Department of Electrical Engineering
Assignment
Date: 14/04/2020

Course Details

Course Title:	Signals and Systems	**Module:**	6th
Instructor:	Engr; Aamir Aman	**Total Marks:**	30

Student Details

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

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

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

part-(i) Homogenous and particular Solution

As we know that the total Solution is equal to the sum of Homogenous & particular eq.

$$y[n] = y_h[n] + y_p[n]$$

Homogenous Solution:

the characteristics equation is

Replace $y[n]$ with λ^n so

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

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

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

Solve the roots with the help of Calculator by himself.

The find (if the roots are real & not equal

$y_h[n] = C_1\lambda_1^n + C_2\lambda_2^n + C_3\lambda_3^n + C_4\lambda_4^n$

or if The root are real & repeated then

$y_h(n) = C_1\lambda^n + C_2 n\lambda_2^n + C_3 n^2\lambda_3^n + C_4 n^3\lambda_3^n$

Particular Sol:

suppose $y_p[n] = 10\,k\,u[n]$

$\Rightarrow 10\,k\,u[n] + 0.567(10k\,u[n-1]) + 33.3 \times 10k\,u[n-2] + 10k\,u[n-4] = 10\,u[n]$

$\Rightarrow 10k + 5.67k + 333k + 10k = 10$

$\Rightarrow 10k + 5.67k + 333k + 10k = 10$

$k(10 + 5.67 + 333 + 10) = 10$

$k = 10/358.67$

$$y_p(n) = \frac{10}{358.67} \times 10\,u(n) = \frac{100}{358.67}u(n) = \frac{100}{358.67}$$

$\lambda^2(\lambda^2 + 0.6\lambda + 33.4) = -1$

Now to finding the value

So

λ^2 Using calculator to find the value

$\lambda^2 = -1$

$\lambda^2 = i^2$

$\boxed{\lambda = \pm i}$

$\lambda^2 + 0.6\lambda + 33.4 = -1$

$\lambda^2 + 0.6\lambda = -1 - 33.4$

$\boxed{\lambda_2 = 34.4}$

$\boxed{\lambda = 34.9}$

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Now as we know we have 3 diffrant roots: 1 imagnary & 2 real & non-repeated

* For imagnary Roots:

$y_h(n) = c_1 \cos \lambda_1^n + c_2 \sin \lambda_2^n$

$y_h(n) = c_1 \cos(1)^n$

* For real & non-repeated Roots.

$y_h(n) = c_1\lambda_1^n + c_2\lambda_2^n + c_3\lambda_3^n$

$\because$ as we have λ_2 & λ_3, so

$= c_1\lambda_1^n + c_2(-34.4)^n + c_3(-35.04)^n$

puting value of $c_1\lambda_1^n = c_1\cos\lambda_1^n$

$$\Rightarrow \boxed{y_h(n) = c_1\cos(1)^n + c_2[-34.4]^n + c_3[-35.04]^n}$$

Homogeneous Solution

* Particular Solution:-

As we know that

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

So $\Rightarrow 10u_n(k) + 0.6(10)ku(n-1) + 33.4(10)ku(n-2) + (1)(10)ku(n-4) = 10u(n)$

* Now for unit step $= 1 = u(n)$

$\Rightarrow 10k + 6.04k + 333k + 10k = 10$

$\Rightarrow k(10 + 6.04 + 333k + 10) = 10$

359.04

$\Rightarrow \quad k\,(359.04) = 10$

Dividing by "359.04"

$$k = \frac{10}{359.04}$$

$$\Rightarrow \boxed{k = 0.0278}$$

Now

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

$= 10 \times \frac{10}{359.67}\,u(n)$

$= 10 \times 0.0278\,u(n)$

$\Rightarrow y_p(n) = 2.8\,u(n)$

$$\boxed{\Rightarrow y_p(n) = 2.8}$$

Now for total solution

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

$= c_1 \cos (1)^n + c_2(-34.4)^n + (-35.04)^n + 2.8$

$\Rightarrow y(n) = c_1 \cos (1)^n + c_2(-34.4)^n + c_3(-35.04)^n + 2.8$

Total solution

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Now Applying initial conditions

