Department of Electrical Engineering

Assignment

Date: 14/04/2020

Course Details

Course Title: Signals and Systems

Instructor: Eng Aamir Aman

Module: 6th

Total Marks: 30

Student Details

Name: Hilal khan

Student ID: 6966

Q1. (a) — Marks 10, CLO 1

Find the total solution of the following Linear Constant difference equation by

a) Homogeneous and Particular solution method

b) Zero input and Zero State solution method.

After finding total solution plot the responses by putting at least four different values and comment on both methods.

$$Y[n] + 0.567\,Y[n-1] + 33.3Y[n-2] + Y[n-4] = x[n]$$

For unit step $x[n] = 10u[n]$

with $y[-1] = 1,\ y[-2] = -1$

Q2. (a) — Marks 05, CLO 1

Find the sampling frequency of

$$x(t) = 5000\cos 5.0\pi t + \sin 0.5\pi t + 5.89\cos 10\pi t\ \sin 0.5\pi t + \sin 100\pi t$$

(b) — Marks 05, CLO 1

Sketch the block diagram representation of discrete-time systems described by the following input-output relation. Also find order of the system, total number of Adders and Scalars.

i) $y[n] - 4\,y[n-2] = 3\,x[n] + 2\,x[n-1] + 4x[n-4]$

ii) $y[n] - 10.3\,y[n-8] = x[n] + 3\,x[n-1]$

Q3. (a) — Marks 05, CLO 2

Consider the following two sequences x[n] and y[n]:

$$x[n] = [1, 3, 6, -4, \underset{\uparrow}{2}, -2, 1, 3, 0, 0, 3]$$

$$y[n] = [2, 4, -2, \underset{\uparrow}{1}, 2, 0, 0, -2, 5]$$

Sketch and label the following sequences. Also specify either they are RSS, LSS or TSS.

(b) — Marks 05, CLO 2

Consider the signal $x(t) = (-1, -1, -2, -2, -2, -1)$

Plot

i) $x(t-2)$

ii) $x(-t)$

iii) $25x(-t)$

iv) $X(t+5)$

v) $X(1/t)$

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Q1 $y[n] + 0.567\, y[n-1] + 33.3\, y[n-2] + y[n-4] = x[n]$

Now

Homogenous and particular solution:-

$\Rightarrow$ **Homogenous Solution**

$$\lambda^{n} + 0.567\, \lambda^{n-2} + 33.3\, \lambda^{n-3} + \lambda^{n-4} = 0$$

$\because x(n) = 0$

$$\lambda^{n-4}(\lambda^{4} + 0.567\, \lambda^{3} + 33.3\, \lambda^{2} + 1) = 0$$

Either $(\lambda^{4} + 0.567\, \lambda^{3} + 3.33\lambda^{2} + 1) = 0$

$$\lambda^{2}(\lambda^{2} + 0.567\lambda + 33.3) = 1$$

Either

$\lambda^{2} = -1$; $\lambda^{2} + 0.567\lambda + 33.3 = -1$

$\lambda = \sqrt{-1}$ $\quad \lambda^{2} + 0.567\lambda = -1 - 33.3$

$\lambda_1 = \pm 1i$; $\lambda(\lambda + 0.567) = -343$

$\lambda_2 = -34.3$

$\lambda + 0.567 = -34.3$

$\Rightarrow \lambda = -34.3 - 0.567$

$\lambda = -34.867$

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Now as we know we have 3 different roots 1 imaganary & 2 real & non-repeated;

$\Rightarrow$ 0 or imaginary root;

$y_n(n) = C_1 \cos \lambda_1^n + C_2 \overset{\sin}{} \lambda_2^n$

$y_n(n) = C_1 \cos(1)^n$

$\Rightarrow$ For real & non-repeated roots;

$y_n(n) = C_1 \cos C_1 \lambda_1^n + C_2 \lambda_2^n + C_3 \lambda_3^n$

$\therefore$ as we have λ_2 & λ_3. so

$= C_1 \lambda_1^n + C_2(-34.3)^n + C_3(-34.867)$

putting value of $C_1 \lambda_1^n = C_1 \cos \lambda_1$

$$\Rightarrow \boxed{y_n(n) = C_1 \cos(1)^n + C_2(-34.3)^n + C_3(-34.867)^n}$$

$\Rightarrow$ **Particular Solution:**

As we know that

$y_p(n) = 10\,k\,u(n)$

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$\Rightarrow 10k\,u(\cancel{n})^{1} + 0.567\,(10)\,ku\,(\cancel{n-1})^{1} + 33.3\,(10)\,ku\,(\cancel{n-2})^{1} + (1)\,10\,ku\,(\cancel{n-4})^{1} = 10\,u(\cancel{n})^{1}$

Now for unit step $\cdot 1 = u(n)$

$\Rightarrow 10k + 5.67k + 33.3k + 10k = 10$

$\Rightarrow k(10 + 5.67 + 33.3 + 10) = 10$

$\Rightarrow k(358.67) = 10$

÷ing by "358.67"

