Solution Manual for Signals Systems and Transforms 5th Edition Phillips Parr Riskin 0133506479 9780133506471

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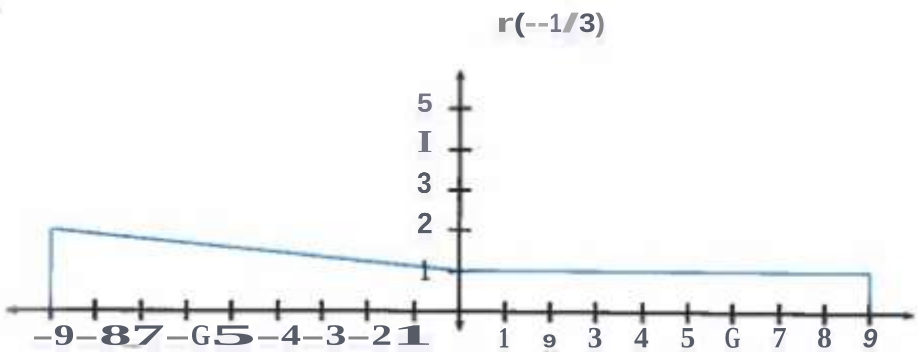
Chapter 2 solutions

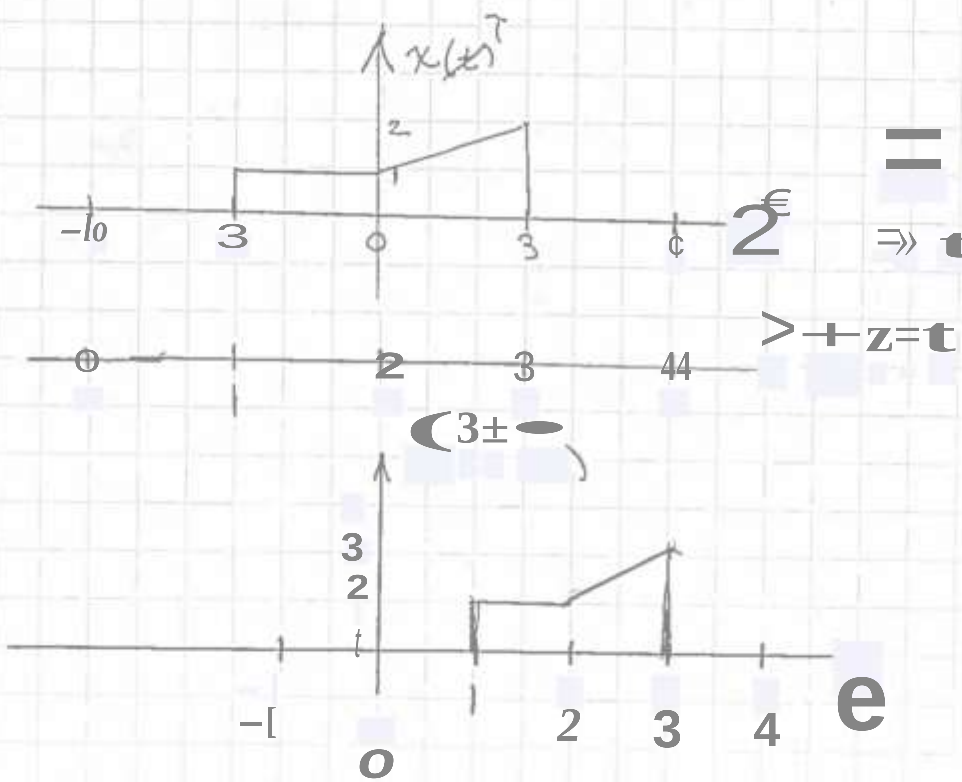
2.1

(a)

(i)



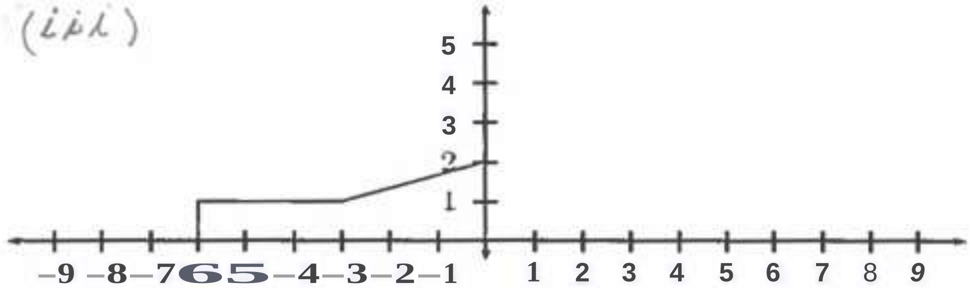
(ii)



RoCGr 2.1 @) ~oteA

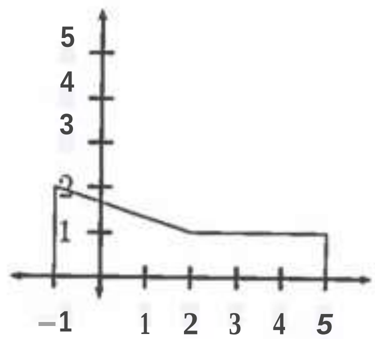
a(3 +t)

2 (iii)



(iv)

2(2 −t)



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7.()

3

−3 −2 --] z 3 44 5

-30 Cf ¢

(z±) = x/v) ? = 3 l -% t 7¢ 3

(3~-%) 1

2 3

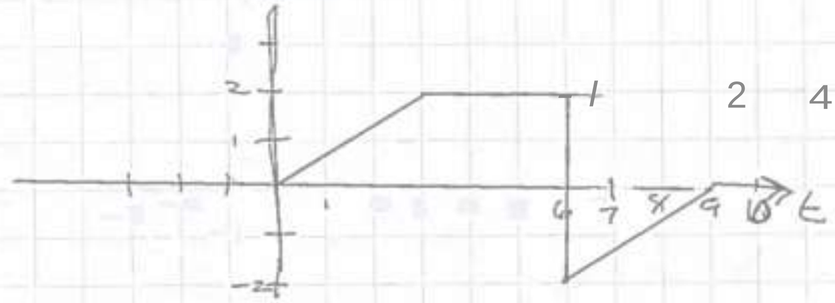
(2c.) (+ t) = z l @ = + 3

-3 q €

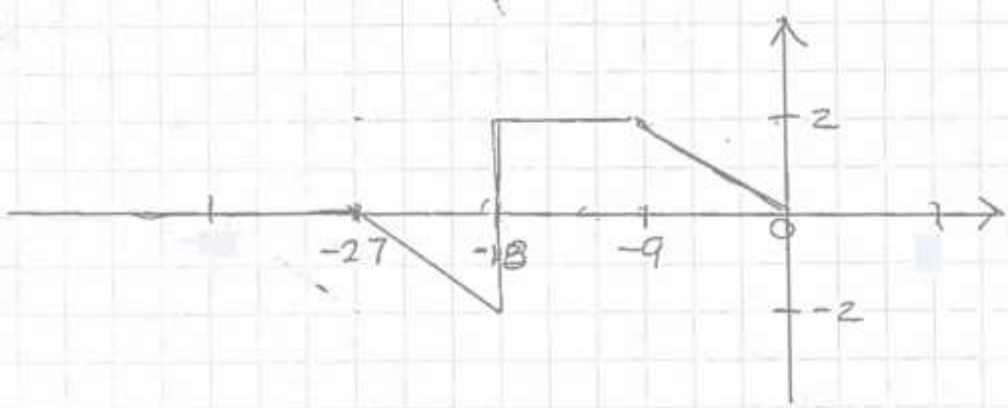
Z ¥(2-4) => 7 t = 2-± 3/ t

r

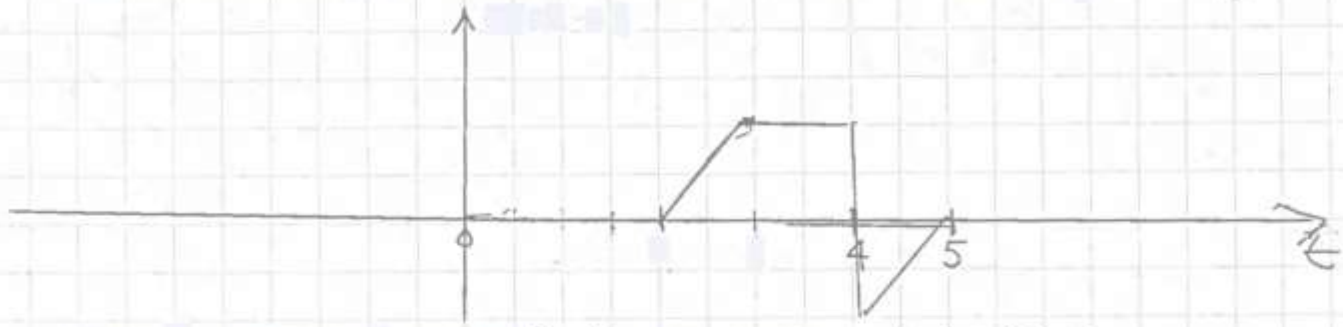
2.1(b)



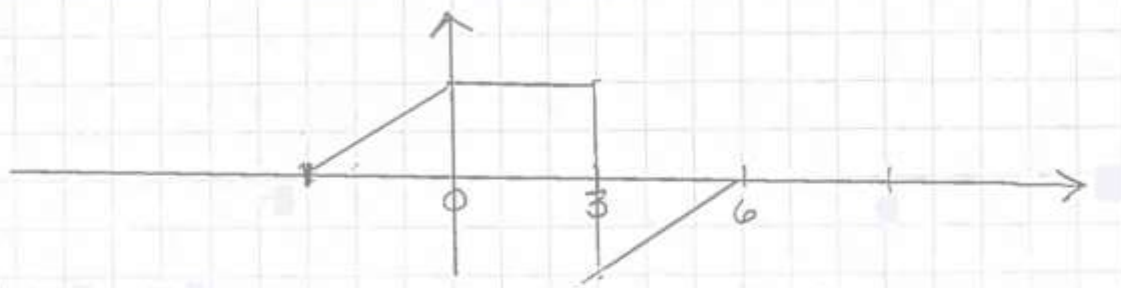
(i) $x(-t/3) = x(\tau) \Rightarrow \tau = -t/3 \Rightarrow t = -3\tau$



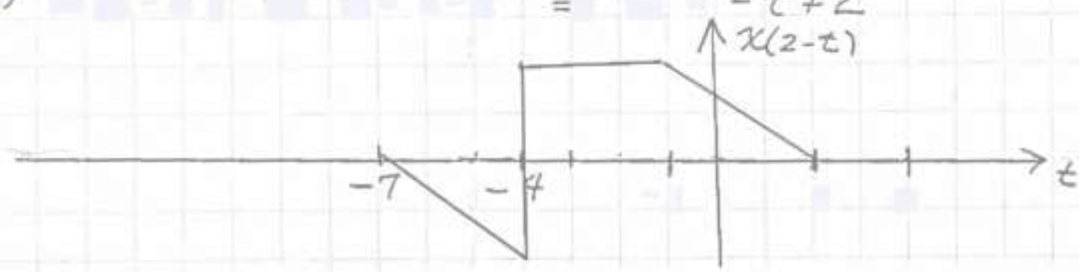
[illegible] $\Rightarrow$ [illegible] $\Rightarrow$ [illegible] $=$ [illegible] $= \tau/3 + 2$



