TUTORIAL

ELG3125B:SIGNAL AND SYSTEM ANALYSIS

Chapter (1)

(Part 1)

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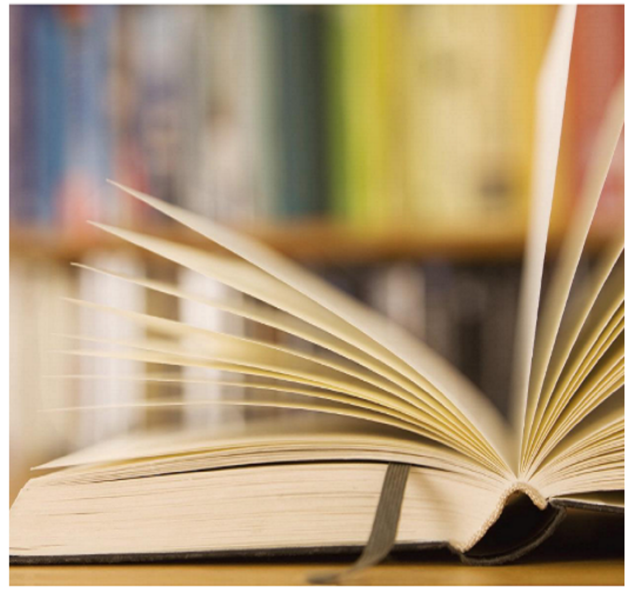

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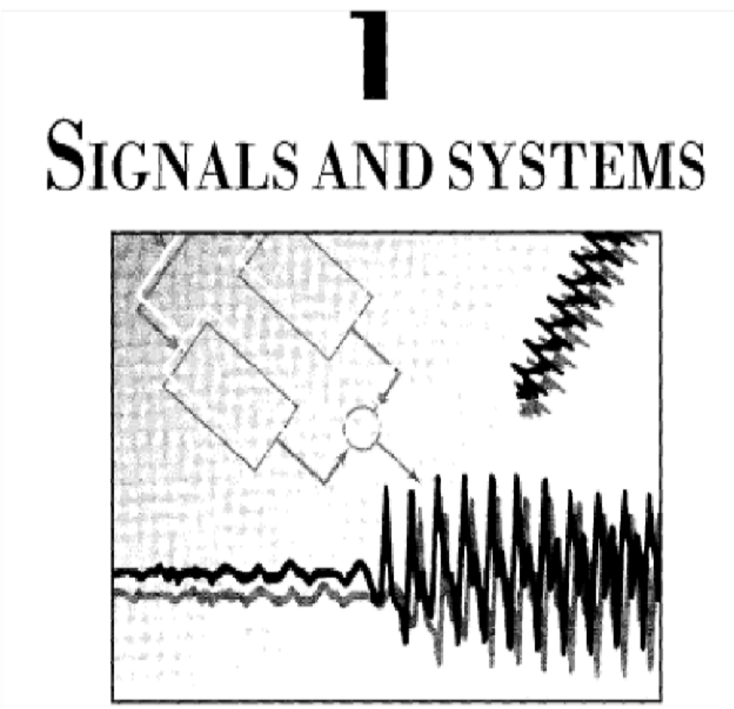


EXERCISE'S CONTINENTS

- **Transformations of the independent variable.**
- ***Periodic Signals Vs Aperiodic Signals.***
- **Fundamentals of Systems.**
- **System Properties.**
- ***LTI - Systems***

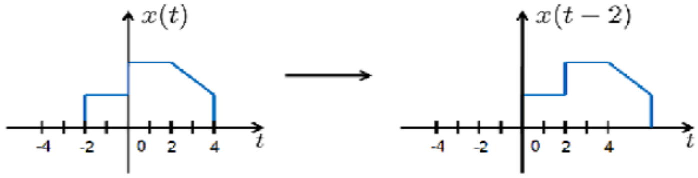
Transformations of the independent variable (1)

1. Time Shift:

Time shift is defined as

- x(t) ➔ x(t - t0)
- x[n] ➔ x[n -n0]:

If $t_0 > 0$, the time shift is known as "delay". If $t_0 < 0$, the time shift is known as "advance".