$\because \ c_1 \cos(1)^{-1} = 0$

$\Rightarrow c_1 \cos(-1) = 0$

$\Rightarrow c_1 = 0/\cos(-1) = 0/1$

$\boxed{c_1 = 0}$

$\Rightarrow y(-1) = 1$

$c_1 \cos(1)^{-1} + c_2(-34.4)^{-1} + c_3(-35.04)^{-1} = 1$

$= -c_1 + \left(-1/34.4\right) c_2 + \left(-1/35.04\right) c_3 = 1$

$= 0. \ 0.02 c_2 - 0.029 c_3 = 1 =$ ①

$\Rightarrow y(-1) = -0.02c_2 - 0.029c_3 = 1 = \boxed{1}$

Now Applying 2nd condition:

$y(-2) = -1$

$= c_1 \cos(1)^{-2} + c_2(-34.04)^{-2}$

$+ c_3(-35.04)^{-2} = 1$

$= 0 + \left(-2/34.04\right) c_2 + \left(-2/35.04\right) = -1$

$= 0.05 c_2 - 0.067 c_3 = -1 = \boxed{2}$

Now xing eq ① with "-5"

$\Rightarrow -5(-0.02 c_2 - 0.029 c_3) = 1(-5)$

$\Rightarrow 0.1 c_2 + 0.015 c_3 = -5 \Rightarrow$ ③

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Also xing eq (2) with "2"

$$2(-0.05\,C_2 - 0.057C_3) = -2 \rightarrow (4)$$

Applying eq (3) & eq (4)

$$0.1\,C_2 + 0.014C_3 = -5$$

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

$$-0.1C_3 = -5-2$$

$$-0.1C_3 = -7$$

$$C_3 = \frac{-7}{-0.1}$$

$$\boxed{C_3 = 70}$$

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Now putting value of c_3 into eq (3)

$$\Rightarrow 0.1c_2 + 0.014(70) = -5$$

$$\Rightarrow 0.1c_2 + 0.98 = -5$$

$$\Rightarrow 0.1c_2 = -5 - 0.98$$

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

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

Part B :-

Zero input & zero state :-

So the Homogeneous & Particular and the ~~f~~ zero input zero state solution answer are same

So for zero input:

$$y_h(n) = c_1 \cos(1)^n + c_2(-34.04)^n + c_3(-35.04)^n$$

and for zero state:-

$$y_p[n) = 10u4(n)$$

which will be

$$y_p(n) = 2.7$$

$\Rightarrow$ total solution will be ; a

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

$$\Rightarrow y(n) = c_1 \cos(1)^n + c_2(-34.04)^n + c_3(-35.04)^n + 2.7$$

Now putting the 4 Random value is total solution;

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

Now $y(n) = 1 = n$

$$= c_1 \cos(1)' + c_2(-34.04)' + c_3(-35.04)' + 2.7$$

$$\Rightarrow y(1) = c_1(1) + c_2(-34.04) + c_3(-35.04) + 2.8$$

Now Applying initial conditions

$\because\ c_1 \cos(1)^{-1} = 0$

$\Rightarrow c_1 \cos(-1) = 0$

$\Rightarrow c_1 = 0/\cos(-1) = 0/$

$\boxed{c_1 = 0}$

$y(-1) = 1$

$c_1 \cos(1)^{-1} + c_2(-34.4)^{-1} + c_3(-35.04)^{-1} = 1$

$= -c_1 + \left(\frac{-1}{34.4}\right) c_2 + \left(\frac{-1}{35.04}\right) c_3 = 1$

$= 0.\ 0.02 c_2 - 0.029 c_3 = 1 =$

$\Rightarrow y(-1) = -0.02 c_2 - 0.029 c_3 = 1 = \boxed{1}$

Now Applying 2nd condition:

$y(-2) = -1$

$= c_1 \cos(1)^{-2} + c_2(-34.04)$

$+ c_3(-35.04)^{-2} = 1$

$= 0 + \left(\frac{-2}{34.04}\right) c_2 + \left(\frac{-2}{35.04}\right) = -1$

$= 0.05 c_2 - 0.067 c_3 = -1 = \boxed{2}$

Now xing eq (1) with "-5"

