EEE 180 Signals & Systems

Introduction

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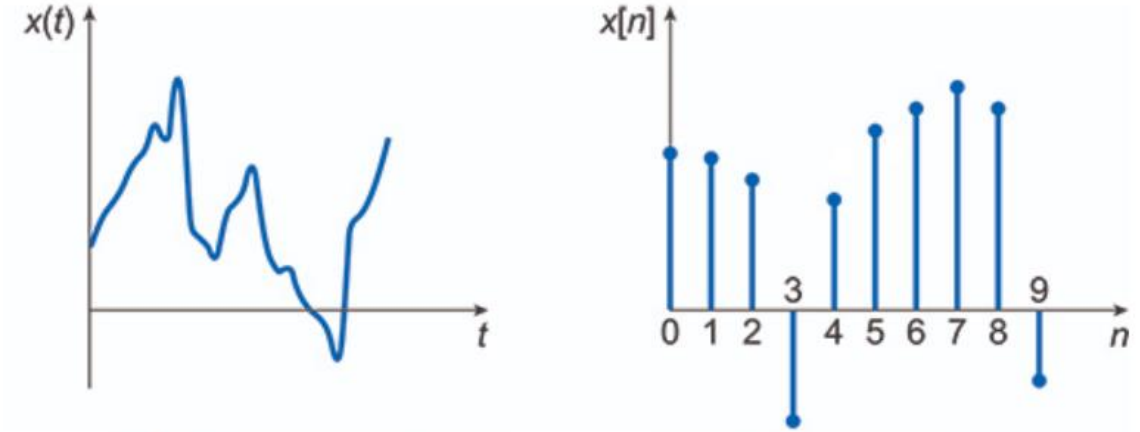
Continuous-Time and Discrete-Time Signals

Continuous-Time Signal: A continuous signal that is specified for every value of t.

Discrete-Time Signal: A signal that is sampled only at discrete time.