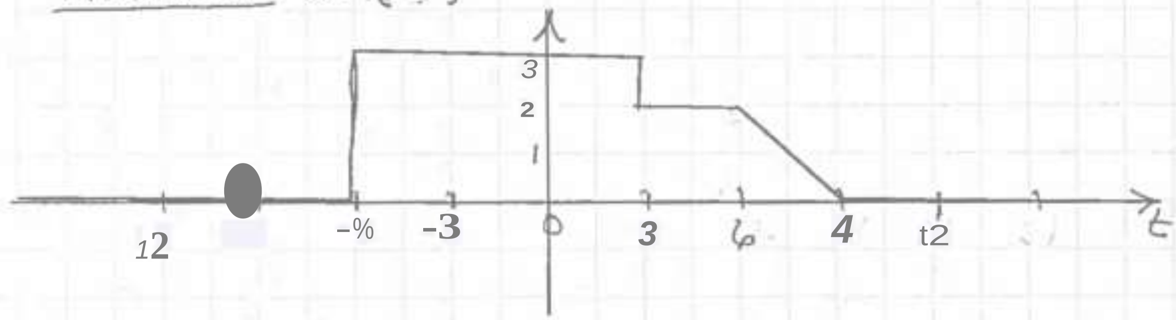
[illegible]) $\Rightarrow$ [illegible] $\Rightarrow t = \tau - 3$



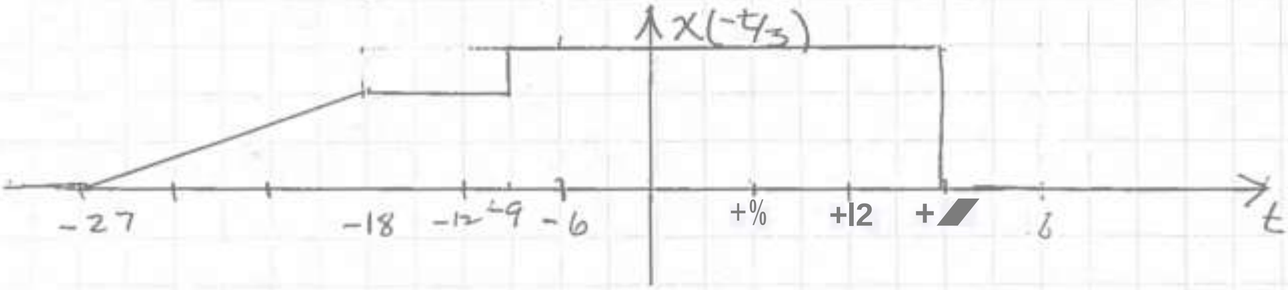
[illegible]) [illegible] $=$ [illegible] $-\tau + 2$



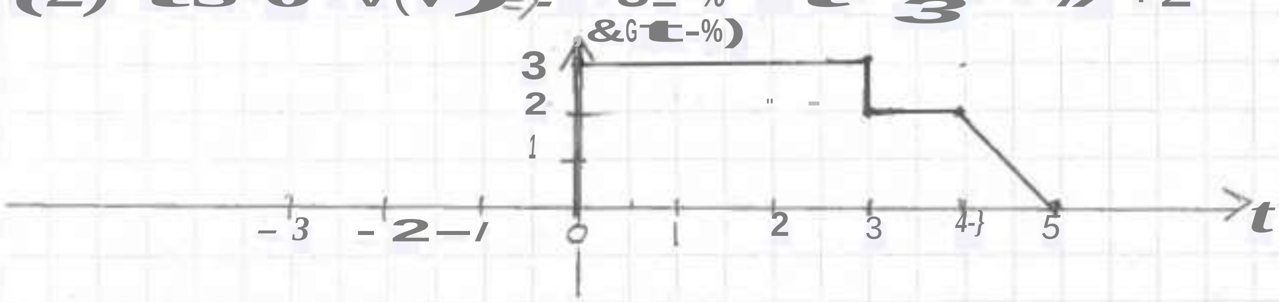
Problem 2.1(c)



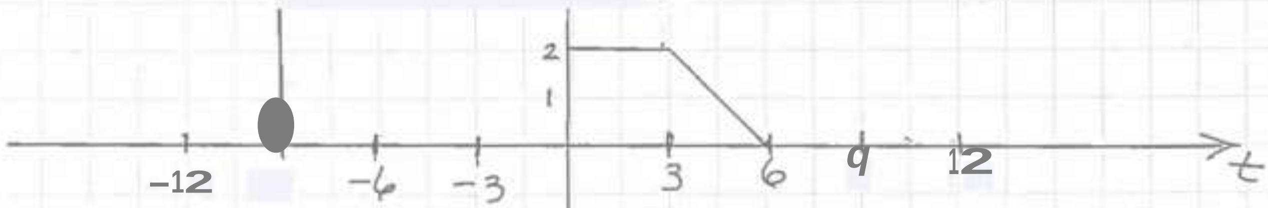
(i) $x(-t/3) = x(\tau) \Rightarrow \tau = -t/3 \Rightarrow t = -3\tau$



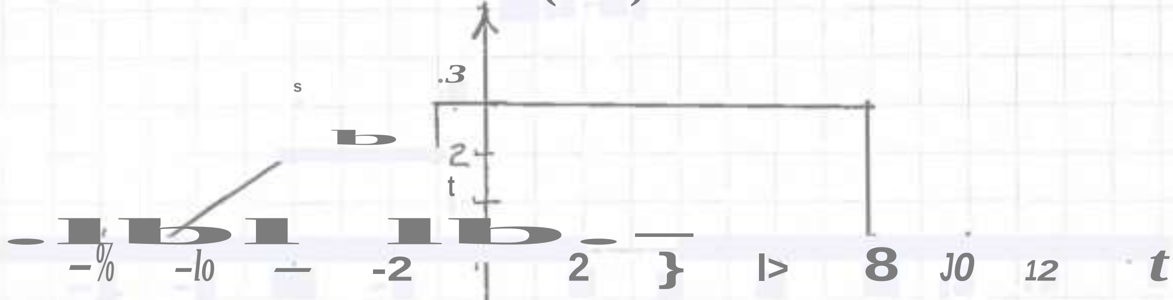
(ii) $x(3t+2) = x(\tau) \Rightarrow \tau = 3t+2 \Rightarrow t = \frac{\tau - 2}{3}$

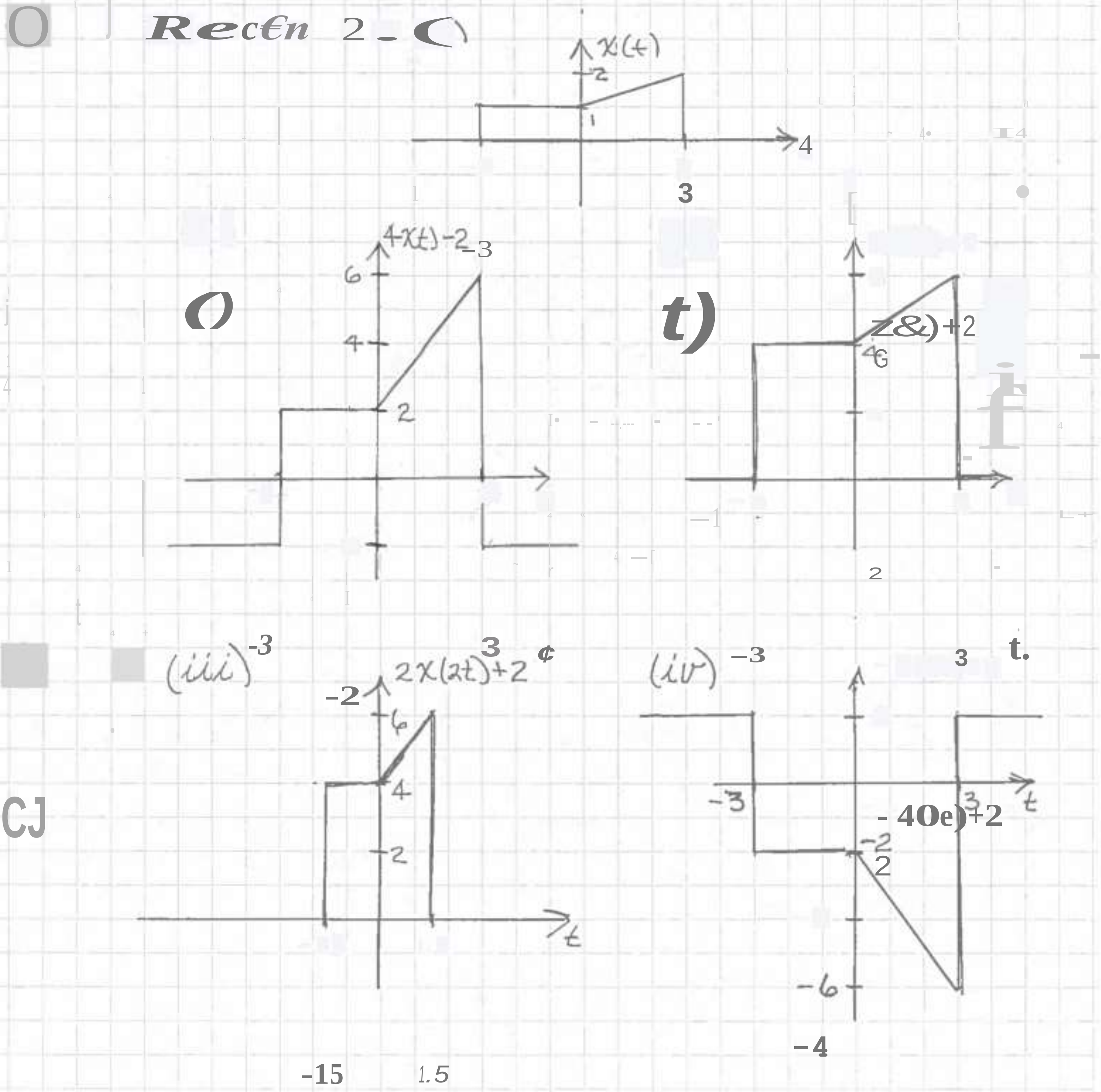


(iii) $x\left(\frac{5+t}{3}\right) = x(\tau) \Rightarrow \tau = \frac{5+t}{3} \Rightarrow t = 3\tau - 5$



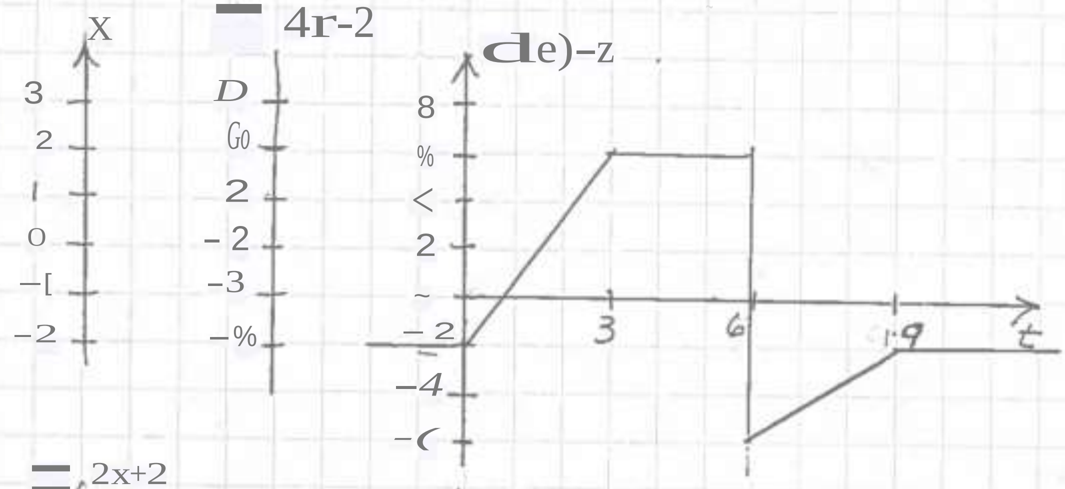
(iv) $x(2-t) = x(\tau) \Rightarrow \tau = 2-t \Rightarrow t = -\tau + 2$