$k = 10/358.67$

$\Rightarrow k = 0.027$

Now

$\Rightarrow y_p(n) = y_{ss}\,k\,u(n)$

$= 10 \times 10/358.67\;u(n)$

$= 10 \times 0.027\;u(n)$

$\Rightarrow y_p(n) = 2.7\,u(\cancel{n})$

$\Rightarrow \boxed{y_p(n) = 2.7}$

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Now for total solution

$y(n) = y_h(n) + y_p(n)$

$= K_1 \cos(1)^n + (2.7)$

$= C_1 \cos(1)^n + C_2(-34.3)^n + C_3(-34.867)^n + 2.7$

$\Rightarrow y(n) = C_1 \cos(1)^n + C_2(-34.3)^n + C_3(-34.867)^n + 2.7$

Total solution

Now Applying Initial condition:-

i) $y(-1) = 1$

$\because C_1 \cos(1)^{-1} = 0$

$\Rightarrow C_1 \cos(-1) = 0$

$\Rightarrow C_1 = 0/\cos(-1) = 0/0$

$C_1 = 0$

$C_1 \cos(1)^{-1} + C_2(-34.3)^{-1} + C_3(-34.867)^{-1} = 1$

$= -C_1 + (-1/34.3) C_2 + (-1/34.867) C_3 = 1$

$= -0 - 0.02 C_2 \quad 1 - 0.028 \; C_3 = 1$

$\Rightarrow y(-1) = -0.02 C_2 - 0.028 \; C_3 = 1 \Rightarrow 1$

Now Applying 2^{nd} condition:-

$y(-2) = -1$

$= C_1 \cos(1)^{-2} + C_2(-34.3)^{-2} + C_3(-34.867)^{-2} = -1$

$= 0 + (-2/34.3) C_2 + (-2/34.867) = -1$

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$= -0.05 C_2 + -0.057 \; C_2 = -1 \Rightarrow 2$

Now xing eq 1 with -5

$\Rightarrow -5(-0.02\,C_2 - 0.028\,C_2) = 1(-5)$

$\Rightarrow 0.1 C_2 + 0.014 C_3 = -5 \Rightarrow 3$

Also xing eq 2 with "2"

$2(-0.05\,C_2 - 0.057\,C_3) = -1(2)$

$-0.1 C_2 - 0.114\,C_3 = -2 \Rightarrow 4$

Adding eq 3 & 4

$$
\begin{aligned}
\cancel{0.1 C_2} + 0.014 C_3 &= -5 \\
-\cancel{0.1 C_2} - 0.114 C_3 &= -2 \\
\hline
-0.1\,C_3 &= -5-2 \\
-0.1\,C_3 &= -7 \\
C_3 &= -7/-0.1
\end{aligned}
$$

$\boxed{C_3 = 70}$.

Now putting value of C_3 into eq 3

$\Rightarrow 0.1 C_2 + 0.014(70) = -5$

$\Rightarrow 0.1 c_2 + 0.98 = -5$

$\Rightarrow 0.1 c_2 = -5 - 0.98$

$\Rightarrow \frac{\cancel{0.1} c_2}{\cancel{0.1}} = \frac{-5.98}{0.1}$

$$\boxed{c_2 = -59.8}$$

Now

b) ZERO INPUT & ZERO STATE:-

$\Rightarrow$ It is also like a homogenous & particular solution & the answer must be same

So for zero input

$y_n(n) = C_1 \cos(1)^n + C_2(-34.3)^n + C_3(-34.867)^n$

for zero state

$y_p = (n) = 10k\,u(n)$

w/c will be

$y_p(n) = 2.7$

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Total solution will be

$y(n) = y_h(n) + y_p(n)$

$\Rightarrow y(n) = c_1 \cos(1)^n + c_2(-34.3)^n + c_3(-34.867)^n + 2.7$

Now putting the 4 random values in total solution;

Ex: $y(n) = n = 1, 2, 3, 4$

Now

$y(n) = 1 = n =$

$= c_1 \cos(1)^1 + c_2(-34.3)^1 + c_3(-34.867)^1 + 2.7$

$\Rightarrow \boxed{y(1) = c_1(1) + c_2(-34.3) + c_3(-34.867) + 2.7}$

Now 2^{nd}

$y(2) = c_1 \cos(2)^3 + c_2(-34.3)^2 + c_3(-34.867)^2 + 2.7$

$= c_1 \cos(1) + c_2(34.3)^2 + c_2(34.8)^2 + 2.7$

$\Rightarrow \boxed{y(2) = c_1 + 1176.4 c_2 + 1211.04 c_3 + 2.7}$

Now 3rd

$$y(3) = c_1\cos(1)^3 + c_2(-34.3)^3 + c_3(-34.867)^3 + 2.7$$

$$y(3) = c_1\cos(1) + c_2(-40353.6) + c_3(-42388.08) + 2.7$$

$$y(3) = \cos(1) - 40353.6\,c_2 - 42388.08\,c_3 + 2.7$$

Now 4th

$$y(4) = c_1\cos(1)^4 + c_2(-34.3)^4 + c_3(-34.867)^4 + 2.7$$

$$= c_1\cos(1) + c_2(1384128.7) + c_3(1477945.18) + 2.7$$

$$y(4) = c_1 + 1384128.7\,c_2 + 1477945.18\,c_3 + 2.7$$

⇒ As we know the answer of homogenous and particular solution must be same as zero input and zero state so here it is also same that's why I am not writing the answer of zero input and zero state.