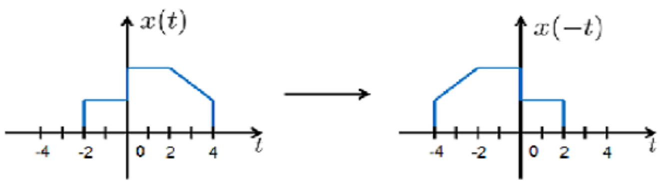


Transformations of the independent variable(2)

2. Time Reversal

Time reversal is defined as,

- x(t) ➔ x(-t)
- x[n] ➔ x[-n]



Transformations of the independent variable(3)

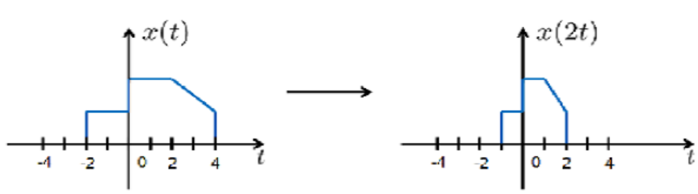
3. Time Scaling

Time scaling is the operation where the time variable t is multiplied by a constant a:

- X(t) ➔ x(at)   a>0

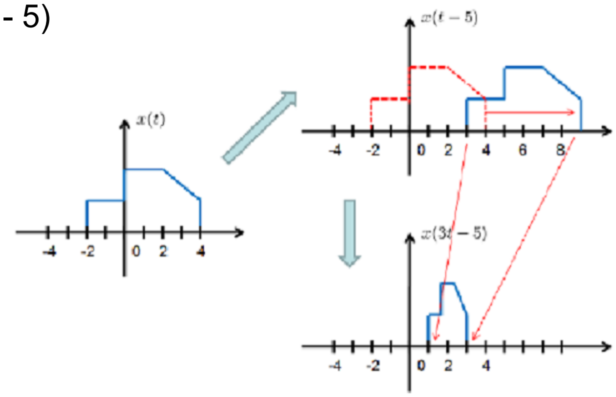
If a > 1, the time scale of the resultant signal is "decimated" (speed up). If 0 < a < 1,

the time scale of the resultant signal is "expanded" (slowed down).



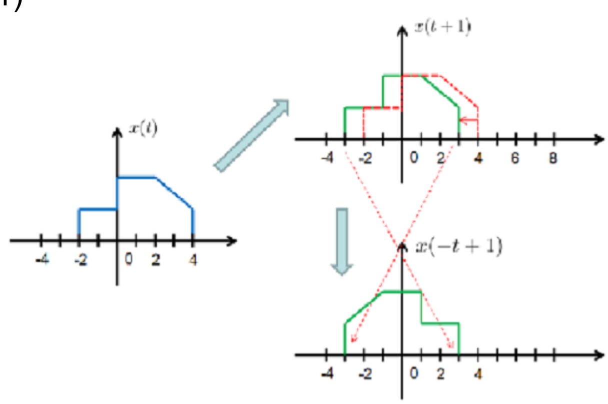
Example1:

(1) x(3t - 5)



Example2

(2). x(-t + 1)



BASIC PROBLEMS

1.21. A continuous-time signal $x(t)$ is shown in Figure P1.21. Sketch and label carefully each of the following signals:

(a) $x(t-1)$ **(b)** $x(2-t)$ **(c)** $x(2t+1)$
(d) $x(4-\frac{t}{2})$ **(e)** $[x(t)+x(-t)]u(t)$ **(f)** $x(t)[\delta(t+\frac{3}{2})-\delta(t-\frac{3}{2})]$

1.22. A discrete-time signal is shown in Figure P1.22. Sketch and label carefully each of the following signals:

(a) $x[n-4]$ **(b)** $x[3-n]$ **(c)** $x[3n]$
(d) $x[3n+1]$ **(e)** $x[n]u[3-n]$ **(f)** $x[n-2]\delta[n-2]$
(g) $\frac{1}{2}x[n]+\frac{1}{2}(-1)^n x[n]$ **(h)** $x[(n-1)^2]$

