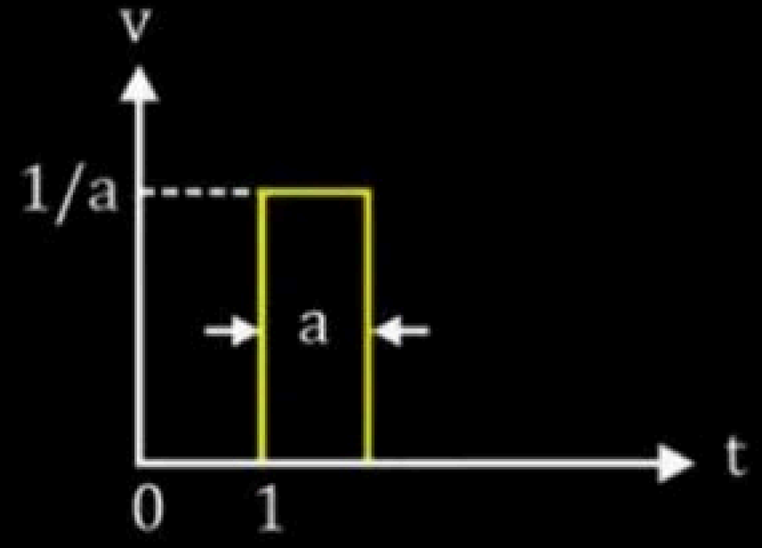
Q. Mach List I with List II and select the correct answer using the codes given below the Lists:

List I

A.



B.