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Q_2

PART (A) **Sampling Frequency :-**

$x(t) = 5000 \cos 5 \cdot 0 \pi t + \sin 0.5\pi t + 5$

$\cos \pi(t) = \sin 0.5 \pi t + \sin 1000 \pi t$

SOLUTION :-

$5000 \cos 5.0 \pi t$

Formula

$T = \frac{2\pi}{\omega}$

By putting values

$T = \frac{2\cancel{\pi}}{\cancel{5.0}\cancel{\pi}}$ 25

$\boxed{T = 2.5}$

$\Rightarrow \sin 0.5 \pi t$

By Formula

$T = \frac{2\pi}{\omega}$

$T = \frac{2\cancel{\pi}}{\cancel{0.5}\cancel{\pi}}$

$\boxed{T = 0.25}$

$\Rightarrow 5.89 \cos 10 \pi t$

By Formula

$T = \frac{2\pi}{\omega}$

$T = \frac{2\pi}{10\pi}$

$\boxed{T = 5}$

$\Rightarrow \sin 0.5 \pi t$

$T = \frac{2\pi}{\omega}$

$T = \frac{2\cancel{\pi}}{\cancel{0.5}\cancel{\pi}}$

$\boxed{T = 0.5}$

$\Rightarrow \sin 100 \pi t$

$T = \frac{2\pi}{\omega}$

$T = \frac{2\pi}{100\pi}$

$\boxed{T = 50}$

So

$f_1 = 2.5$, $f_2 = 0.25$, $f_3 = 5$

$f_4 = 0.25$, $f_5 = 50$

From the above equation the greater frequency is 50.

$f_s = 2f_m$

$f_s = 2(50)$

$\boxed{f_s = 100}$

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Q_2

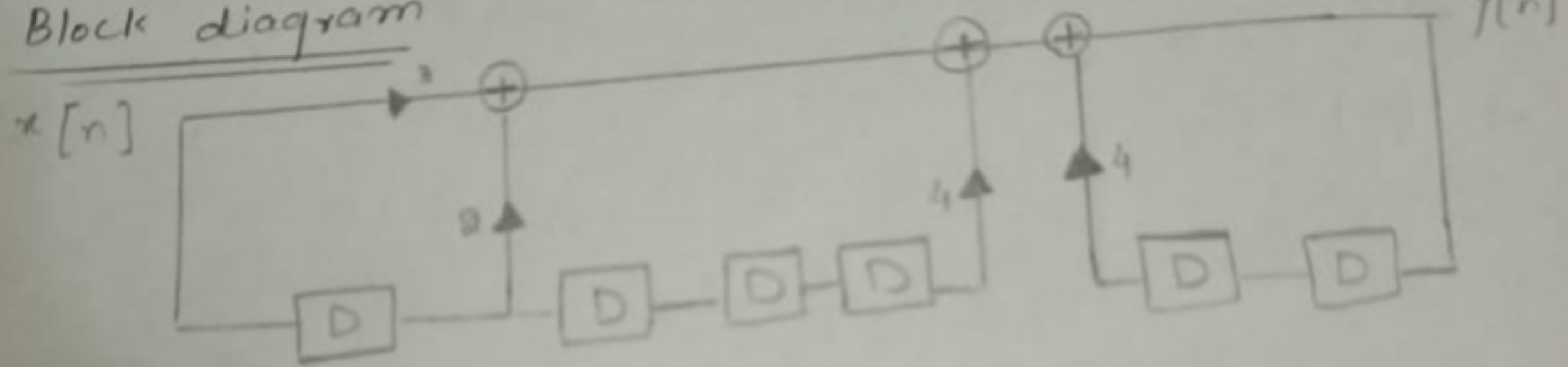
PART (B)

(i) $y(n) - 4y[n-2] = 3x[n] + 2x[n-1] + 4x[n-4]$

SOLUTION:-

$\Rightarrow y[n] = 4y[n-2] + 3x[n] + 2x[n-1] + 4x[n-4]$

Block diagram



We know that order of the system is the maximum delay

So (order of the system = 4)