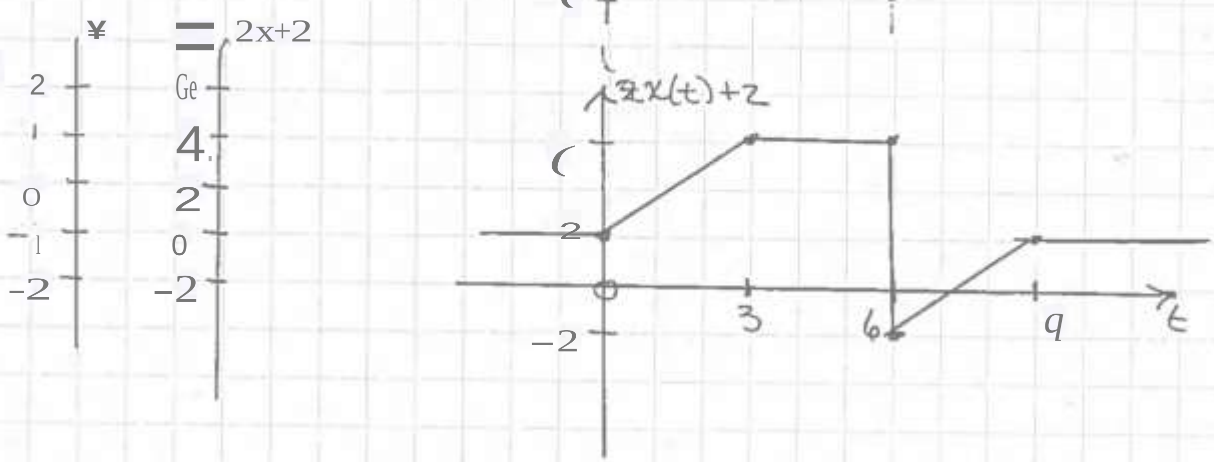


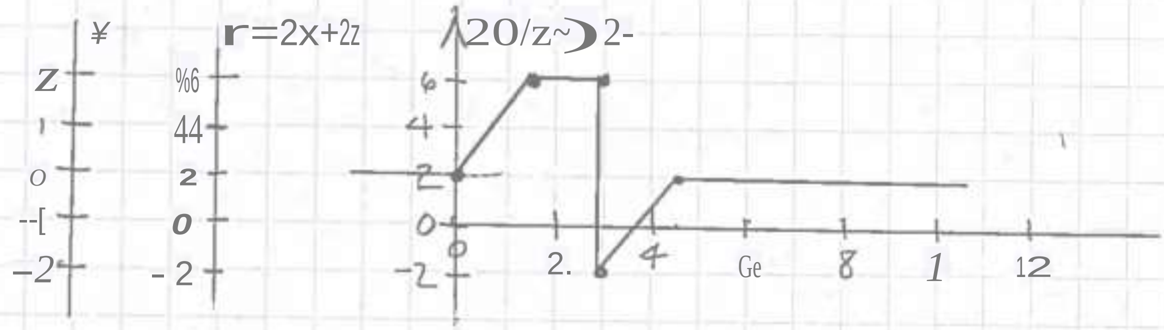


x(t)
2
1
3
4x(t)-2
6
4
2
(iii)
2x(2t)+2
6
4
2
t
(iv)
-3
3
t
-2
-6

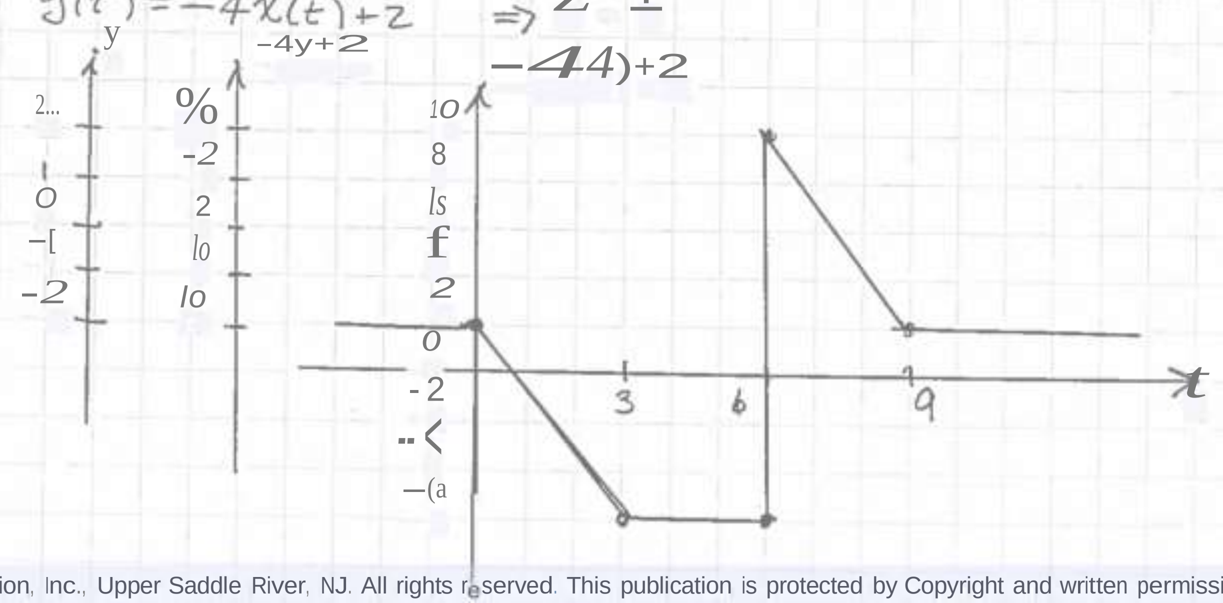
O





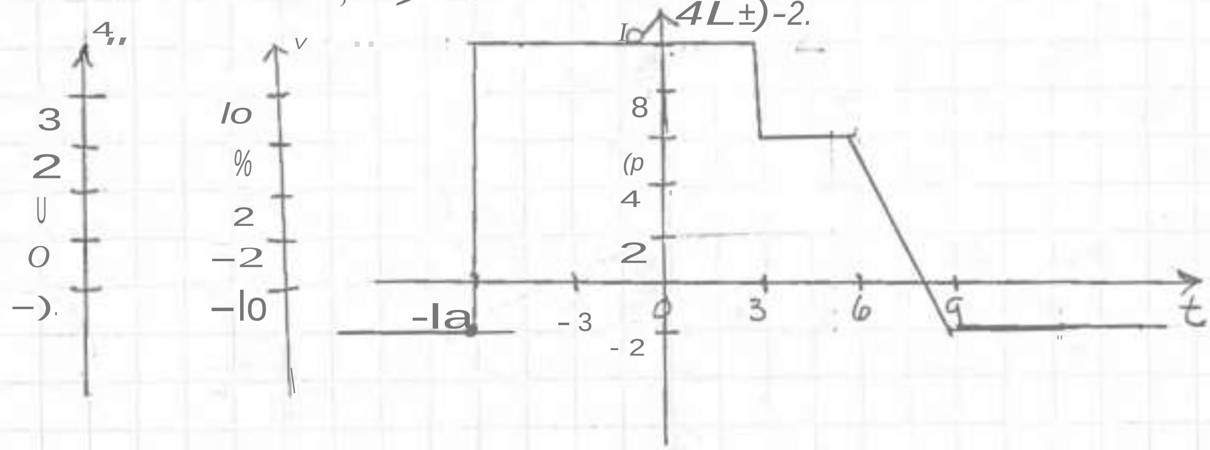


(iv) y(t) = −4x(t)+2

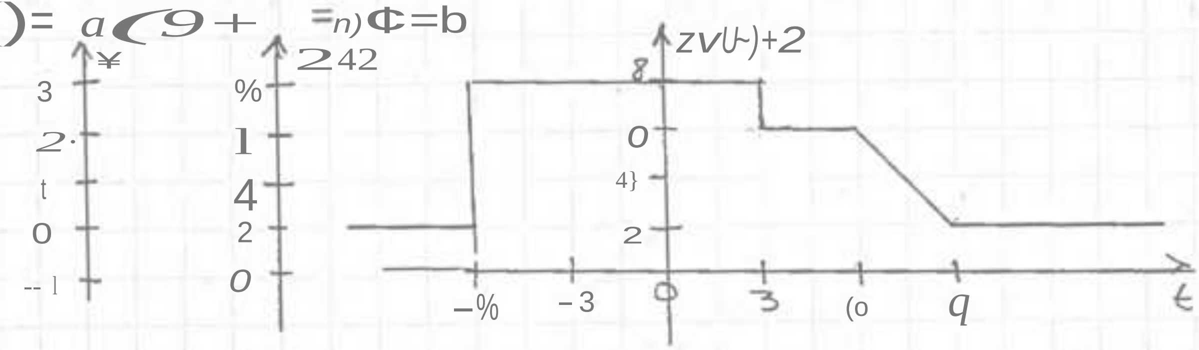


Pa.2(¢

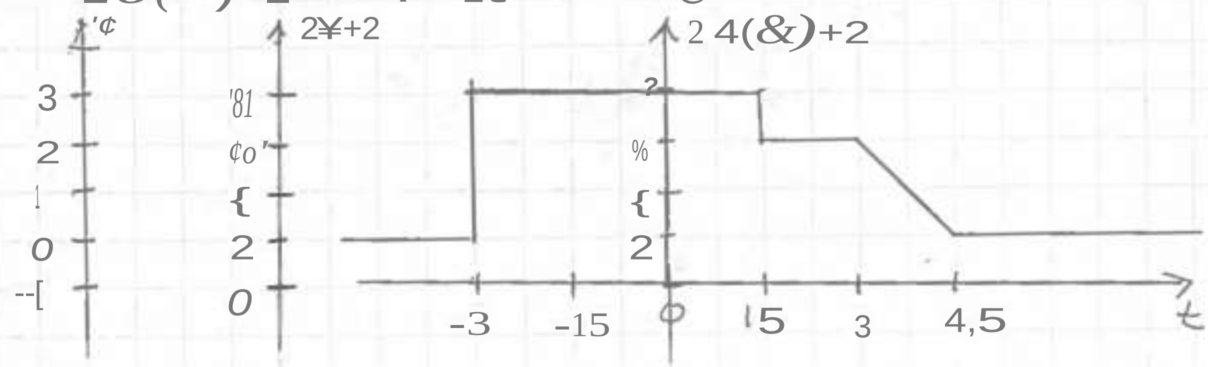
() gt) = 4 Ie)−2) τ =±



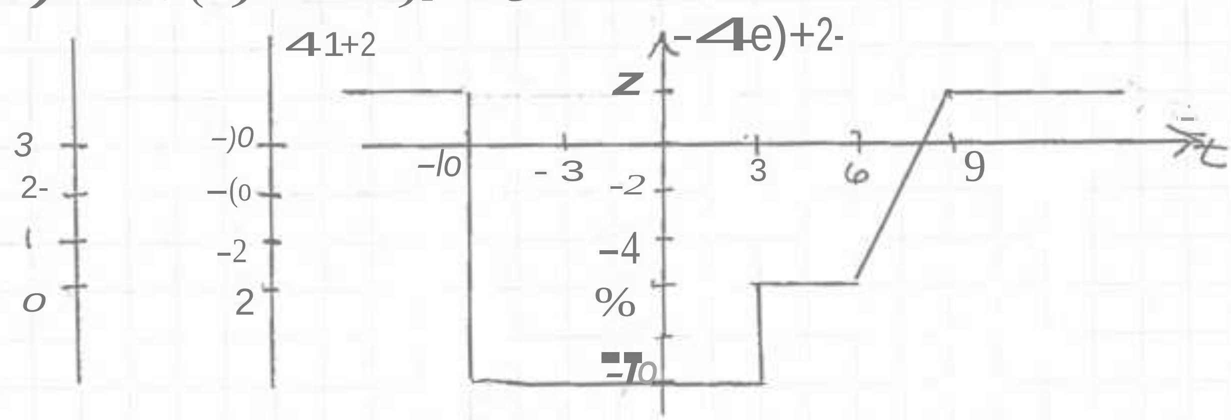
(2) ()= a(9+ =n)¢=b



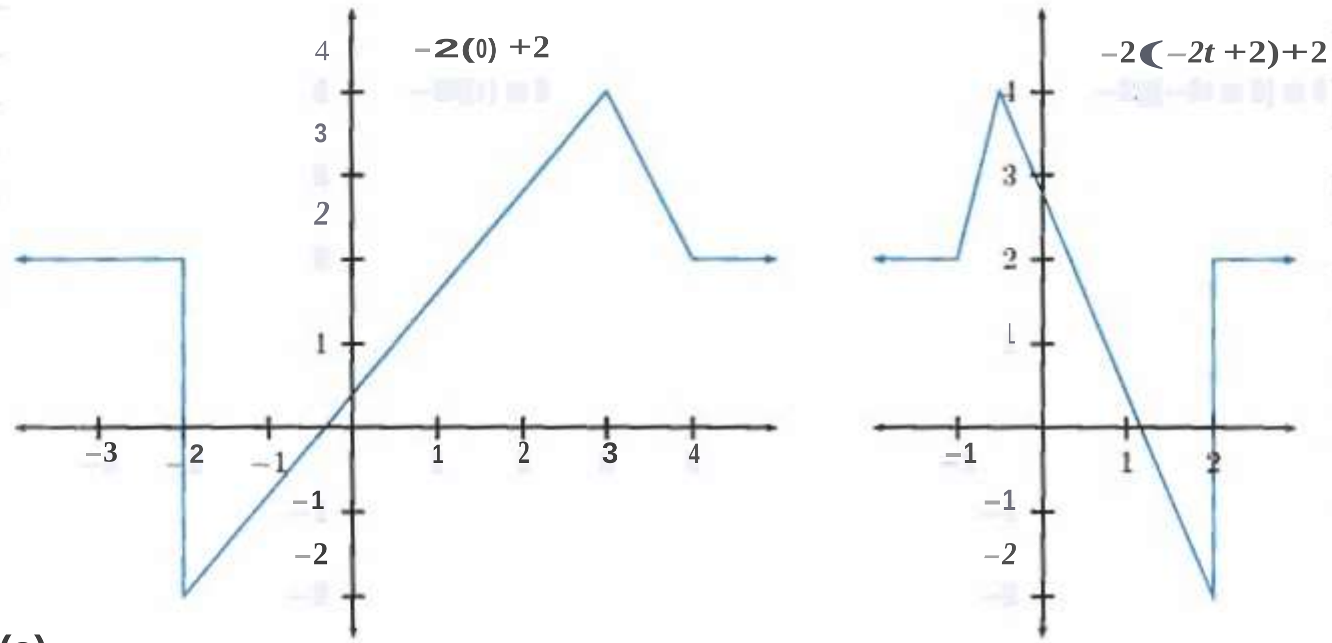
(c2) =2O(')+2 > ?- 2t = =@/



(v) y(v)= -W(±)+2 =)r=t



PROBLEM 23



(a)

$y(t) = -2((-2t+2)) + 2$

(b)

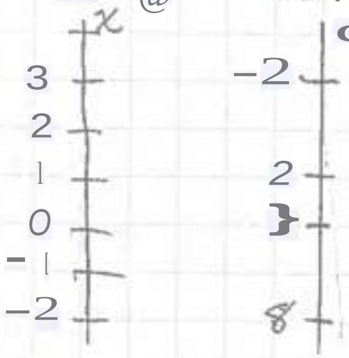
t	y(t)	$2t+2$	$-2((-2t-1))+2$
-0.5	4	3	4
-1	2	4	2
1	0.4	0	0.4

Solution P 2.4

(a) $g(t) = x(-2t+4)$

$y = -\frac{1}{2}\tau + 2 \qquad \tau = -2t+4$

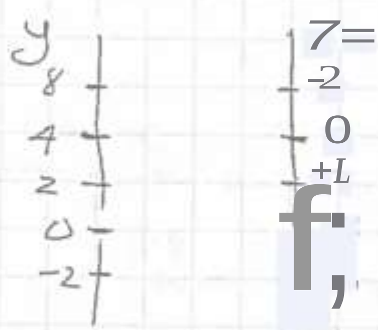
$y = -2x + 4$ ✓



(b) $x(t) = -\frac{1}{2}y(-2t+4)+2 \Rightarrow \tau = -2t+4$