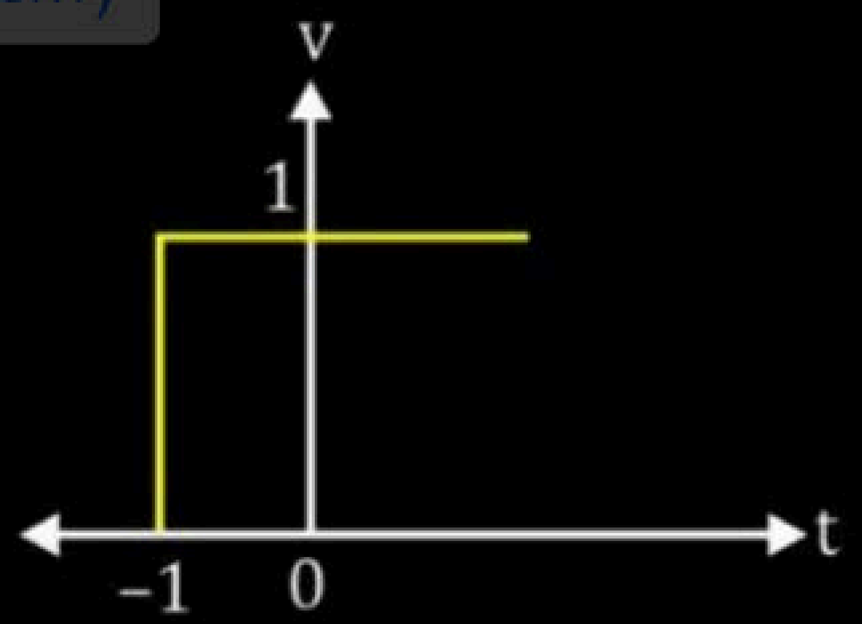


List II

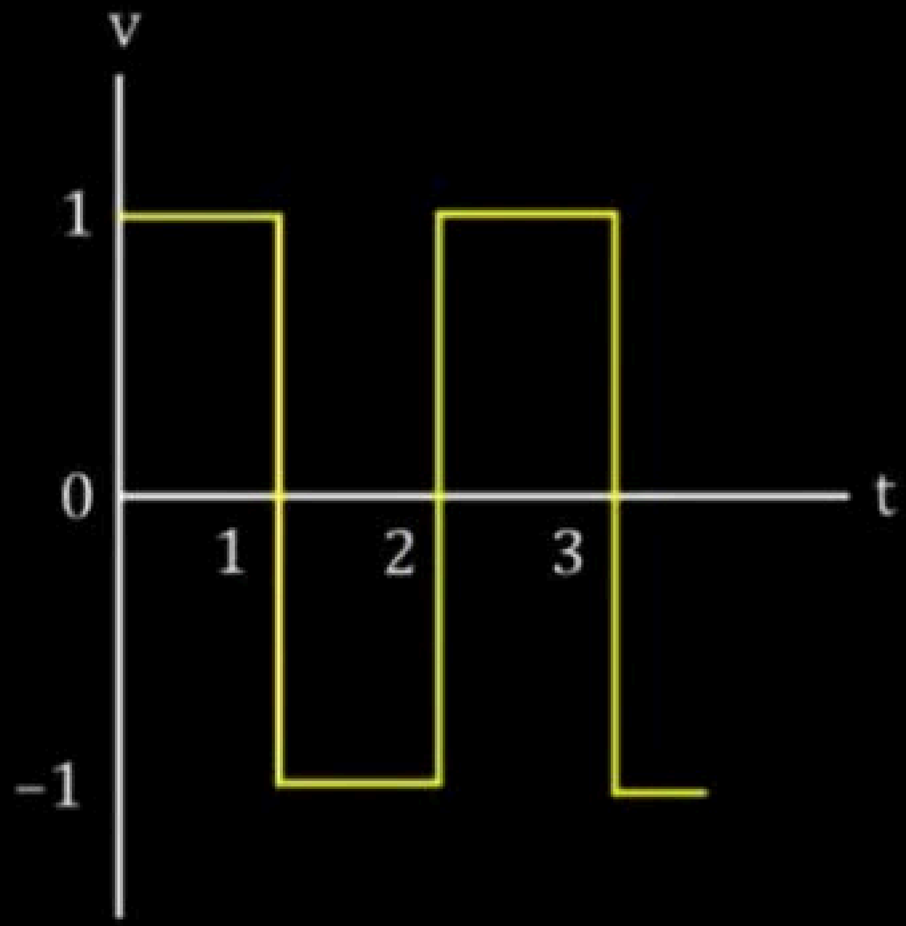
1. $v(t) = u(t+1)$

2. $v(t) = u(t-1) - 2u(t-1)$
$+2u(t-2) - 2u(t-3) + \cdots$

C.



D.



3. $v(t) = u(t-1) - u(t-3)$

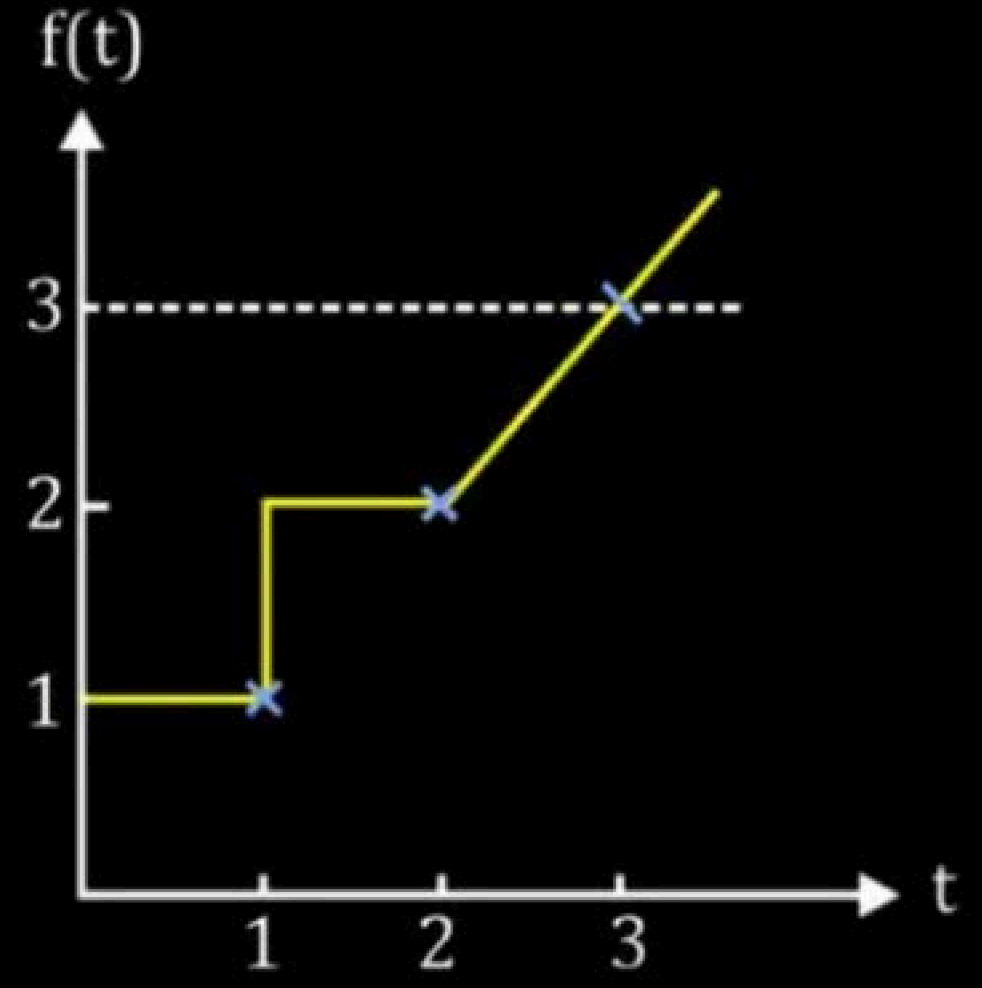
4. $\underset{a - 0}{\text{Lim}}\, v(t) = \delta(t-1)$