$\Rightarrow -5(-0.02 c_2 - 0.029 c_3) = 1(-5)$

$\rightarrow 0.1 c_2 + 0.015 c_3 = -5 \rightarrow$ (3)

* Now 2nd

$$y(2) = c_1 \cos(1)^2 + c_2(-34.04)^2 + c_3(-35.04) + 2.7$$

$$= c_1 \cos(1) + c_2(34.04)^2 + c_3(35.04)^2 + 2.7$$

$$\Rightarrow y(2) = c_1 + 1186.4 c_2 + 1221.04 c_3 + 2.7$$

* Now 3rd

$$y(3) = c_1 \cos(1)^3 + c_2(-34.04)^3 + c_3(-35.04)^3 + 2.7$$

$$y(3) = c_1 \cos(1) + c_2(-39444.8) + c_3(-43022.16) + 2.7$$

$$= c_1 \cos(1) - 3944.8 c_2 - 43022.16 c_3 + 2.7$$

* Now 4th

$$y(4) = c_1 \cos(1)^4 + c_2(-34.04)^4 + c_3(-35.04)^4 + 2.7$$

$$= c_1 \cos(1) + c_2(1342635.74) + c_3(1507496.76) + 2.7$$

$$= c_1 + 1342635.74 c_2 + 1507496.76 c_3 + 2.7$$

$c_1 = 1342635.74$

$c_2 = 1507496.76$

$c_3 = 2.7$

Q-2. Part — (a)

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

For sampling frequency

$$f_s \geq 2 f_m$$

So!

$$x(t) = 5000 \cos 5.0\pi t + \sin 0.5\pi t + 5.89\left(\frac{1}{2}\right)\left(\sin(10\pi + 0.5\pi)t + \sin(10\pi - 0.5\pi)t\right) + \sin 100\pi t$$

$$\Rightarrow x(t) = 5000 \cos 5.0\pi t + \sin 0.5\pi t + 2.94(\sin 10.5\pi t - \sin 9.5\pi t) + \sin 100\pi t$$

$$\Rightarrow x(t) = 5000 \cos 5.0\pi t + \sin 0.5\pi t + 2.94 \sin 10.5\pi t - 2.94 \sin 9.5\pi t + \sin 100\pi t$$

Now

$\omega_1 = 5.0\pi \Rightarrow 2\pi f_1 = 5.0\pi \Rightarrow f_1 = 2.5$ Hz

$\omega_2 = 0.5\pi \Rightarrow 2\pi f_2 = 0.5\pi \Rightarrow f_2 = 0.25$ Hz

$\omega_3 = 10.5\pi \Rightarrow 2\pi f_3 = 10.5\pi \Rightarrow f_3 = 5.25$ Hz

$\omega_4 = 9.5\pi \Rightarrow 2\pi f_4 = 9.5\pi \Rightarrow f_4 = 4.75$ Hz

$\omega_5 = 100\pi \Rightarrow 2\pi f_5 = 100\pi \Rightarrow f_5 = 25$ Hz. $\longrightarrow f_{maximum}$

So

$$f_s \geq 2 f_m$$

$$f_s \geq 2(25)$$

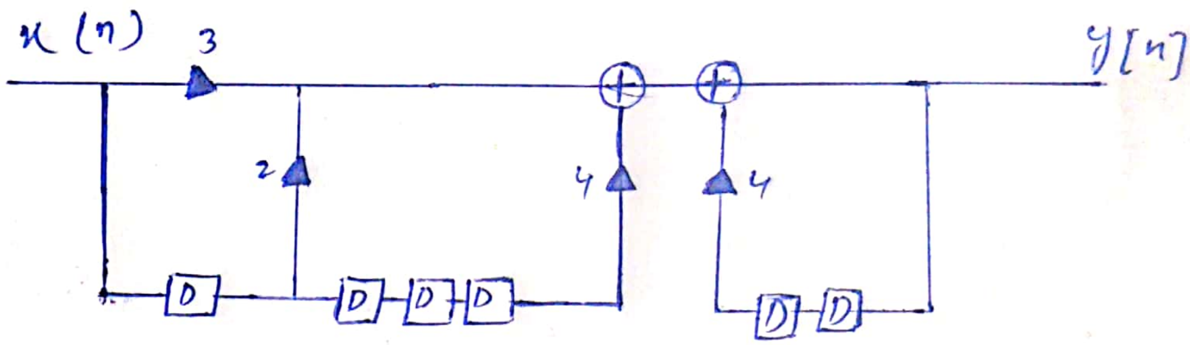
$$f_s \geq 50 \text{ Hz.}$$

Q No 2:-
part (b)