$\Rightarrow t = -\frac{1}{2}\tau + 2$

$x = -\frac{1}{2}y + 2$



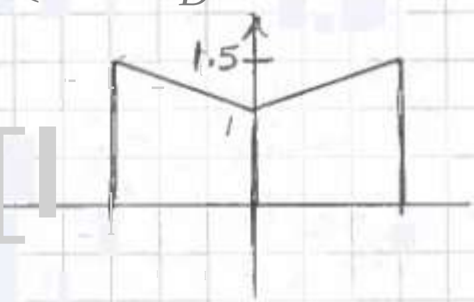
✓

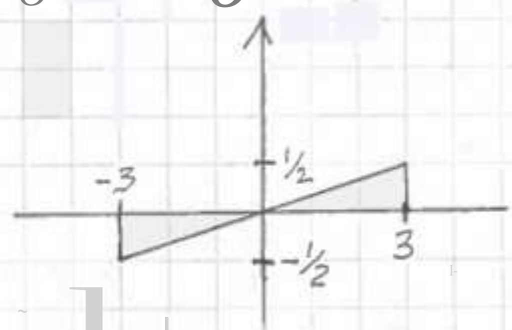
Problem 2.

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

$x_o(t) = \frac{1}{2}[x(t) - x(-t)]$ (2.1?)

t	x(t)	x(-t)	$x_e(t)$	$x_o(t)$
3	0	0	0	0
a	2	|	3/	/2
t5	) 5	/	1.25	0.25
0	l	|		0
-15		1,5	1.25	-O25
-3		2	3	-ha
(-3	D	0	o	0





(b) $x_o(t) + x_e(t) = x(t)$

-3

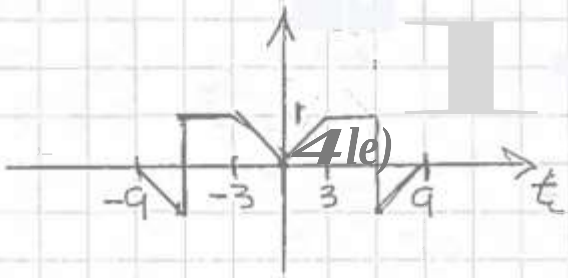
veM£

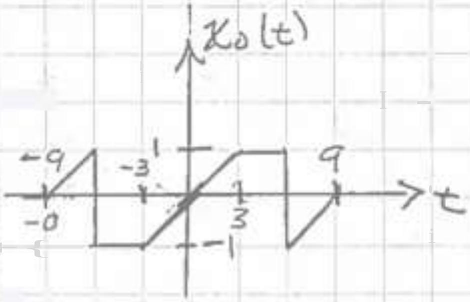
3

Problem 2.5

(b)

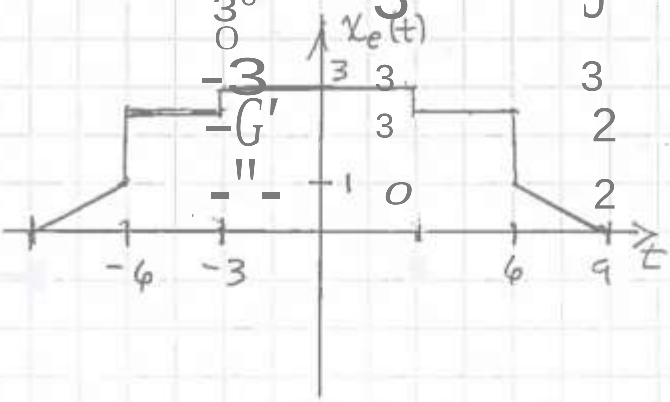
t	x(t)	x(-t)	$x_e(t)$	$x_o(t)$
>	0	0	0	0
%	-2	0	--[	-}
d	2	0	J	t
3	2	0	I	I
0	0	0	0	0
+3	0	2	)	I
-%	0	-2	-f	1

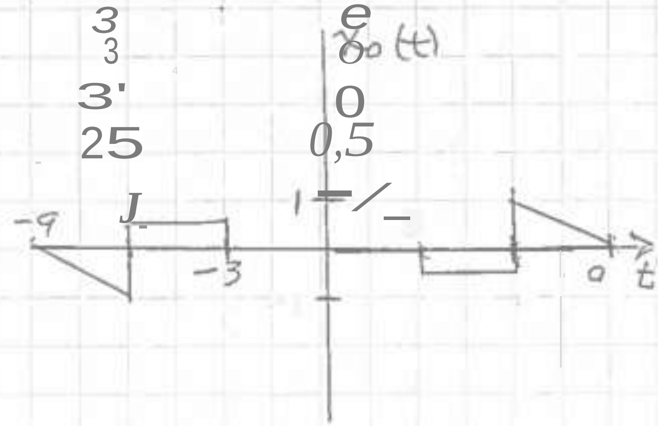




(c)

t	x(t)	x(-t)	$x_e(t)$	$x_o(t)$
>	0	0	0	0
6	2	9	1	1
			2	.5
G•	2		55	-0
3°	3	3	3	e
0			3	0
-3	3	3	3'	0
-G'	3	2	25	0,5
-"-	0	2	J	=/_