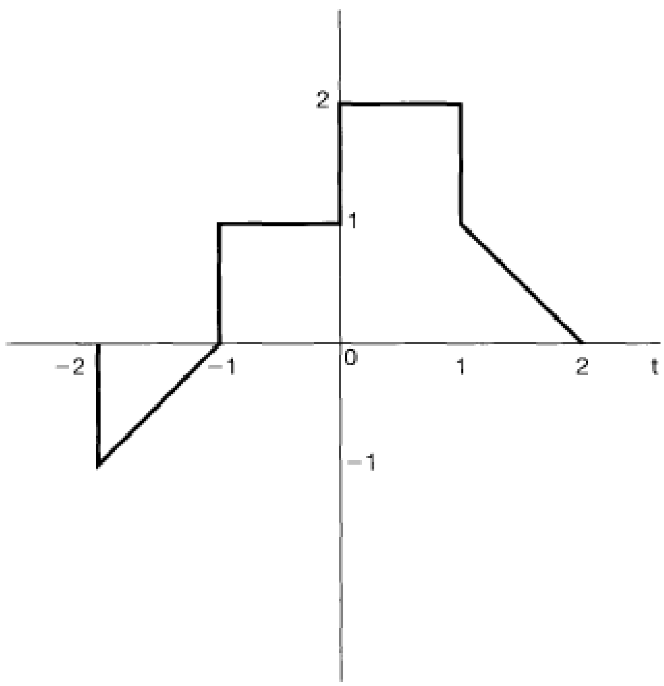


Figure P1.21

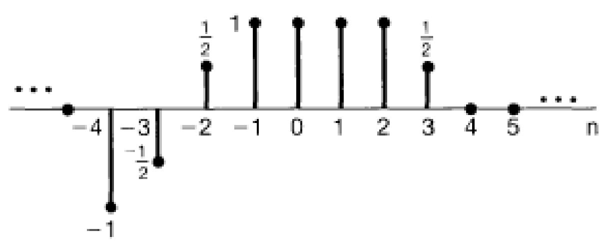
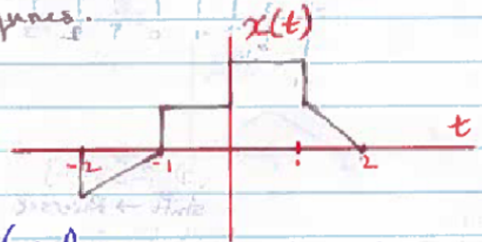


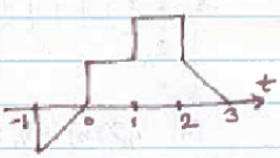
Figure P1.22

1.21 The signals are sketched in the following Figures.



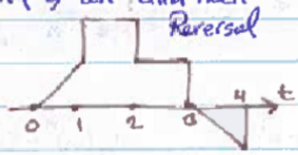
Note:- (Shifting, reversal, and time-scaling operations are order-dependent)

(a) $x(t-1)$



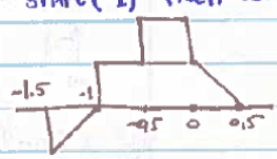
(b) $x(2-t)$

shift (-2) "left" and then Reversal

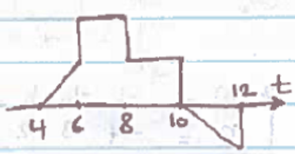


(c) $x(2t+1)$

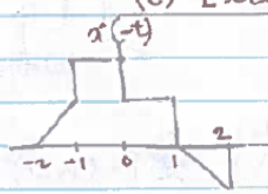
shift (-1) then compress

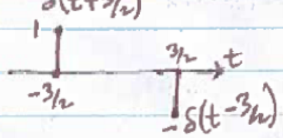


(d) $x(4-t/2)$



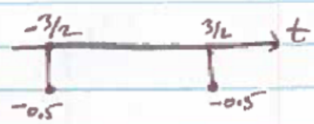
(e) $[x(t)+x(-t)]u(t)$, $u(t) = 1$ $(t \geq 0)$