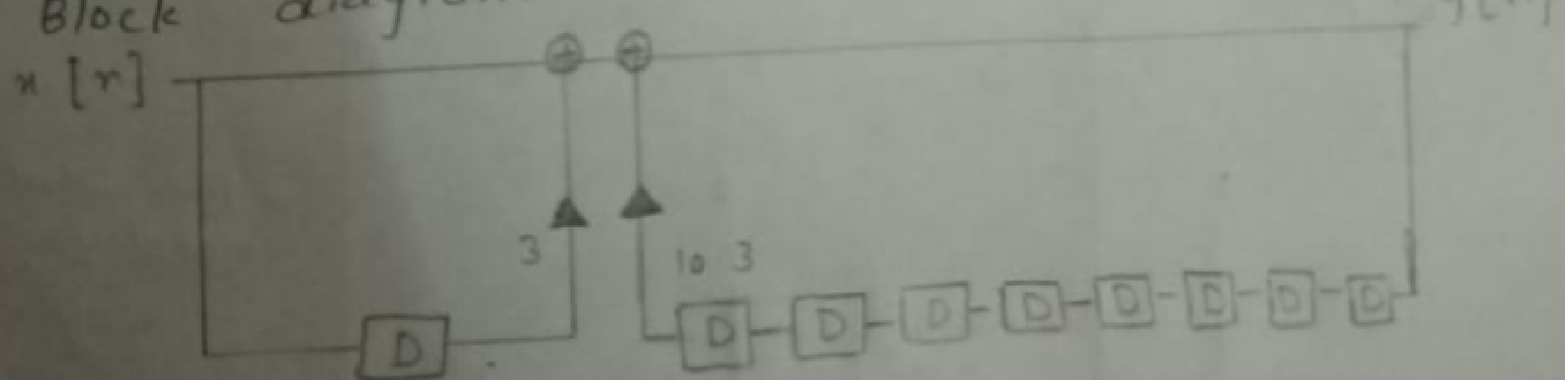
$$\begin{bmatrix} \text{Adders} = 3 \\ \text{Scalar} = 4 \end{bmatrix}$$

ii) $y[n] - 10.3y[n-8] = x[n] + 3x[n-1]$

SOLUTION:-

$\Rightarrow y[n] = 10.3y[n-8] + x[n] + 3x[n-1]$

Block diagram



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(order = 8)

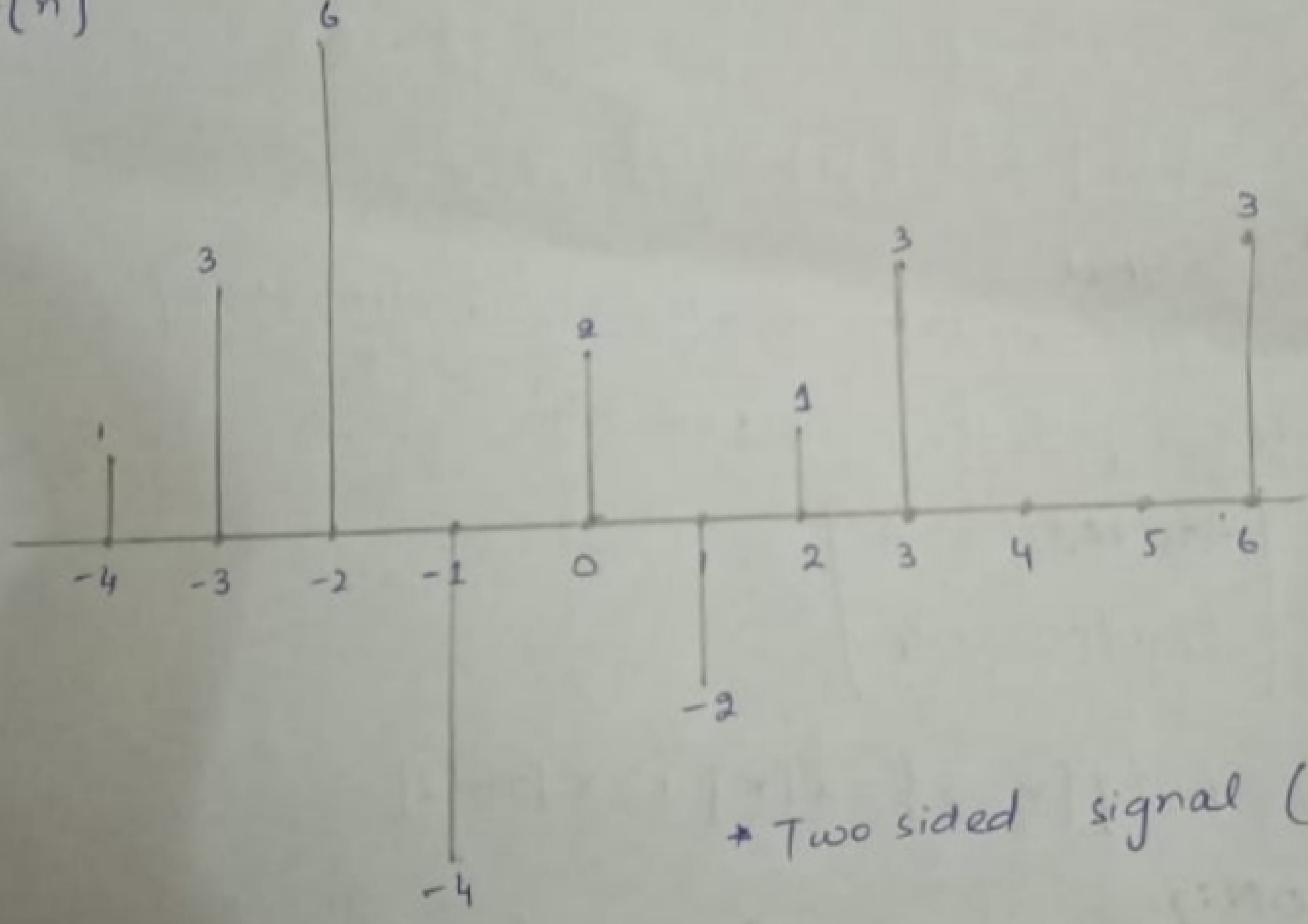
$$\begin{bmatrix} \text{Adders} = 2 \\ \text{Scalars} = 2 \end{bmatrix}$$