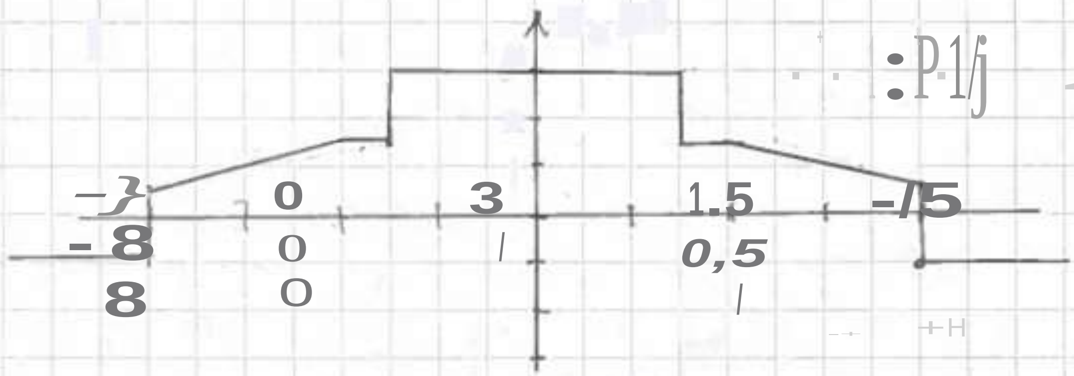
3

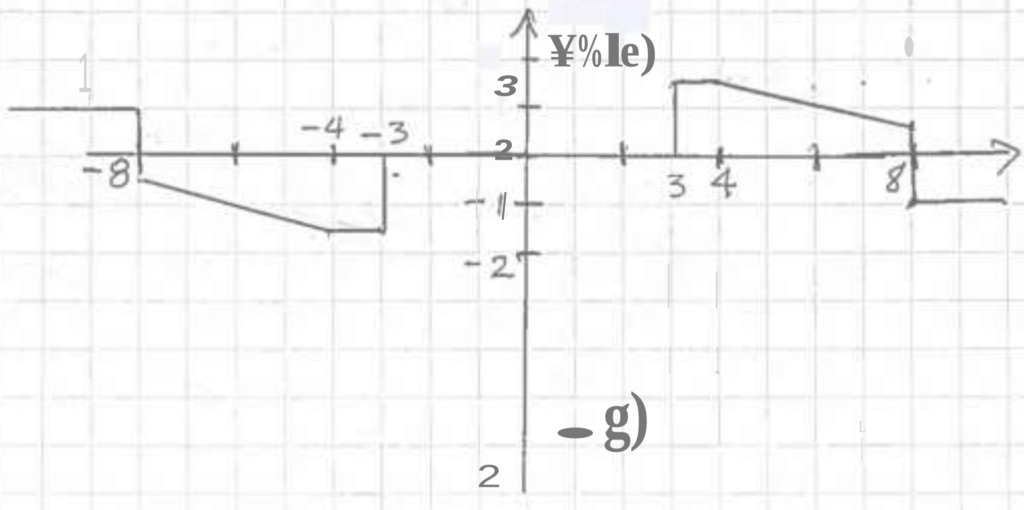
-9 3 -1

O

Problem 2.5 (d)

±	x(t)	C(-0)	Ket)	%..(e)
	-2			–
> 8		o	–l	[
3	l	o	or5	0.5
/	3	O	1.5	1.5
3+	3	0	is	.5
37	3	3	3	0
–3t	3	3	3	O
–37	0	3	l.5	–15
		-2	–	





e

role a.%

() X() = ht ⇒ (-t)=4±

X (-t) = ~ (--t') /, 'L (r", oJd

-t i's t/

j %e"-zσS. =

I+jll, @w=u) : b is eden

⇒

() z@e= 50»ss± tv)=5Cs3(¢)

=5O3¢ = 53t

Xe

ts €

() d—a(e+am = Ai(3[¢+4J))

(le)= – Cs&(st)

(e) x(t) =

(e= d(-t):. X) is euo

@ vale) –u(-t) ⇒ (-t)= (-t)- u(e)

-[ts -ut-e]

= -

1(e) =–¢-t) : (e Ts 3dd

(4(e\ u(e-) +(-t-)

L(-t)= — (-t-)+(t-v)

a4(–t) =5e) , o o () is Ad

PROBLEM 2.7

(a) $\int_{-T}^{T} x_o(t) = \int_{-T}^{0} x_o(t)dt + \int_{0}^{T} x_o(t)dt$; $x_o(t) = -x_o(-t)$

$\therefore \int_{-T}^{0} x_o(t)dt = -\int_{-T}^{0} x_o(-t)dt \Big|_{t=-\tau} = \int_{-T}^{0} x_o(\tau)d\tau = -\int_{0}^{T} x_o(\tau)d\tau$

$\therefore \int_{-T}^{T} x_o(t)dt = 0$

(b) $\int_{-T}^{T} x(t)dt = \int_{-T}^{T}[x_e(t) + x_o(t)]dt = \int_{-T}^{T} x_e(t)dt$

and $A_x = \lim_{T\to\infty} \frac{1}{2T}\int_{-T}^{T} x(t)dt = \lim_{T\to\infty}\frac{1}{2T}\int_{-T}^{T} x_e(t)d\tau$

(c) $x_o(0)=-x_o(-0)= -x_o(0)$. The only number with $a=-a$ is $a=0$ so this implies $x_o(0)=0$.
$x(0)=x_e(0)+x_o(0)=x_e(0)$.

PROBLEM 2.8

(a) Let $z(t)$ be the sum of two even functions $x(t)$ and $y(t)$. To show that $z(t)$ is even, we need to show that $z(t) = z(-t)$ for all t. This is easy to show, since $z(t) = x(t) + y(t)$ and $z(-t) = x(-t) + y(-t)$ (since to get $z(-t)$ we just plug in $-t$ everywhere for t, which amounts to just plugging in $-t$ in $x(t)$ and $y(t)$). Now since $x(t)$ and $y(t)$ are even, by definition $x(t) = x(-t)$ and $y(t) = y(-t)$ so $x(t) + y(t) = x(-t) + y(-t)$ so $z(t) = z(-t)$.

(b) Let $x(t)$ and $y(t)$ be two odd functions. Then $x(-t) + y(-t) = -x(t) + (-y(t)) = -(x(t) + y(t))$ which shows that $x(t) + y(t)$ is odd.

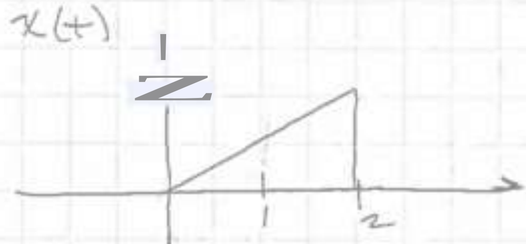
(c) Let $z(t) = x(t) + y(t)$ as in part a, where now $x(-t) = x(t)$ and $y(-t) = -y(t)$. We need to show that $z(t) \neq z(-t)$, $z(t) \neq -z(-t)$. Consider that $z(-t) = x(-t) + y(-t) = x(t) - y(t)$. In order to have $z(t)$ be even, we would therefore need to have $x(t) + y(t) = x(t) - y(t)$ for all t, which is equivalent to having $y(t) = -y(t)$ for all t, which is not possible for nonzero $y(t)$. Similarly, in order to have $z(t)$ be odd, we would need to have $z(t) = -z(-t) = x(t) + y(t) = y(t) - x(t)$, which is not possible for nonzero $x(t)$. So the sum of an even and odd function must be neither even nor odd.

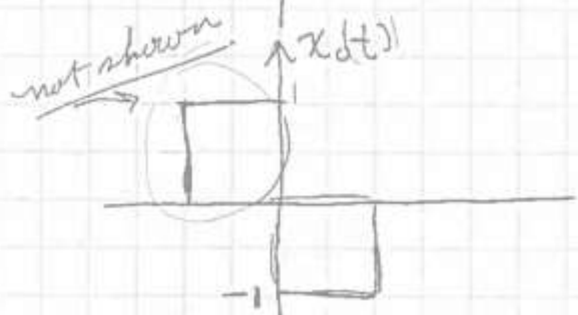
(d) Let $z(t) = x(t)y(t)$ where $x(t) = x(-t)$ and $y(t) = y(-t)$. Then $z(-t) = x(-t)y(-t) = x(t)y(t) = z(t)$ which shows that $z(t)$ is even.

(e) Let $z(t) = x(t)y(t)$, where $x(t) = -x(-t)$ and $y(t) = -y(-t)$. Clearly $z(t)$ is even because $z(-t) = x(-t)y(-t) = (-x(t))(-y(t)) = x(t)y(t) = z(t)$, which is the definition of evenness.

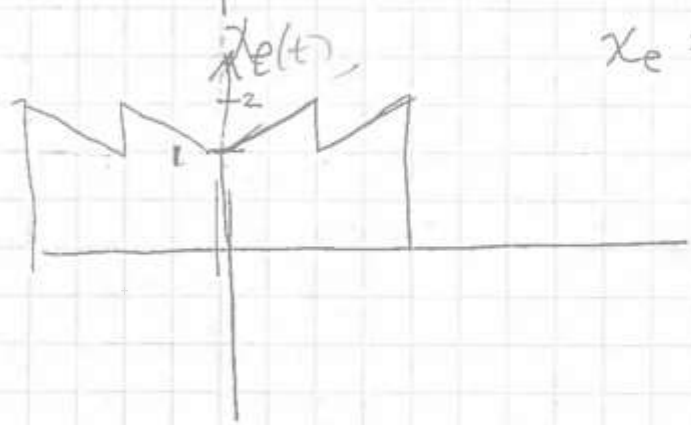
(f) Let $z(t) = x(t)y(t)$, where $x(t) = -x(-t)$ and $y(t) = y(-t)$. Clearly $z(t)$ is odd because $z(-t) = x(-t)y(-t) = (-x(t))y(t) = -x(t)y(t) = -z(t)$, which is the definition of oddness.

P2.%

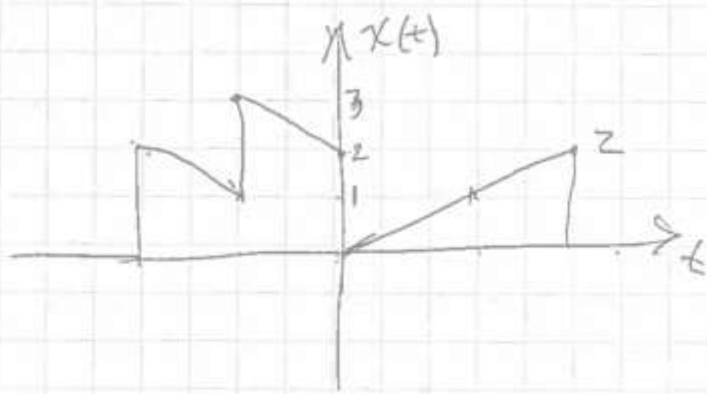




$$x_o(t) = \frac{x(t) - x(-t)}{2}$$



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



$$x(t) = x_o(t) + x_e(t)$$

ezo ,

$\frac{2\pi}{3}$

(a) sin(t)= sin(t +n?2n) for an integer *n*. so 7sin(3t) = 7sin(3t + n2) = 7sin (3(t + *n*≠)); therefore r(t) is periodic with fundamental period T = and fundamental frequency n = #f= 3.

(b) sin(8(t + f) + 3O) = sin(8t + 2n + 30) = sin(8/+ 30).
g =8and *Ti*= =f.

(c) *e!'* = cos(*t*) + *j*sin(t) is periodic with fundamental period 2m. so *e!"* is periodic with fundamental period ±; = n. and fundamental frequency *en* = 2.