* is $y[n] - 4y[n-2] = 3x[n] + 2x[n-1] + 4[n-4]$

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

Block diagram:-



we know that
order of this system is
the maximan delay

So (order of the system = 4)

Adders	=	3
Scalars	=	4

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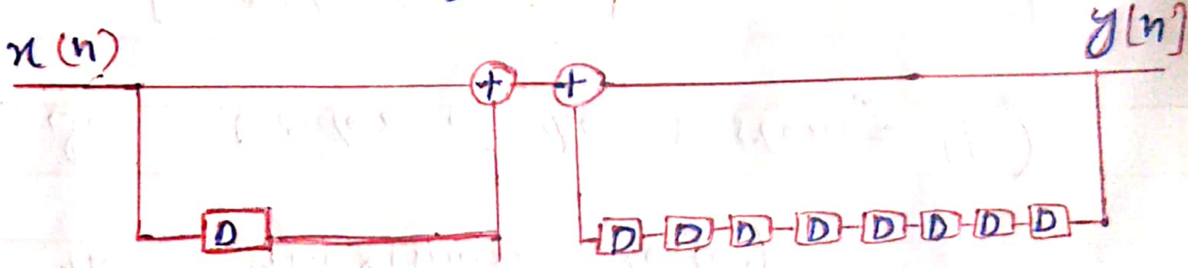
* ii) $y[n] - 10.3y[n-8] = x[n] + 3x[n-1]$

Sol

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

Block diagram



(order = 8)

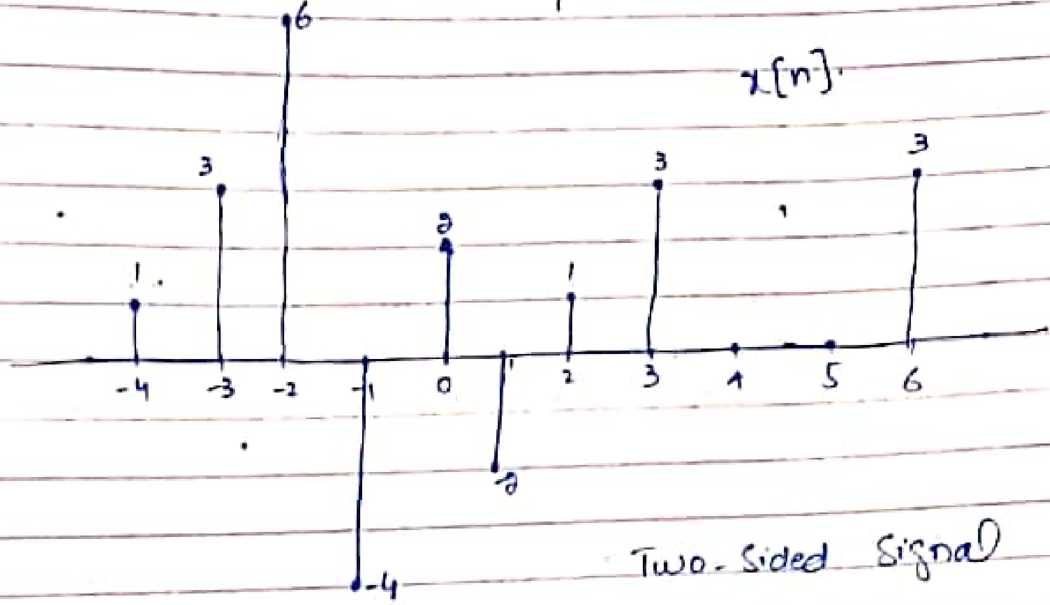
(Adders = 2)

(scalars = 2)