Q:- 3

PART(A) $\Rightarrow x[n] = [1, 3, 6, -4, \underset{\uparrow}{2}, -2, 1, 3, 0, 0, 3]$

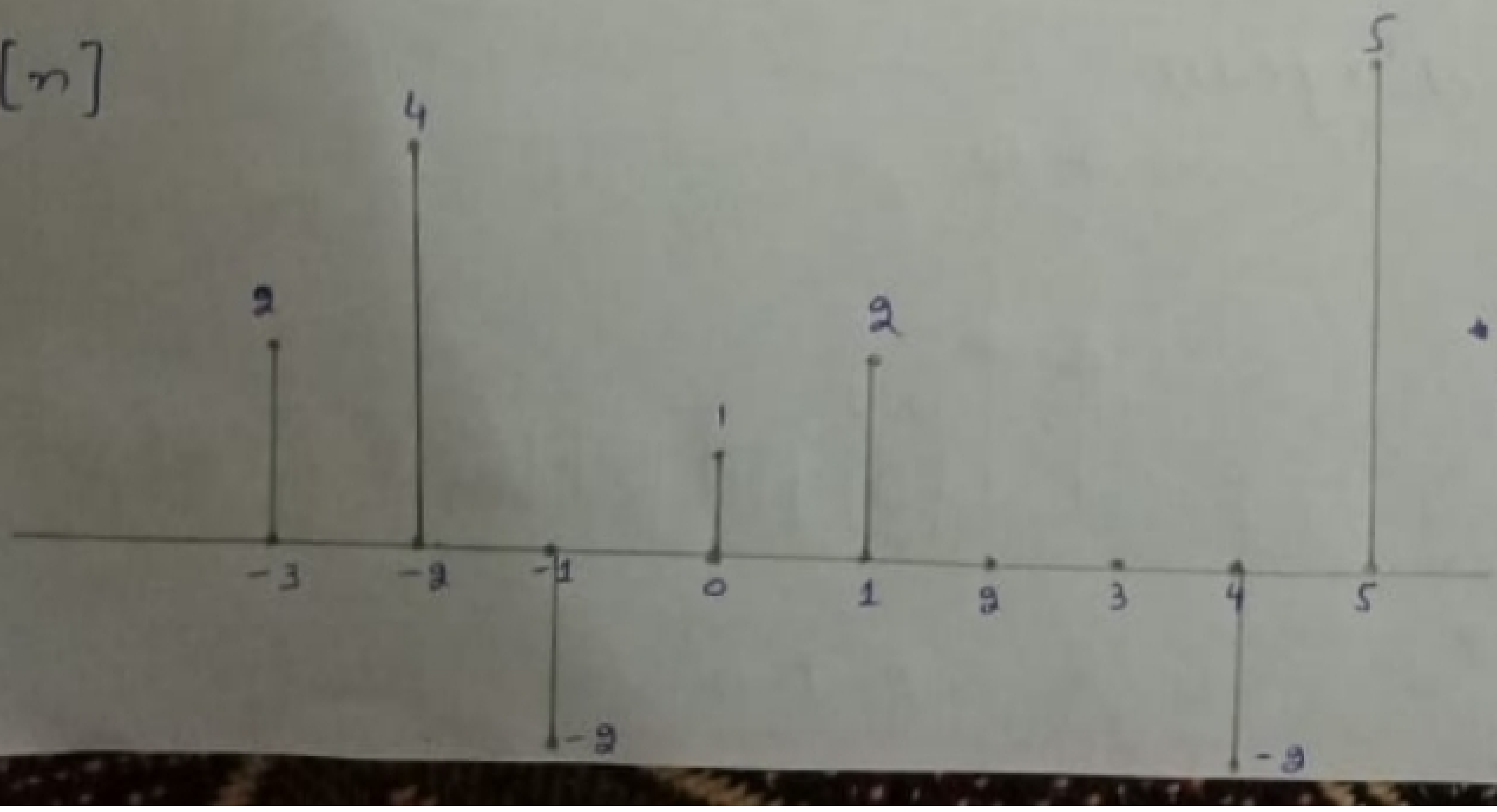
$\Rightarrow y[n] = [2, 4, -2, \underset{\uparrow}{1}, 2, 0, 0, -2, 5]$