Codes :

	A	B	C	D
(a)	1	2	3	4
(b)	3	4	1	2
(c)	4	3	2	1
(d)	4	3	1	2

Q. Consider the following waveform diagram

Which one of the following gives the correct description of the waveform shown in the above diagram?



A. $u(t) + u(t-1)$

B. $u(t) + (t-1)u(t-1)$

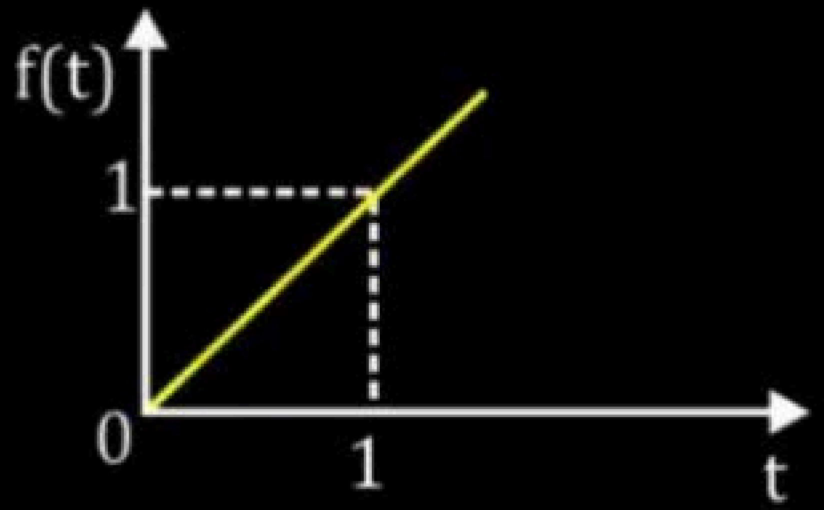
C. $u(t) + u(t-1) + (t-2)u(t-2)$

D. $u(t) + (t-2)u(t-2)$

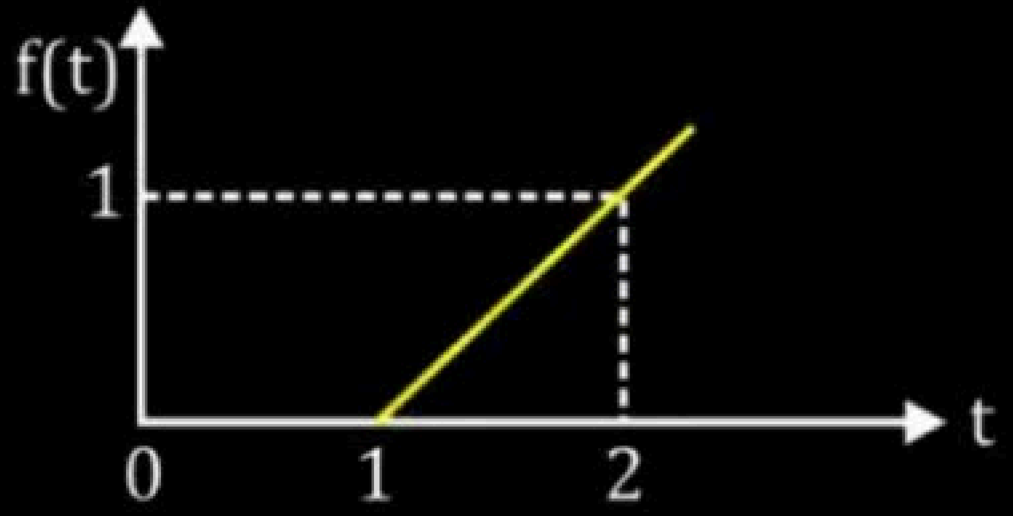
Q. Match the waveforms on the left-hand side with the correct mathematical description listed on the right hand side.