(d) $\cos 2t + \sin 5t$

$T_1 = \frac{2\pi}{2} = \pi$, $T_2 = \frac{2\pi}{5}$ ⇒ $\frac{T_1}{T_2} = \frac{\pi}{2\pi/5} = 5/2$ ratio of integers

$T_0 = k_0 T_1 \therefore T_0 = 2\pi (s)$, (periodic) $k_0 = 2$

(e) $e^{-j(10t+\pi/3)} = e^{-j\pi/3} e^{-j10t} = (\cos\pi/3 - j\sin\pi/3)\, e^{-j10t}$

$= (0.5 + j0.866)\, e^{-j10t}$

$T_0 = \frac{2\pi}{10} = \pi/5\ (s)$, periodic

(f) $e^{j15t} - e^{j20t}$

e^{j15t} & e^{j20t} are

$T_1 = \frac{2\pi}{15}$, $T_2 = \frac{2\pi}{20}$ = — = $\frac{20}{15}$ ratio of integers ∴ periodic

$\frac{20}{15} = \frac{4}{3}$

hoof po-ode - $\frac{2\pi}{5}$ s

±, _1s.
T, /0

$\frac{2\pi/5}{2\pi/15} = 3$, $\frac{2\pi/5}{2\pi/20}$ = % = % =3T, =

.4

O

P2,W

() xe =a¢ ± i 5t

(b) $x(t) = \cos t + \sin \pi t$

(c) $x(t) = \cos 3t + \sin 9t$

(d) vGe) = Cr± + A4n¢ + Ca(t)

(e € = Cart + - - &n4 , ₫T±

(£) &e=0%».(8u +so°)+ @ 2t a..(3u)

5»(utu

(a) $T_1 = 2$I , $T_2 = \frac{2\pi}{5}$, $\frac{T_1}{T_2} = \frac{2\pi/3}{2\pi/5} = \frac{5}{3}$

7%=3T = .1 ∴ periodic

(b) , 2 ,T%= an/g = 1 $\frac{T_1}{T_2} = 2\pi$ not a ration of integers

;°. 7% UWOC

(c) T,= a2/-3 , T2=2/9 , T/T $= 9/3 = 3/1$ ⇒ ration of integers

T% = 21/3 , food¢

(d) $T_1 = \frac{2\pi}{3\pi} = 2/3$, 7 -A-! / 4π , T3 -a/5

$\frac{T_1}{T_2} = \frac{2/3}{1/2} = \frac{4}{3}$, $\frac{T_1}{T_3} = \frac{2/3}{2\pi/5} = \frac{10}{6\pi} = \frac{5}{3\pi}$ ← NOT A RATIO OF INTEGERS ∴ SUM IS NOT PERIODIC

(e) $T_1 = \frac{2\pi}{4\pi} = 1/2$, $T_2 = \frac{2\pi}{6\pi} = 1/3$, $T_3 = \frac{2\pi}{5\pi} = \frac{2}{5}$

$\frac{T_1}{T_2} = \frac{1/2}{1/3} = \frac{3}{2}$, $\frac{T_1}{T_3} = \frac{1/2}{2/5} = 5/4$ both ratios of integers ∴ Sum periodic

lcm of denominators $= 4 \times 2 = 8 = k_0$

$T_0 = 8T_1 = 4$ s.

(f) $T_1 = 2\pi/3$, $T_2 = \frac{2\pi}{2}$, $T_3 = \frac{2\pi}{3\pi}$, $\frac{T_1}{T_3} = \frac{2\pi/3}{2/3} = \pi$ not rational ∴ Sum not periodic

3.12

(a) /e)= 52(±–00°) + 2 02(7±)

¥()= 5 4.(t -lo) pi.vlc 1, =16n/l5

¥5(= 2 a.(7t oo,=7 4d/s

$T_1 = \frac{2\pi}{15}$; $T_2 = \frac{2\pi}{7}$ $\frac{T_1}{T_2} = \frac{7}{15}$ ← ratio of integer ∴ Sum is periodic

$k_0 = 15 \Rightarrow T_0 = 15T_1 = \underline{2\pi}$ s

O d,(e=5 a.¥ .> pad_ U=5

lo =5e'5t > A?2cc ta=(5

Y) = A?¢ {<<. cr=l

77=2, ,7=37 ,T%=an/5

K,= '473074,=%_ 2. do=5

7% =57 =27

(c) $x_1(t)$ is periodic $T_1 = \frac{2\pi}{\pi} = 2$

$x_2(t)$ is periodic $T_2 = \frac{2\pi}{3}$

$\frac{T_1}{T_2} = \frac{2}{2\pi/3} = \frac{3}{\pi}$ not rational ∴ Sum not periodic

$\cos 4\pi t$ is periodic w/ $T_1 = 2\pi/4\pi = 1/2$

(d) $\sum_{n=-\infty}^{\infty} \text{rect}\left(\frac{t+n/2}{0.2}\right)$ is periodic with $T_1 = 0.5$ s

$4\sin\left(\frac{5\pi}{7}t + \pi/4\right)$ is periodic w/ $T_2 = \frac{2\pi}{5\pi/7} = \frac{14}{5}$

$\frac{T_1}{T_2} = \frac{1/2}{1/2} = 1$; $\frac{T_1}{T_3} = \frac{1/2}{14/5} = \frac{5}{28} \Rightarrow k_0 = 28$, $T_0 = 28T_1 = \underline{14\text{ s}}$

PROBLEM 2.13

(a) For a\(t) +(t) to be periodic we need some number T such that r;(t+T)+r(t+T) = r(t) +1g(t) for all t. This can only be true if 1·1 (t+T) = 1·i(t) and 1·2(t+T) = J.'2(t)~ which can only be true if $T = k_1 T_1$ and $T = kT$ (T is an integer multiple of both the periods). So we need there to be some integers k and A'2 such that kT= ~2T2 ~ ~ = l7.

(b) Put # in its most reduced firm '{ by canceling any common terms in the numerator and denominator; then Ti = nT = mT,

Problem 2.14

(a)

```
>> syms t
>> xa=5exp(-t/2);
>> ezplot(xa), grid
```

(b)

```
>> syms t
>> xb=5exp(-2t);
>> ezplot(xb),grid
```

(c)

```
>> symS t
>> xc=5exp(t/2);
>> ezplot(xo),grid
```

(d)

```
>> syms t
>> xd=5(1-exp(-t/2));
>> ezplot(xd), grid
```

(e)

```
>> syms t
>> xe=5(1-exp(-2t));
>> ezplot(xe), grid
```

(f)

```
>> syms t
>> xf=52sin(2t);
>> ezplot(xf),grid
```

(g)

```
>> syms t
>> xg=5exp(-20)2sin(2t);
>> ezplot(xg),grid
```

(h)

```
>> syms t
>> xh=5exp(-0.5t)2sin(2);
>> ezplot(xh),grid
```

Problem 2.15

(a)

cos(0 +¢) = Re{e **1** } =Re{e"**e1**}

= Re{(cos6 + **j** sin0)cos¢ + **j** sin ¢)}

= Re{cos6cos ¢ + **j** sin6cos¢

+ *j* cos6sin ¢ –sin6sin ¢}

= cos6cos¢ --sin6sin¢

(b)

sin(0+¢)= Im{e} = Im{e"er)

= Im{(cos6 + *j sin6)cos* ¢ + j sin4

= Im{(cos6cos ¢ + j sin6cos¢

+ j cos6sin¢ –sin 6sin ¢}

= cos6sin ¢ +sin6cos¢

(c)

cos6cos = Re e" e1; +e-J;} / 2 =Re {eJ(0+;) +e1(0-;)} / 2

= Re{eJ(B+;) / 2 + eJ(0-;)} / 2 = cos(B+¢) / 2 + cos(B–¢) / 2

(d)

$$\sin\theta\cos\phi = \mathrm{Im}\left\{e^{j\theta}\frac{e^{j\phi}+e^{-j\phi}}{2}\right\}$$

$$= \mathrm{Im}\left\{\frac{e^{j(\theta+\phi)}+e^{j(\theta-\phi)}}{2}\right\}$$

$$= \frac{1}{2}[\sin(\theta+\phi)+\sin(\theta-\phi)]$$

P@Bug2.1%

Ce = 3Ca(a±)+ 02(z±)

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3-02)e" (+2et

ge"•@ ke

t,'(%) ra4

+6\ =+0.%2«d

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'S e +ɪ €

Mio e g(3±–0.32) +€ (2¢–a.32)

2

(e)= Vi'C.(A±–o•32a2)

= 5 &< (z±–l&.5°\)

Problem 2.1.6 (Continued)

(d) vb) = # ee(me) + 54−@T±)

ve, te s

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=(-3$\e 4π, (+40) e38%

(2 − 3/2 j =\r«Fhr)=%/−n

=5 34
 2

= 5e −40% e ##± + se 20.4 e −j4n¢

= 5 e jeff~−0-hc.j) + g 2 .2... 'J-('-1-rTt − o, b'/.,)

(o) = 5 Ca(&−o4 ad)

(e) $x(t) = A\cos(\omega_0 t) + B\sin(\omega_0 t)$

5 Ca ((t − 3c.&7°)

$$= A\,\frac{e^{j\omega_0 t} + e^{-j\omega_0 t}}{2} + B\,\frac{e^{j\omega_0 t} - e^{-j\omega_0 t}}{j2}$$

$$= \frac{A - jB}{2} e^{j\omega_0 t} + \frac{A + jB}{2} e^{-j\omega_0 t}$$

$$= \sqrt{\frac{A^2+B^2}{4}}\;\angle \tan^{-1}\frac{-B}{A}\; e^{j\omega_0 t} + \sqrt{\frac{A^2+B^2}{2}}\;\angle \tan^{-1}\left(\frac{B}{A}\right) e^{-j\omega_0 t}$$

$$= \frac{\sqrt{A^2+B^2}}{2}\, e^{j\tan^{-1}\left(\frac{-B}{A}\right)} e^{j\omega_0 t} + \frac{\sqrt{A^2+B^2}}{2}\, e^{j\tan^{-1}\left(\frac{B}{A}\right)} e^{-j\omega_0 t}$$

$$\tan^{-1}\left(\frac{B}{A}\right) = -\tan^{-1}\left(-B/A\right)$$

$$\therefore\; x(t) = \sqrt{A^2+B^2}\;\frac{e^{j(\omega_0 t - \tan^{-1} B/A)} + e^{-j(\omega_0 t - \tan^{-1} B/A)}}{2}$$

$$= \sqrt{A^2+B^2}\,\cos\left(\omega_0 t - \tan^{-1}(B/A)\right)$$

PROBLEM 2.17

$$y(t) = \frac{1}{2}\int_{-\infty}^{\infty} x(t)\,e^{j\pi t/2}\,\delta(2t-3)\,dt$$

$$\delta(2t-3) = \frac{1}{2}\,\delta(t-3/2)$$

$$\frac{1}{2}\delta(t-3/2)\,x(t)\,e^{j\pi t/2} = \frac{1}{2}x(3/2)\,e^{j3\pi/4}$$

$$\therefore\ y(t) = \frac{1}{4}\,x(3/2)\,e^{j3\pi/4}\int_{-\infty}^{\infty}\delta(t-3/2)\,d\tau$$

$$y(t) = \frac{1}{4}\,x(3/2)\,e^{j3\pi/4}$$

PROBEM 2.19

(a) Let $\tau = at$, then $\int_{-\infty}^{\infty} \delta(at)\,dt = \int_{-\infty}^{\infty} \delta(\tau)\frac{d\tau}{a}$

$$= \frac{1}{a}\int_{-\infty}^{\infty} \delta(\tau)\,d\tau \Rightarrow \delta(at) = \frac{1}{a}\delta(t),\ a>0$$

for $a<0$, $at = \tau \Rightarrow -|a|t = \tau$

$\Rightarrow dt = \frac{-d\tau}{|a|}$

$$\therefore \int_{-\infty}^{\infty} \delta(at)\,dt = \int_{\infty}^{-\infty} \delta(\tau)\frac{-d\tau}{|a|} = \frac{1}{|a|}\int_{-\infty}^{\infty} \delta(\tau)\,d\tau$$

$\therefore \delta(at) = \frac{1}{|a|}\delta(t)$ for the general case.