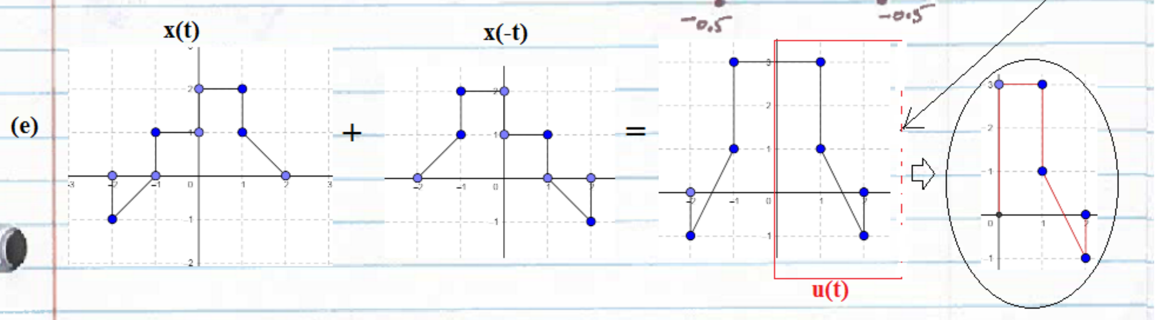


(f) $x(t)\left[\delta(t+3/2) - \delta(t-3/2)\right]$

$x(3/2) = 0.5$ & $x(-3/2) = -0.5$ ⇒ from figure

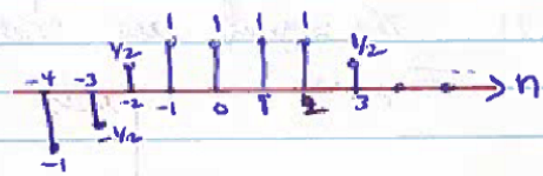


(e)

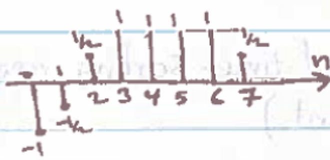


1.22

$x[n]$



(a) $x[n-4]$



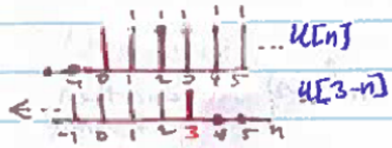
(b) $x[3-n]$

shift → Reversal

(c) $x[3n]$

(d) $x[3n+1]$

shift → compress

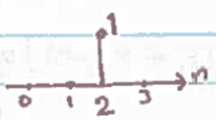


... $u[n]$

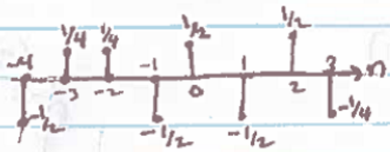
$u[3-n]$

(e) $x[n]u[3-n]$

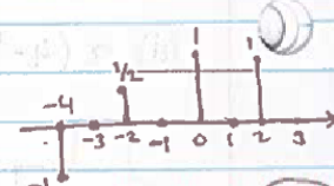
(f) $x[n-2]\delta[n-2]$



$\frac{1}{2}(-1)^n x[n]$

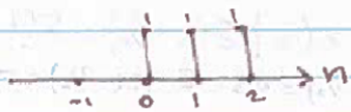


(g) $\frac{1}{2}x[n] + \frac{1}{2}(-1)^n x[n]$



$x[n]$ =	-1	-1/2	1/2	1	1	1	1	1/2
n =	-4	-3	-2	-1	0	1	2	3
$(n-1)^2$ =	25	16	9	4	1	0	1	4

(h) $x[(n-1)^2]$



1.23. Determine and sketch the even and odd parts of the signals depicted in Figure P1.23. Label your sketches carefully.