Waveform

(P)



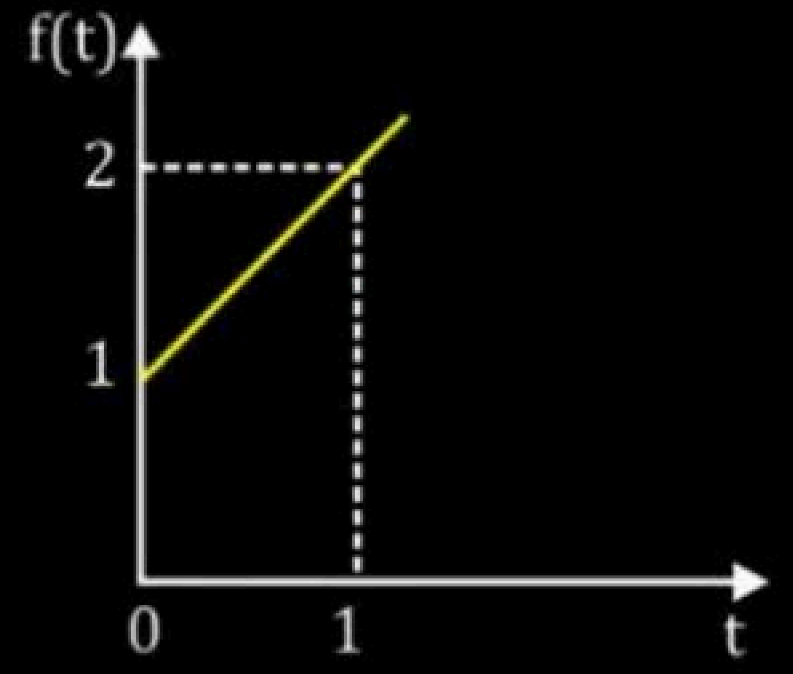
(Q)



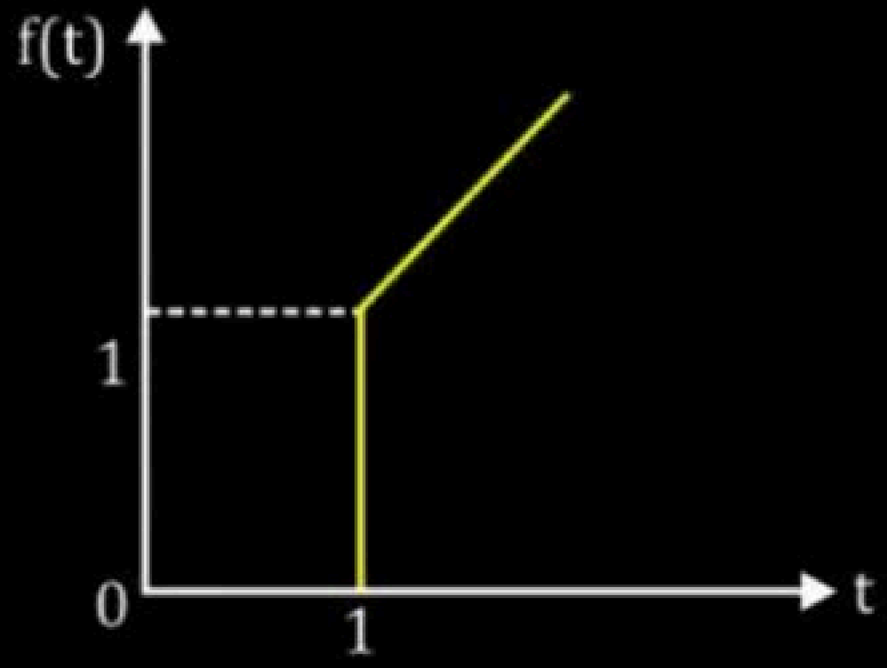
f(t)

1. $tu(t-1)$
2. $(t+1)\,u(t-1)$
3. $tu(t)$

(R)



(S)