(b)
$$\int_{-\infty}^{t} \delta(\sigma)\,d\sigma = \begin{cases} 1, & t>0 \\ 0, & t<0 \end{cases} = u(t)$$

$$\therefore \int_{-\infty}^{t} \delta(\tau - t_0) = \begin{cases} 1, & t>t_0 \\ 0, & t<t_0 \end{cases} = u(t-t_0)$$

(c)

Recall the rules about integrating delta functions: $\delta(t)$ is nonzero only at $t=0$, so $x(t)\delta(t) = x(0)\delta(t)$, and $\int_{-\infty}^{\infty} \delta(t)dt = 1$, so $\int_{-\infty}^{\infty} x(t)\delta(t)dt = \int_{-\infty}^{\infty} x(0)\delta(t)dt = x(0)\int_{-\infty}^{\infty} \delta(t)dt = x(0)$. We can time-shift the delta function: $\delta(t-t_0)$ is nonzero only at $t=t_0$, so $x(t)\delta(t-t_0) = x(t_0)\delta(t-t_0)$ and $\int_{-\infty}^{\infty} x(t)\delta(t-t_0)dt = x(t_0)$.

i) $\int_{-\infty}^{\infty} \cos(2t)\delta(t)dt = \cos(2\cdot 0)\int_{-\infty}^{\infty} \delta(t)dt = 1$.

ii) $\delta(t-\frac{\pi}{4})$ is a time-shifted version of $\delta(t)$, and is nonzero only at $t=\frac{\pi}{4}$. So:

$$\int_{-\infty}^{\infty} \sin(2t)\delta(t-\tfrac{\pi}{4})dt = \int_{-\infty}^{\infty} \sin(2\cdot\tfrac{\pi}{4})\delta(t-\tfrac{\pi}{4})dt$$

$$= \sin(\tfrac{\pi}{2})\int_{-\infty}^{\infty} \delta(t-\tfrac{\pi}{4})dt = \sin(\tfrac{\pi}{2}) = 1$$

2.19 (c)(iii) [.=abs-oa

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(iv) Is0 e-i@-)le $= \int_{-\infty}^{\infty} \sin\left(\frac{\pi}{2}-\frac{\pi}{4}\right)\delta\left(t-\frac{\pi}{2}\right)dt$

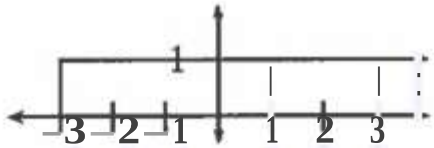
= +/)[§t1e = 0.7o'7

(v) $\int_{-\infty}^{\infty} \sin(t-\pi/6)\,\delta(2t-2\pi/3)\,dt = \int_{-\infty}^{\infty} \sin(t-\pi/6)\,\delta[2(t-\pi/3)]\,dt$

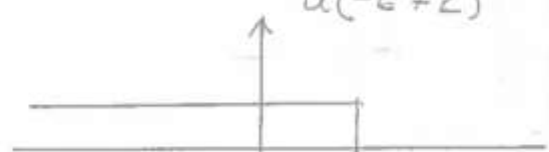
$= \int_{-\infty}^{\infty} \sin(\pi/3-\pi/6)\,\delta[2(t-\pi/3)]\,dt = \frac{1}{2}\sin(\pi/6) = 0.25$

PROBLEM 2.20

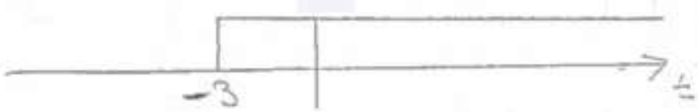
(a) $u(2t+6) = u(t+3)$



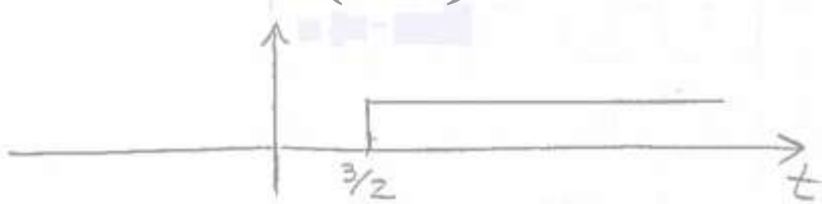
(b) $u(-3t+6) = u[-3(t-2)] = u(-t+2)$



(c) $u(t/3+1) =$

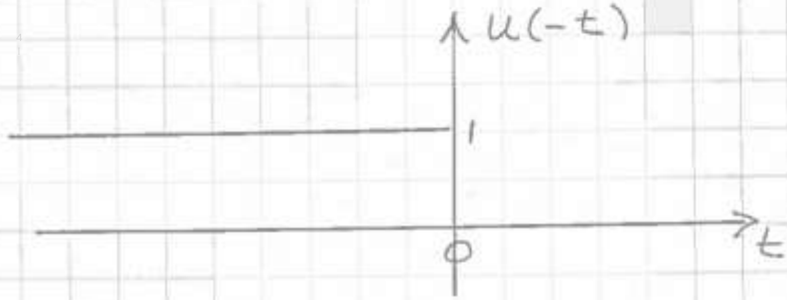


(d)

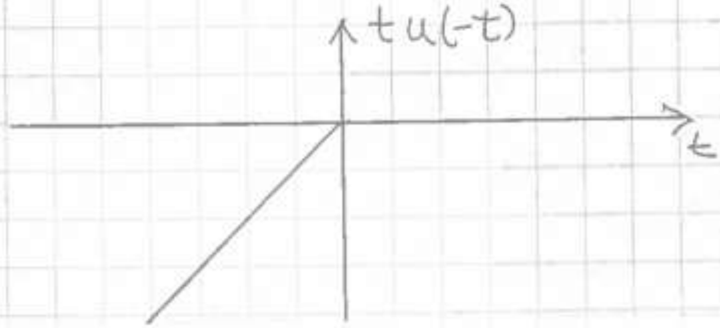


PROBLEM 3.21

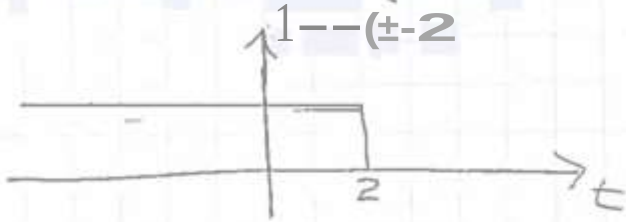
(a) $u(-t) = 1 - u(t)$



(b) $t\,u(-t) = t[1 - u(t)]$

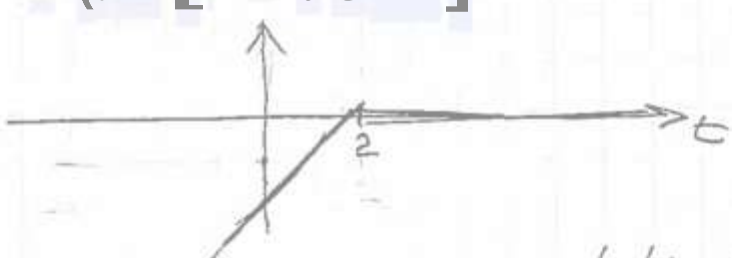


(c) $u(-t+2) = u[-(t-2)] = 1 - u(t-2)$

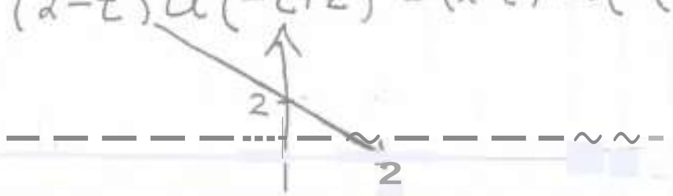


(d) $(t-2)u(-t+2) = (t-2)u[-(t-2)]$

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



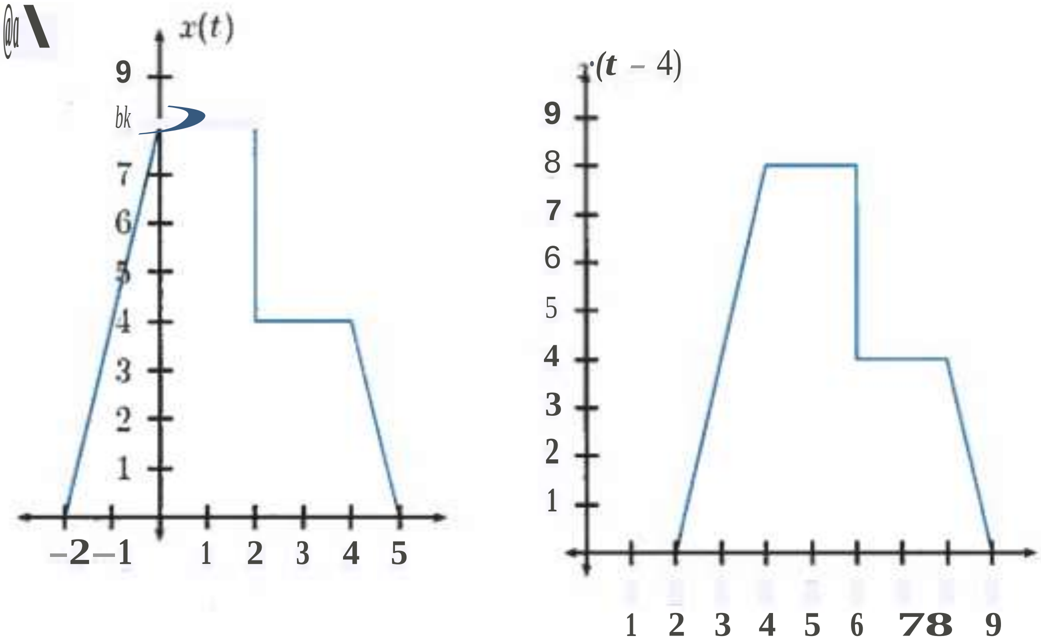
(e) $(2-t)u(-t+2) = (2-t)u(-(t-2)) = (2-t)[1-u(t-2)]$