$\Rightarrow x[n]$



* Two sided signal (T.S.S)

$\Rightarrow y[n]$



* Two sided signal (TSS)

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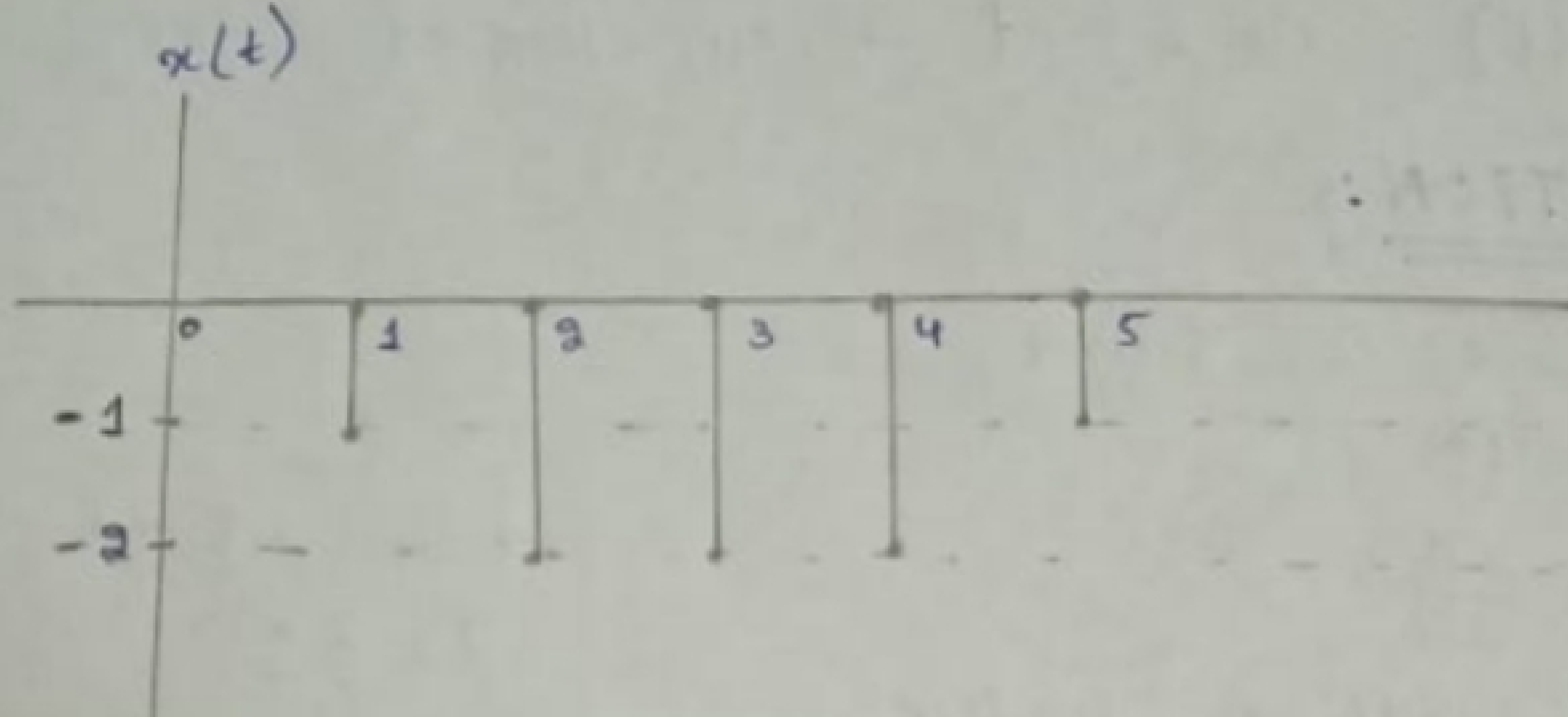
Q3