4. $(t+1)u(t)$

5. $(t-1)u(t)$

6. $(t-1)u(t-1)$

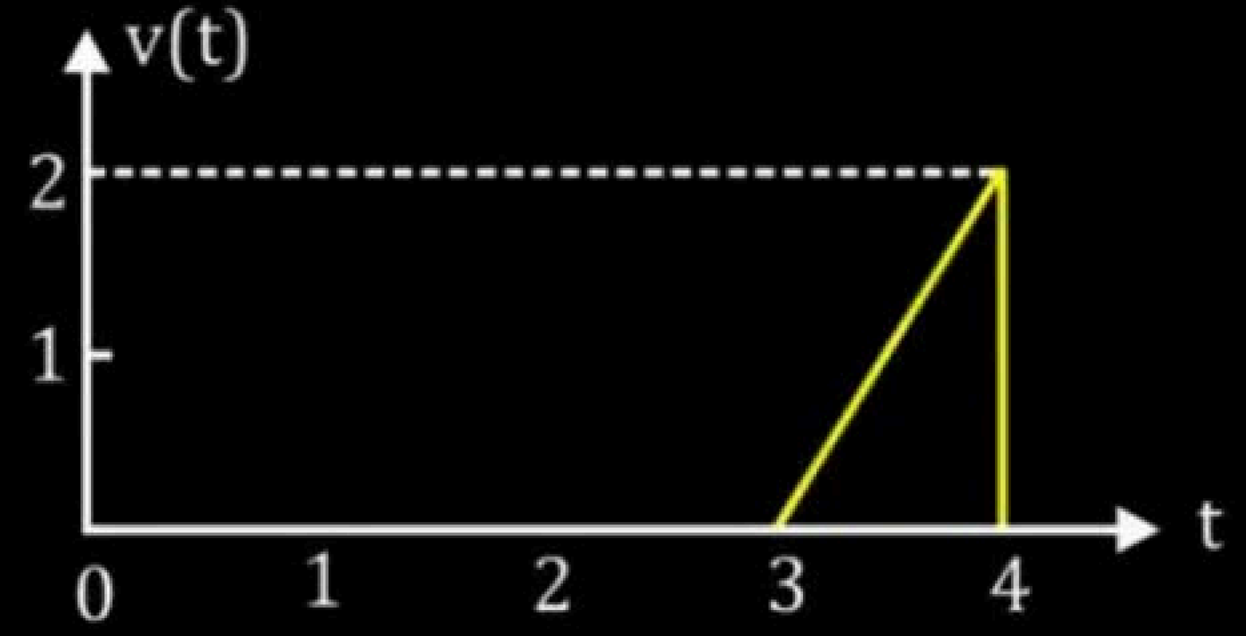
A. P-1, Q-3, R-4, S-2

B. P-3, Q-6, R-4, S-1

C. P-1, Q-6, R-2, S-4

D. P-2, Q-3, R-4, S-1

Q. In the graph shown below, which one of the following express v(t) ?



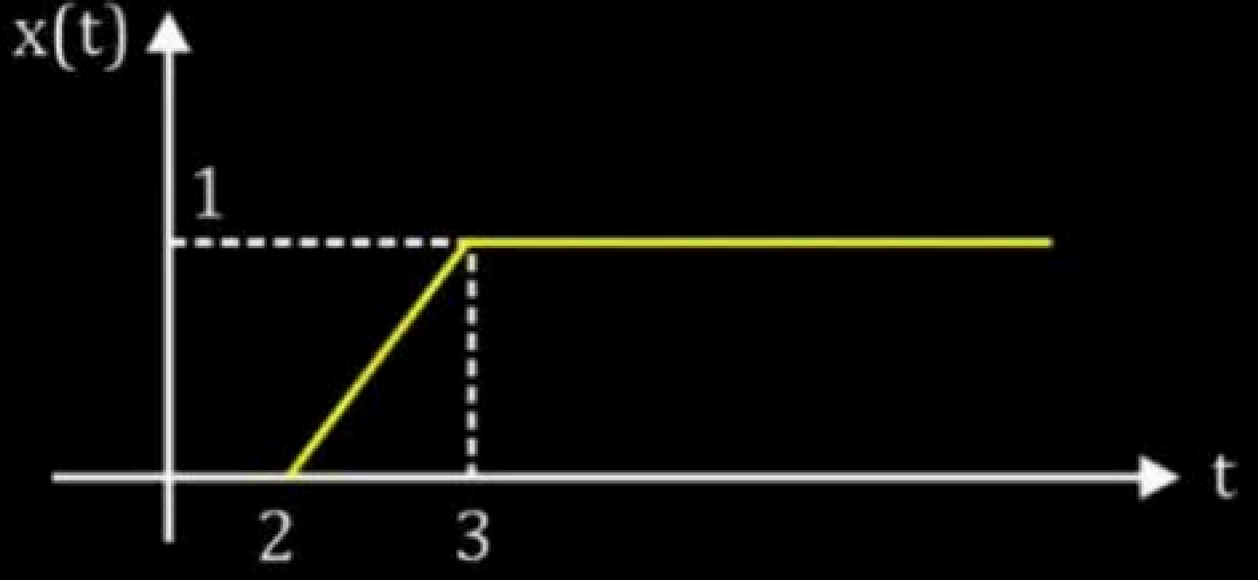
A. $(2t+6)[u(t-3)+2u(t-4)]$

B. $(-2t-6)[u(t-3)+u(t-4)]$

C. $(-2t+6)[u(t-3)+u(t-4)]$

D. $(2t-6)[u(t-3)-u(t-4)]$