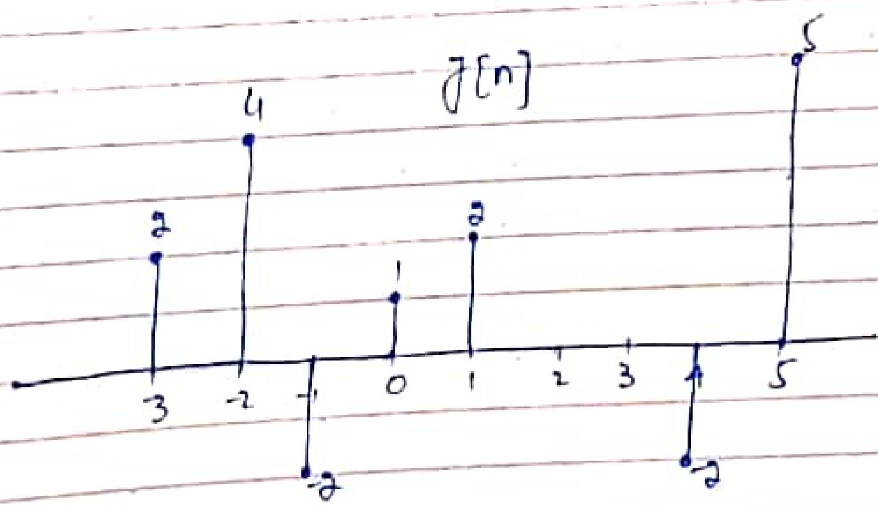
Q3:

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

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



Two-Sided Signal (TSS)



Two-Sided Signal (TSS)

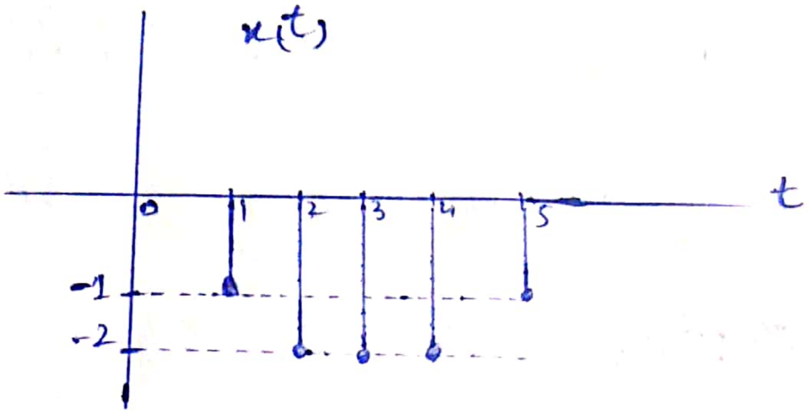
Q No:3

Part (b)

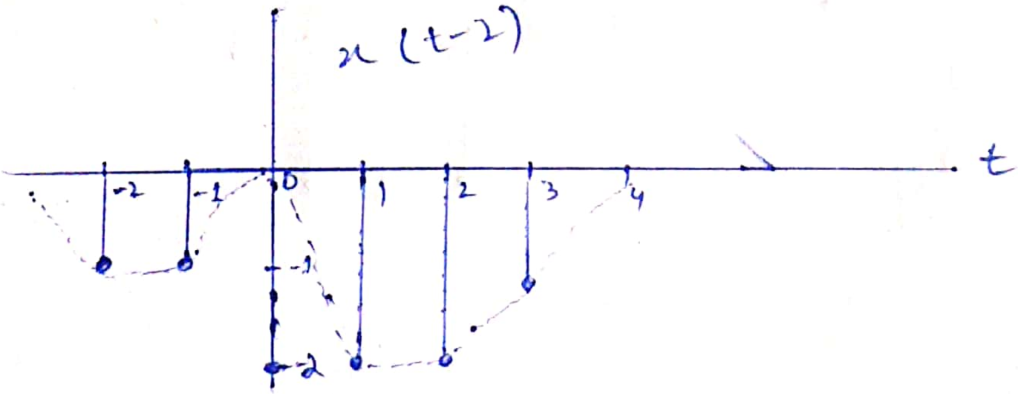
$x(t) = \{\underset{0}{-1}, \underset{1}{-1}, \underset{2}{-2}, \underset{3}{-2}, \underset{4}{-2}, \underset{5}{-1}\}$