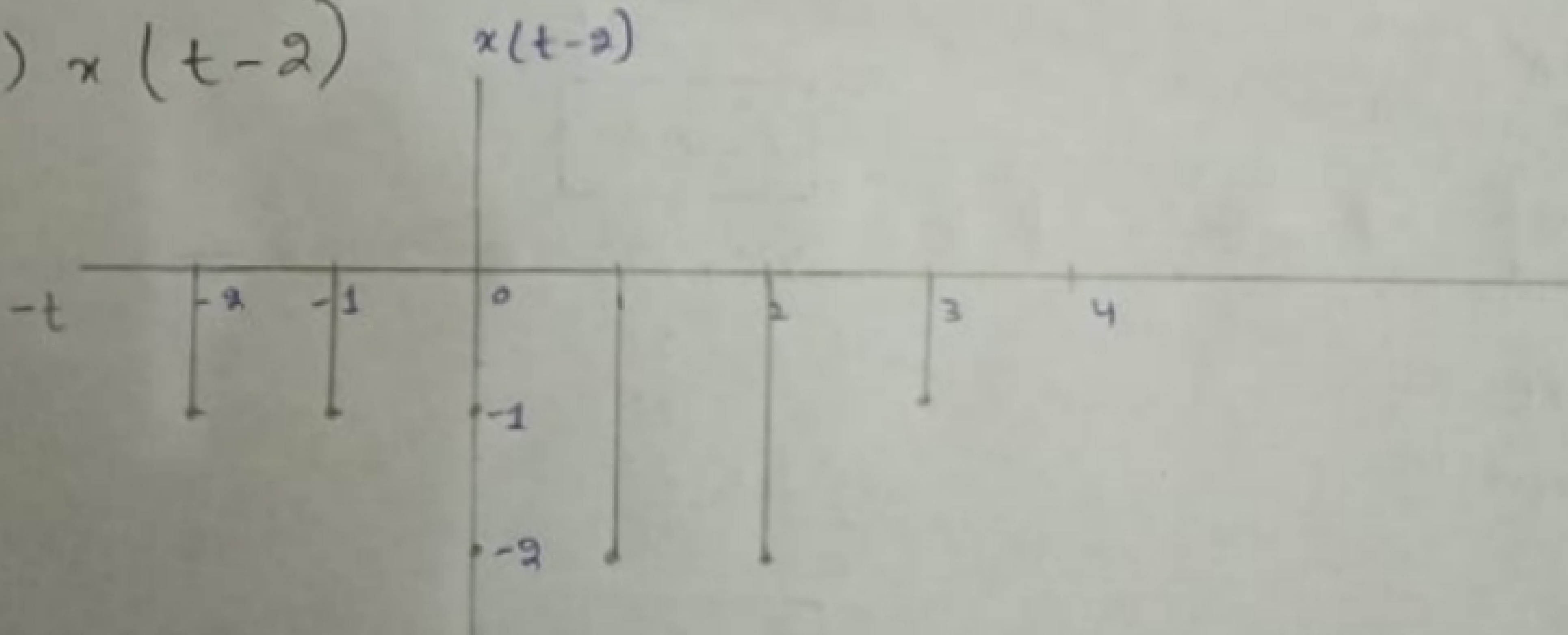
PART (B) $\Rightarrow x(t) = (-1, -1, -2, -2, -1)$