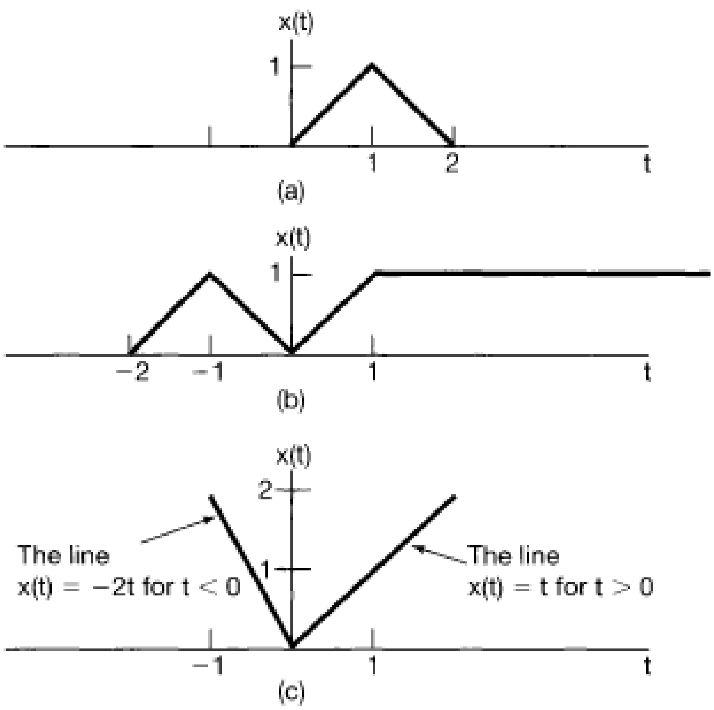


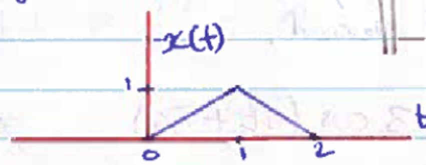
Figure P1.23

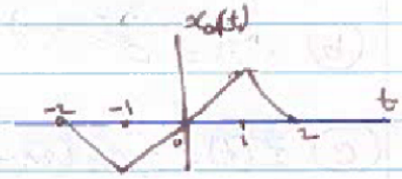
1.23 Determine and sketch the even and odd parts of the signals.

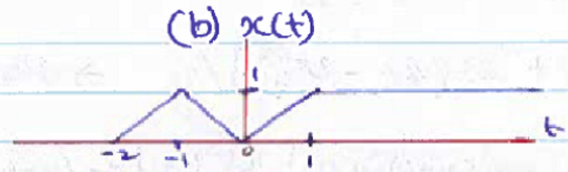
$x_e(t) = \frac{1}{2}[x(t) + x(-t)]$

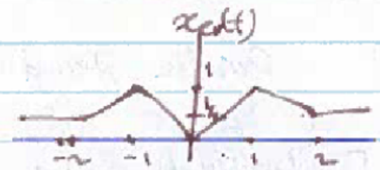
$x_o(t) = \frac{1}{2}[x(t) - x(-t)]$

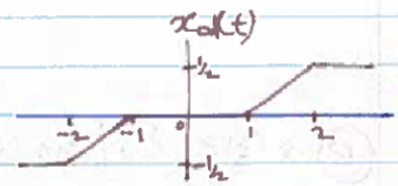
(a)