Plot

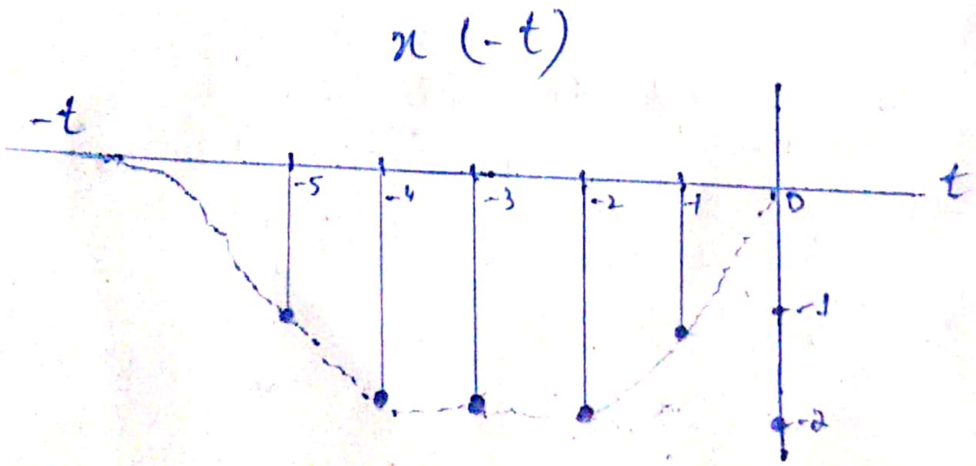
Sol



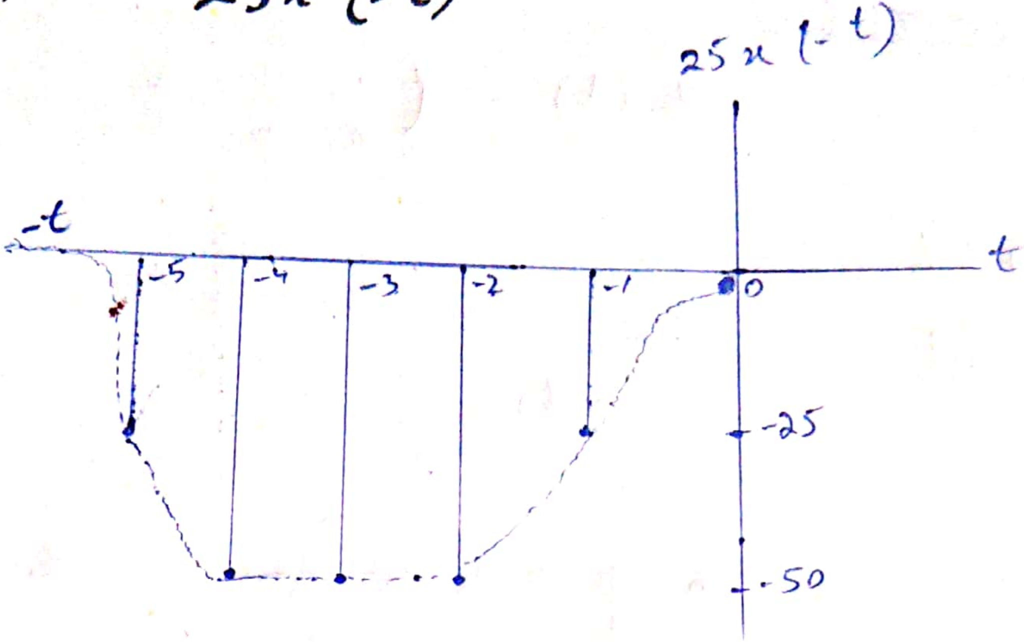
(i) $x(t-2)$



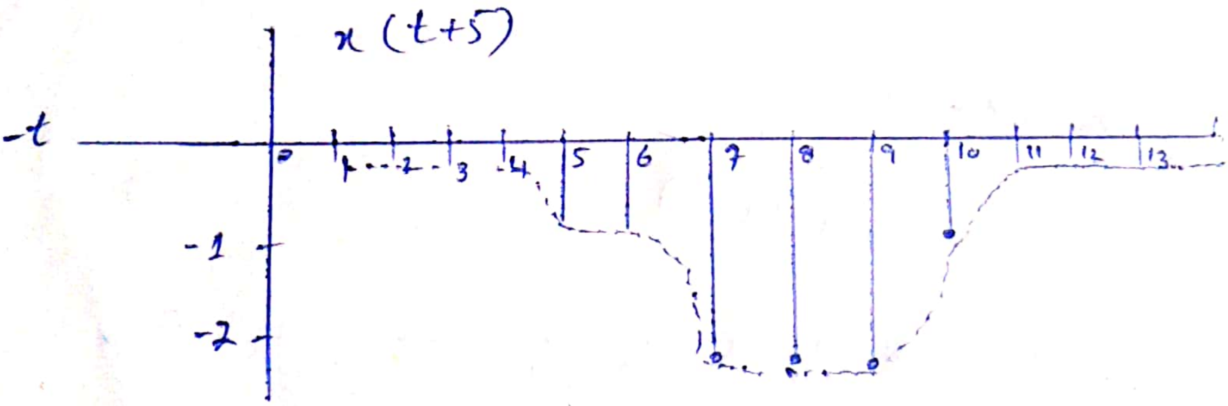
(ii) $x(-t)$



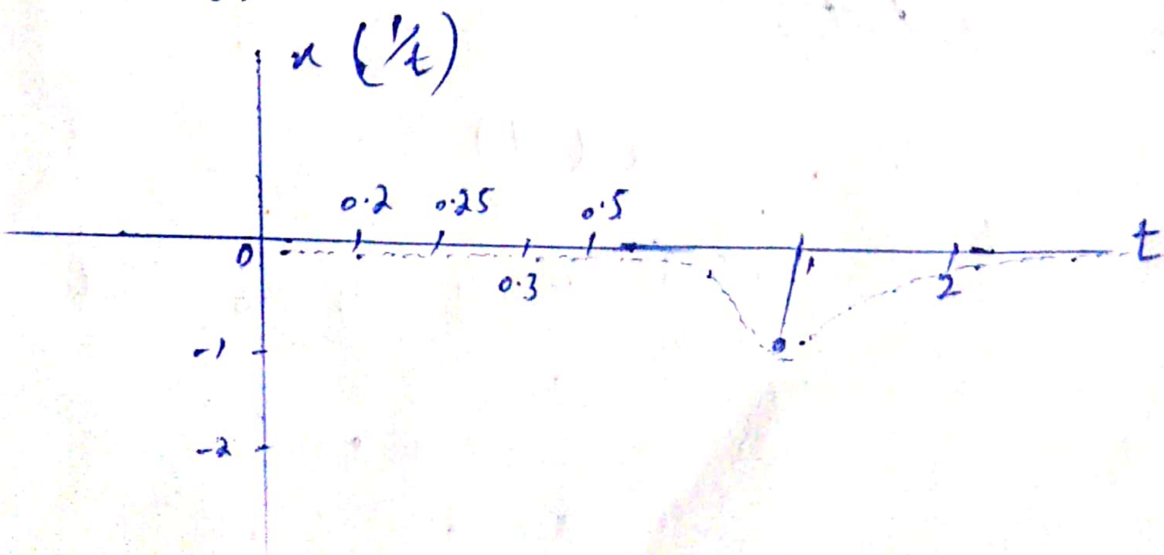
(iii) $25x(-t)$



(iv) $x(t+5)$



(v) $x(1/t)$



So

at $t=0$ $x(\frac{1}{0}) \Rightarrow x(\alpha) \Rightarrow x(\alpha)=0$

at $t=1$ $x(\frac{1}{t}) \Rightarrow x(1) \Rightarrow x(1)=0$

at $t=2$ $x(\frac{1}{2}) \Rightarrow x(0.5)$ $x(0.5)=0$

at $t=3$ $x(\frac{1}{3}) \Rightarrow x(0.33) \Rightarrow x(0.33)=0$

at $t=4$ $x(\frac{1}{4}) \Rightarrow x(0.25) \Rightarrow x(10.25)=0$