PLOT :-

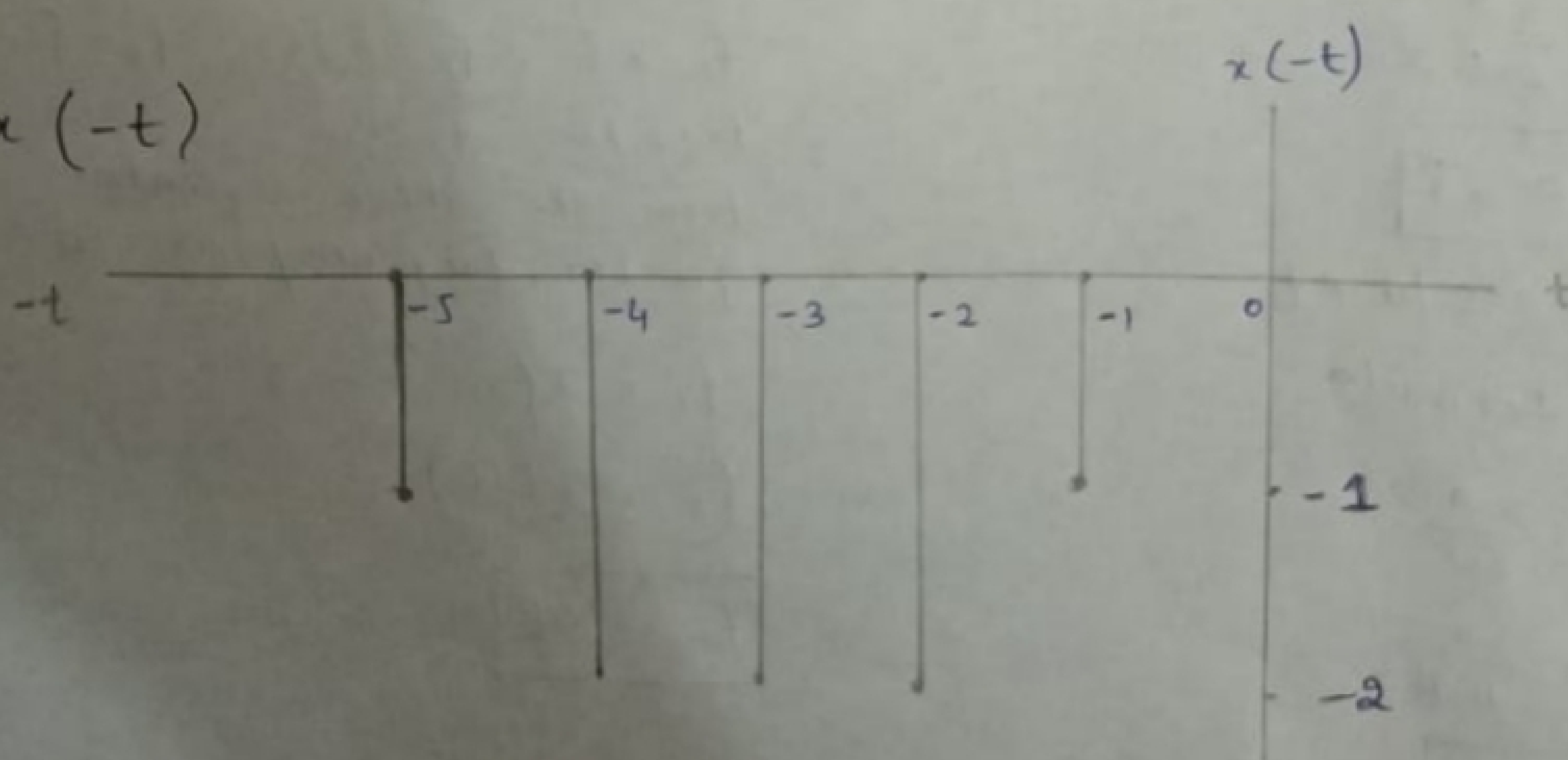
$\Rightarrow x(t)$



(i) $x(t-2)$



ii) $x(-t)$



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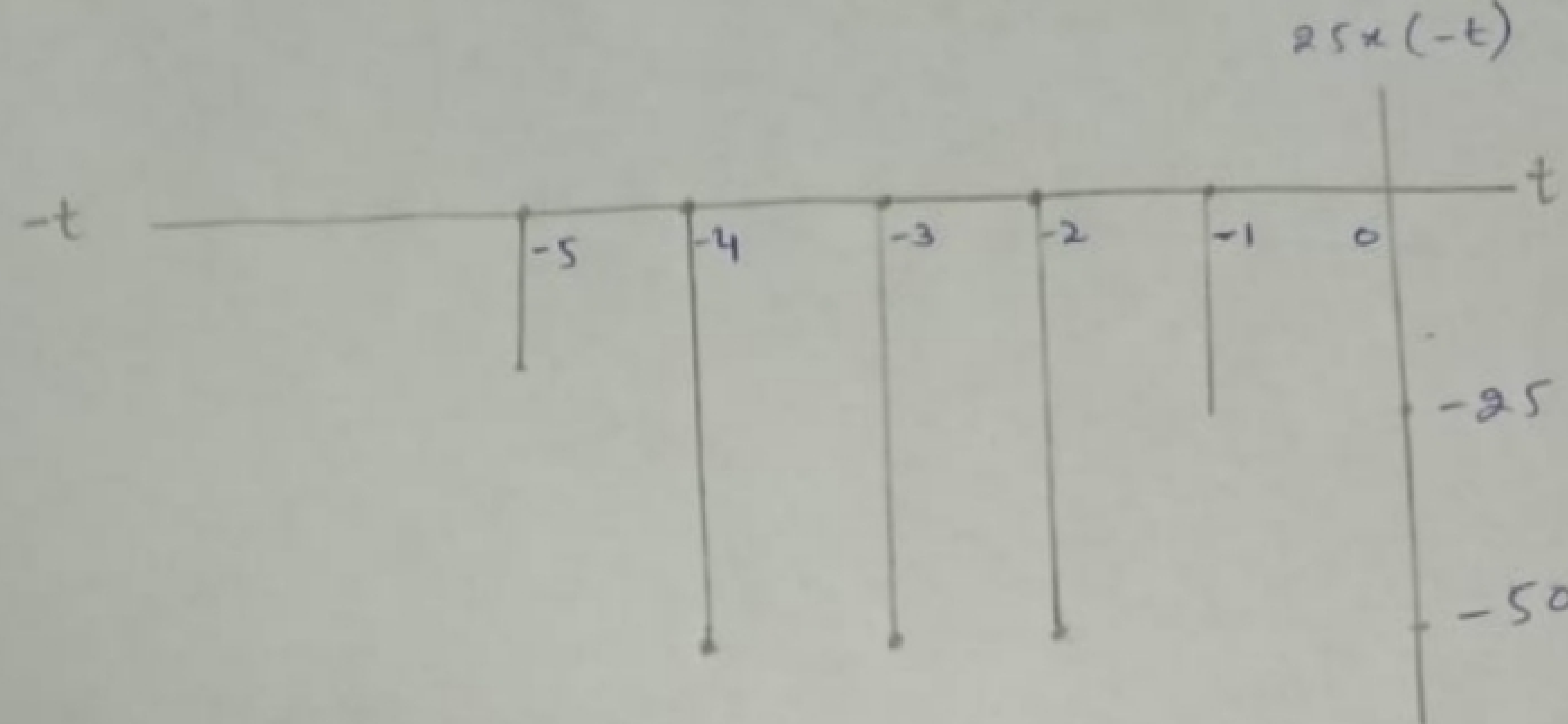
iii) $25x(-t)$



iv) $x(t+5)$