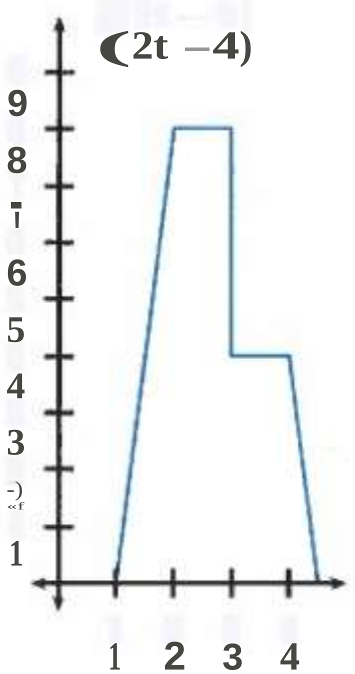
PROBLEM 2.22

$$x(2t-4) = 4(2t-2)u(2t-2) - (2t-4)u(2t-4) - u(2t-6) - (2t-8)u(2t-8) - (2t-9)u(2t-9)$$
$$= 4(2t-2)u(t-1) - (2t-4)u(t-2) - u(t-3) - (2t-8)u(t-4) - (2t-9)u(t-4.5)$$

(a)

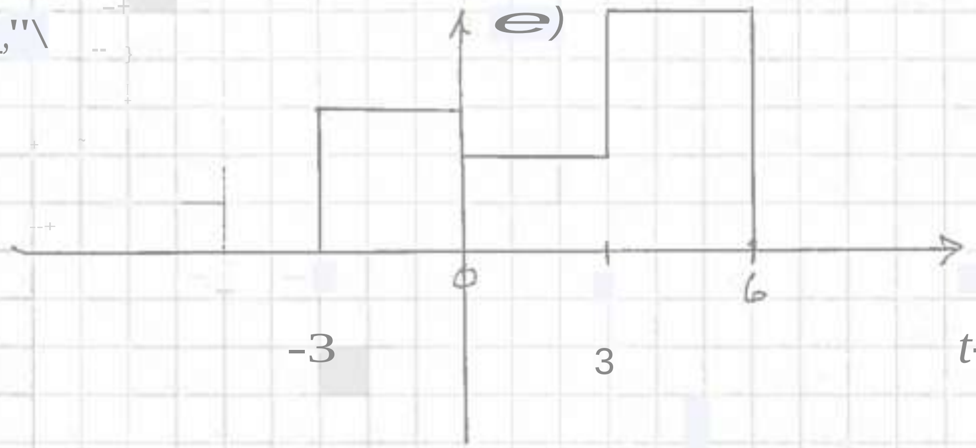


(b)



PROBLEM 2.23

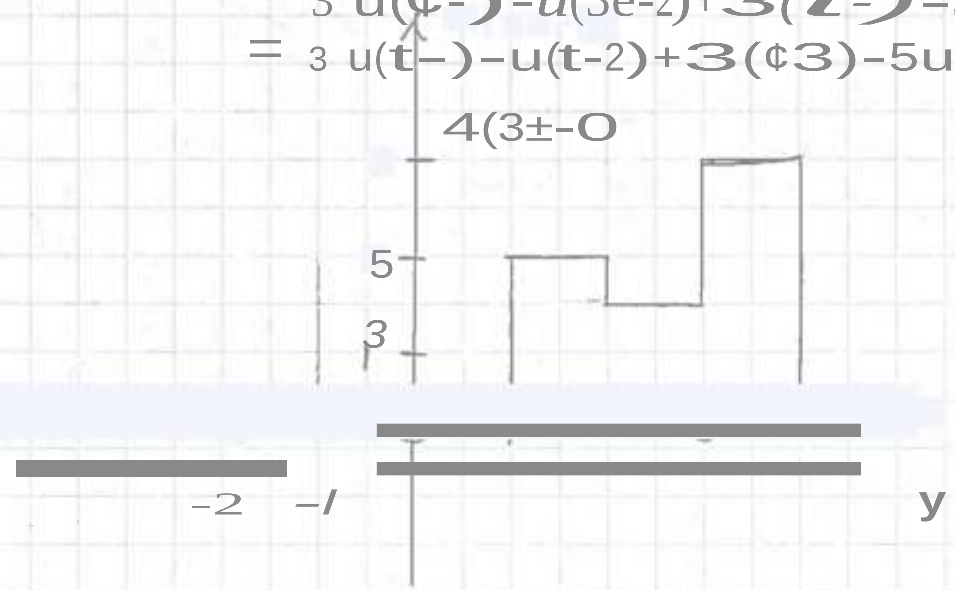
$$x(t) = 3u(t+3) - u(t) + 3u(t-3) - 5u(t-6)$$



(b) $x(3t-6) = 3u(3t-6+3) - u(3t-6) + 3u(3t-6-3)$
$- 5u(3t-6-6)$

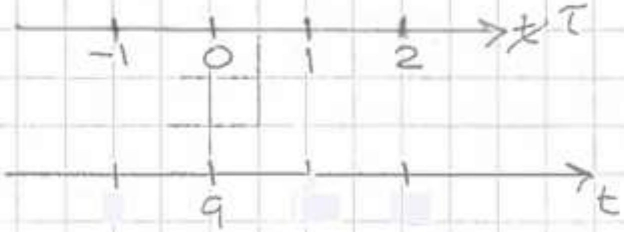
$= 3u(3t-3) - u(3t-6) + 3u(3t-9) - 5u(3t-12)$

$= 3u(t-1) - u(t-2) + 3u(t-3) - 5u(t-4)$

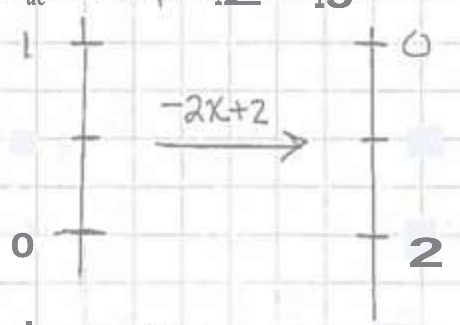


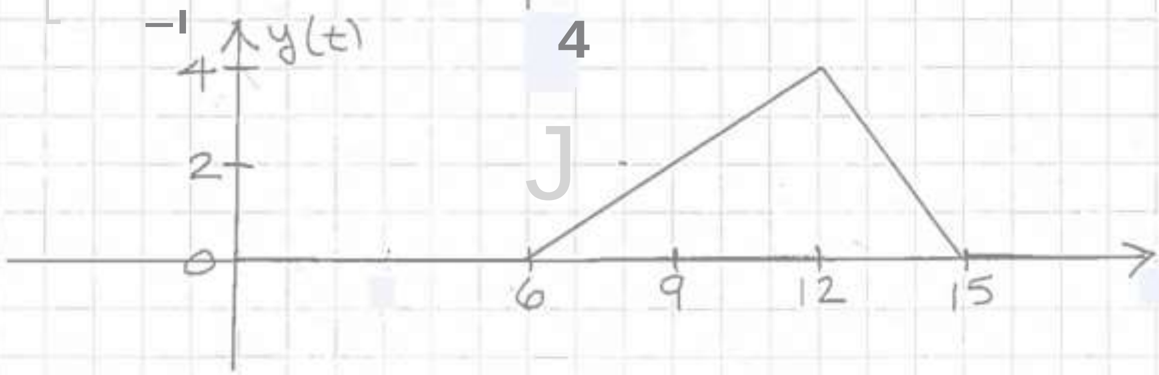
(a) $x(t) = 1 - (t+1)[u(t+1) - u(t-1)]$

(b) use time transformation



and amplitude transformation





PROBLEM 2.25

(a) x,) = 2tu(t − ±-)t(t-)) +2/-2)t±-2)

46) t<0 , , &=0'

o«<l, , =2¢

l±<2, 1, = 2±-± + =4-2±

z<±, z,#)= '-2±+2±==o'

«e» w-zu-4-z±

it

Peosusy 2.21

« z4+= 3[tats-@)@-)]

−3[kt−a e-2)—3)1k&-)]

(&ea , o

(be<1 le= s

t<2) (e)= st−3¢+3= 3/

(3kt<3, &Ue)=t −3t+3 3t+% = 3t+

(¢>l3) , &=3±3¢3-3¢%+3-8= o ~/

() ale) is periodic T =4

%(¢= Σ x(¢+4n)

,Z 1 unate-4)−−o)teal

- 3/(t-2++)«(-z+»)-(3+)—3+0)]

?@@152.37

«h.)-T[rnei] , g— T±Lr, Ea]

y — TIT r] + 1% {1 Ir1u,] + 5La8]

y — 7{1 , rust3r +{,,D, Ba]? +T IT,Ea]

« =1= 7[[[5JT]

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(d) gt=¢et)xsI)

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O 3No—1o-site, its]]

3. a¢ (inr j__ T T

7roller 2,32

C %) = 2u+1)- ue)-u(t-t)

= z2fake+-ul]+[le-~(±-0)

= 2 (±+) +¥(t)

• ±le) = 2g(+6 + +

bi z -| |

• = 4-z-r) = ft+w)]

PROBLEM 2.33

(a)

(i) The system is memoryless only if $t_0 = 0$.

(ii) The system is invertible; $x(t) = y(t+t_0)$.

(iii) The system is causal only if $t_0 \geq 0$.

(iv) The system is BIBO stable.

(v) The system is time invariant.

$$x(t-t_0-t_1) \longleftrightarrow y(t-t_1)$$

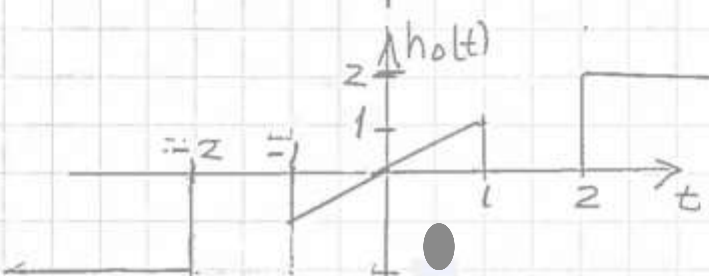
(vi) The system is linear.

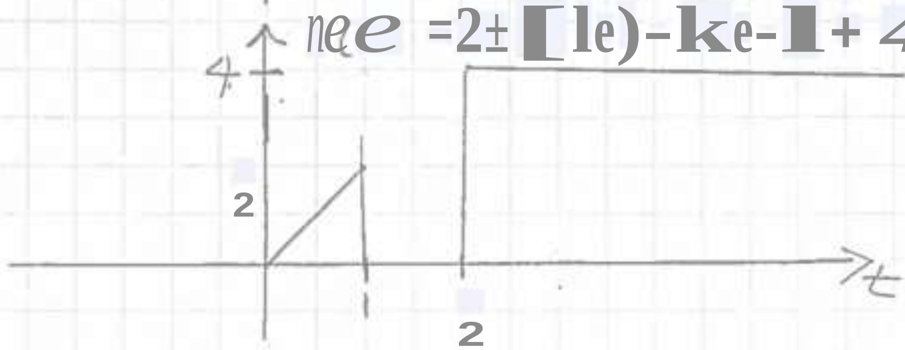
$$x_1(t-t_0) \longrightarrow y_1(t)$$

$$x_2(t-t_0) \longrightarrow y_2(t)$$

$$a x_1(t-t_0) + b x_2(t-t_0) \longrightarrow a y_1(t) + b y_2(t).$$

PROBLEM 2.34





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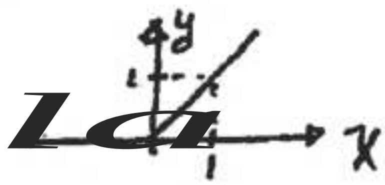

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