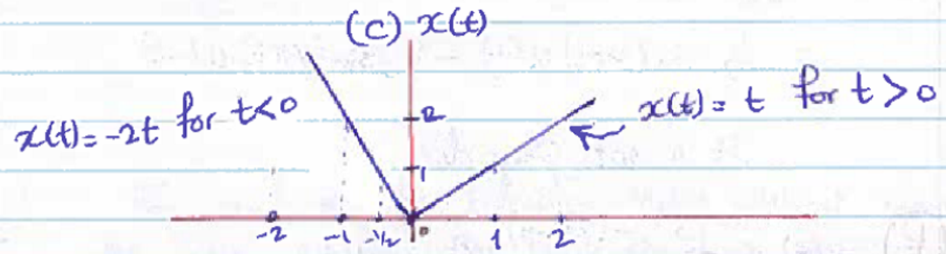


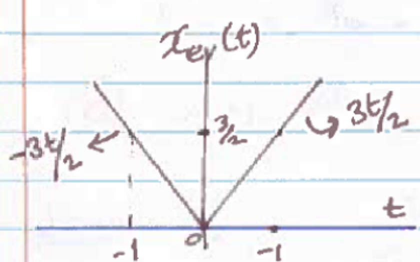


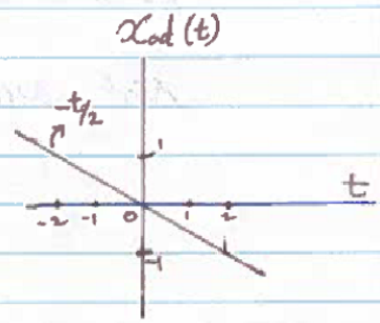


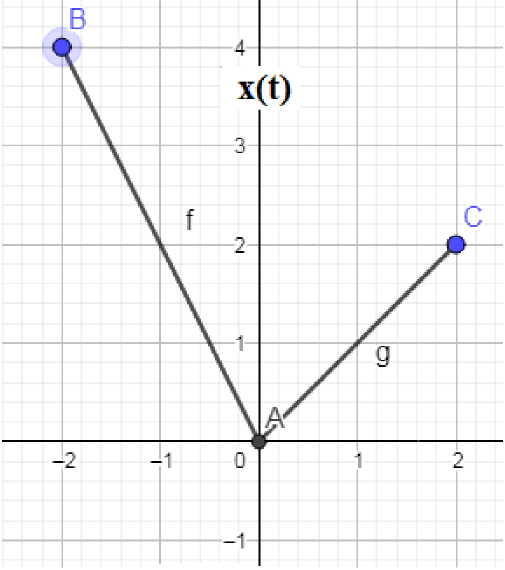


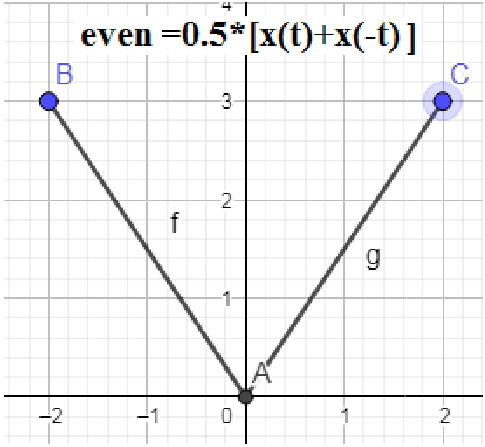


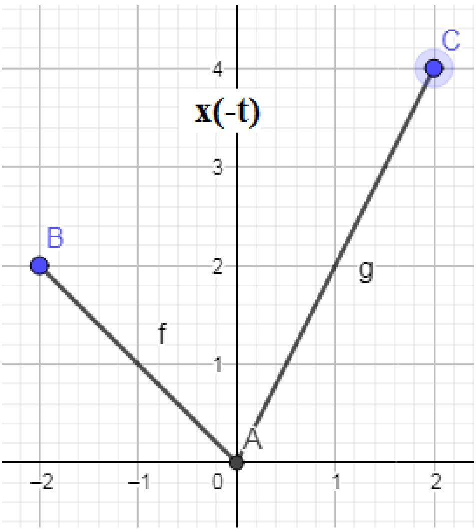


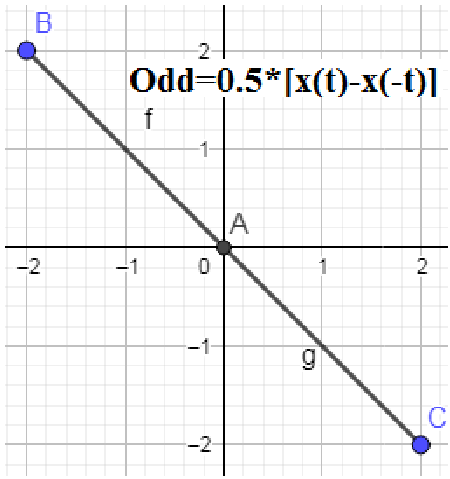





x(t)
B
C
A
f
g
4
3
2
1
0
−1
−2
1
2


even =0.5*[x(t)+x(-t)]
B
C
A
f
g
4
3
2
1
0
−2
−1
1
2


x(-t)
B
C
A
f
g
4
3
2
1
0
−2
−1
1
2


Odd=0.5*[x(t)-x(-t)]
B
C
A
f
g
2
1
0
−1
−2
−2
−1
1
2

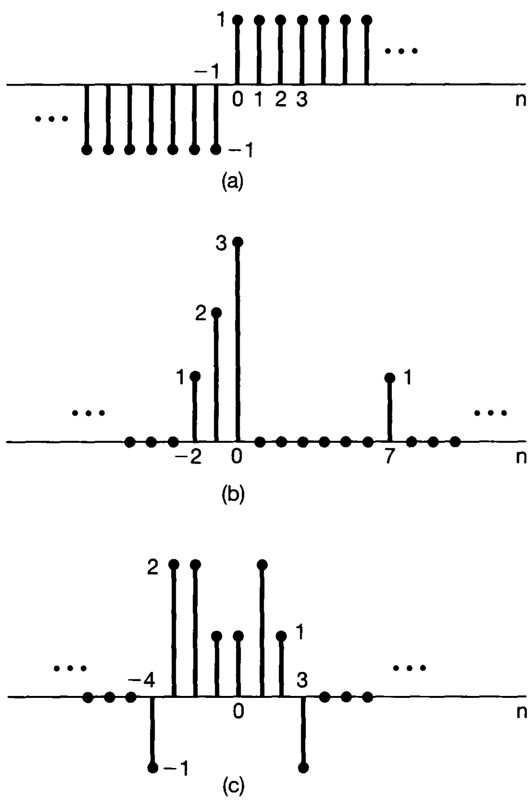


Figure P1.24

1.25. Determine whether or not each of the following continuous-time signals is periodic. If the signal is periodic, determine its fundamental period.

(a) $x(t) = 3\cos(4t + \frac{\pi}{3})$ **(b)** $x(t) = e^{j(\pi t - 1)}$

(c) $x(t) = [\cos(2t - \frac{\pi}{3})]^2$ **(d)** $x(t) = \mathcal{E}v\{\cos(4\pi t)u(t)\}$

(e) $x(t) = \mathcal{E}v\{\sin(4\pi t)u(t)\}$ **(f)** $x(t) = \sum_{n=-\infty}^{\infty} e^{-(2t-n)}u(2t - n)$

1.26. Determine whether or not each of the following discrete-time signals is periodic. If the signal is periodic, determine its fundamental period.

(a) $x[n] = \sin(\frac{6\pi}{7}n + 1)$ **(b)** $x[n] = \cos(\frac{n}{8} - \pi)$ **(c)** $x[n] = \cos(\frac{\pi}{8}n^2)$