Q. The signal x(t) shown in figure expressed in terms of unit steps & unit ramp function as



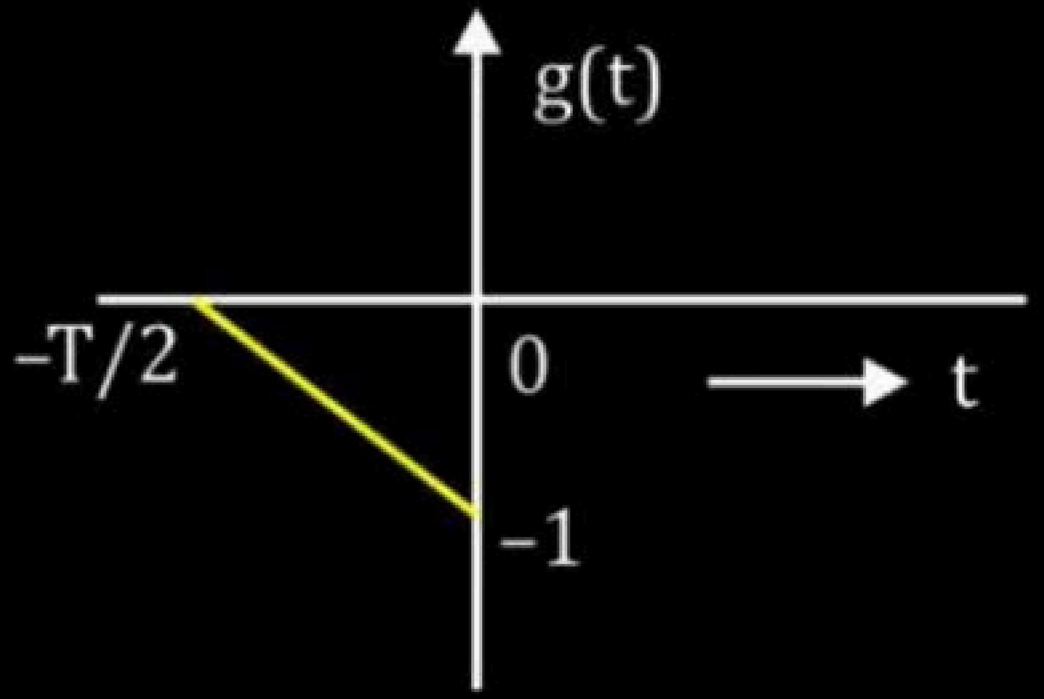
A. $r(t-2) - r(t-3) + u(t-3)$

B. $r(t-2)u(t-2) + r(t-3)u(t-3) + u(t-3)$

C. $r(t-2) - r(t-3)$

D. $2r(t-2) - r(t-3) + 2u(t-3)$

Q. Represent the following signal in terms of step and ramp functions



A. $-(2/T)r(t+(T/2))[u(t+(T/2))-u(t)]$

B. $(2/T)r(t+(T/2))\,[u(t+(T/2))-u(t)]$

C. $(2/T)r(t+(T/2))[u(t+(T/2))+u(t)]$

D. $(-2/T)r(t+(T/2))[u(t+(T/2))+u(t)]$