(d) $x[n] = \cos(\frac{\pi}{2}n)\cos(\frac{\pi}{4}n)$ **(e)** $x[n] = 2\cos(\frac{\pi}{4}n) + \sin(\frac{\pi}{8}n) - 2\cos(\frac{\pi}{2}n + \frac{\pi}{6})$

1.27. In this chapter, we introduced a number of general properties of systems. In particular, a system may or may not be

(1) Memoryless
(2) Time invariant
(3) Linear
(4) Causal
(5) Stable

Determine which of these properties hold and which do not hold for each of the following continuous-time systems. Justify your answers. In each example, $y(t)$ denotes the system output and $x(t)$ is the system input.

1.25 Determine whether or not each of the following continuous time signals is periodic. If the signal is periodic determine its fundamental period.

(a) $x(t) = 3\cos(4t + \pi/3)$ periodic. period $= \pi/2$

(b) $x(t) = e^{j(\pi t - 1)}$ periodic. period $= 2$

(c) $x(t) = [\cos(2t - \pi/3)]^2$

$= [1 + \cos(4t - 2\pi/3)]/2 \Rightarrow$ Periodic. period $= \frac{2\pi}{4} = \frac{\pi}{2}$

(d) $x(t) = \mathcal{E}v[\cos(4\pi t)u(t)] = \frac{1}{2}[\cos(4\pi t)u(t) + \cos(4\pi t)u(-t)]$

$= \frac{1}{2}\cos(4\pi t)$ periodic, period $= 1/2$

(e) $x(t) = \mathcal{E}v[\sin(4\pi t)u(t)] = \frac{1}{2}[\sin(4\pi t)u(t) + \sin(-4\pi t)u(-t)]$

$= \frac{1}{2}\sin(4\pi t)u(t) - \frac{1}{2}\sin(4\pi t)u(-t)$

It is not periodic

(f) $x(t) = \sum_{n=-\infty}^{\infty} e^{-(2t-n)}u(2t-n)$

Not periodic