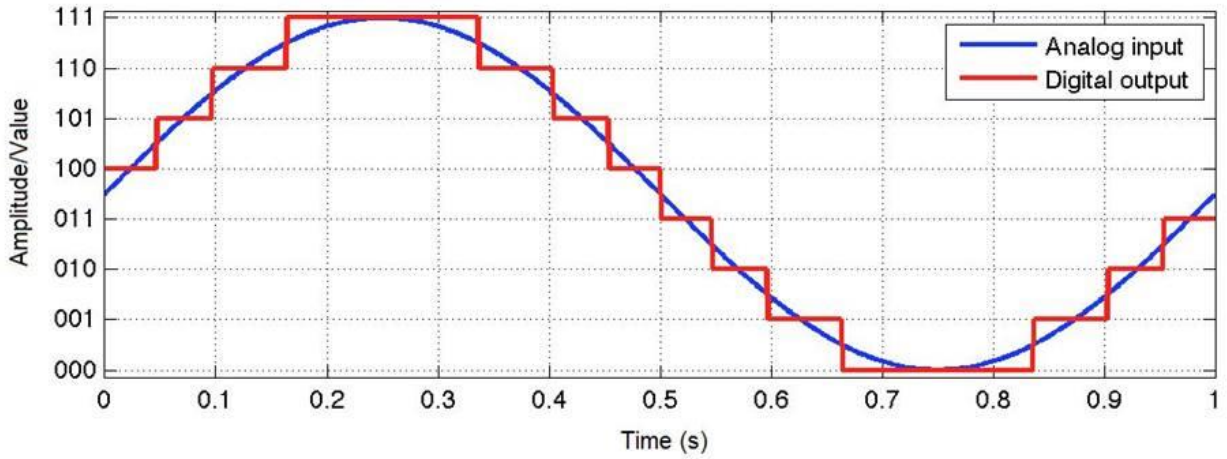


(a) Continuous-time signal; (b) discrete-time signal

Analog and Digital Signals

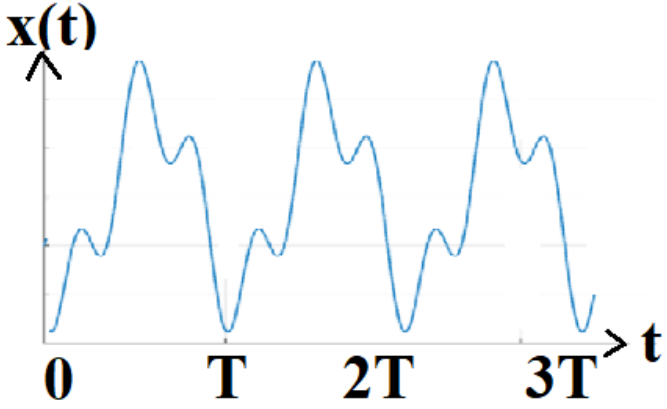
- An analog signal is a continuous wave that changes over a time period.

- A digital signal is a discrete wave that carries information in binary form.

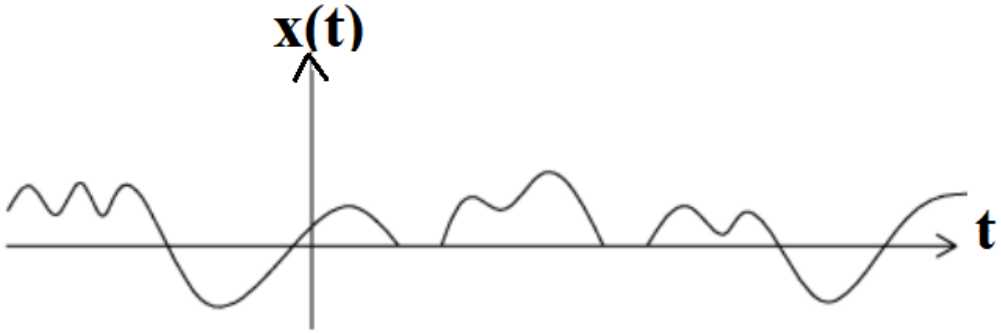


Periodic and Aperiodic Signals

- Periodic signal $x(t) = x(t + T)$ for all t. T: period



(a) Periodic signal



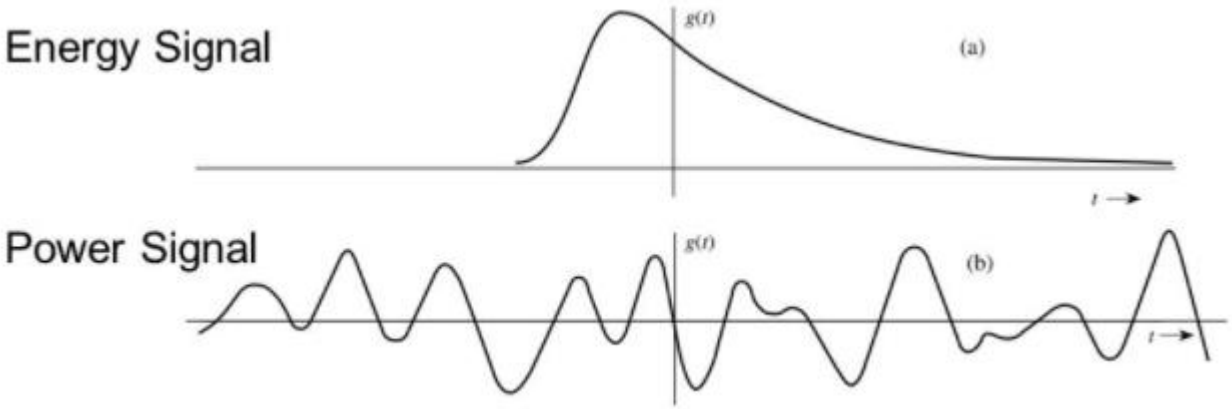
(b) Aperiodic signal

Energy and Power Signals

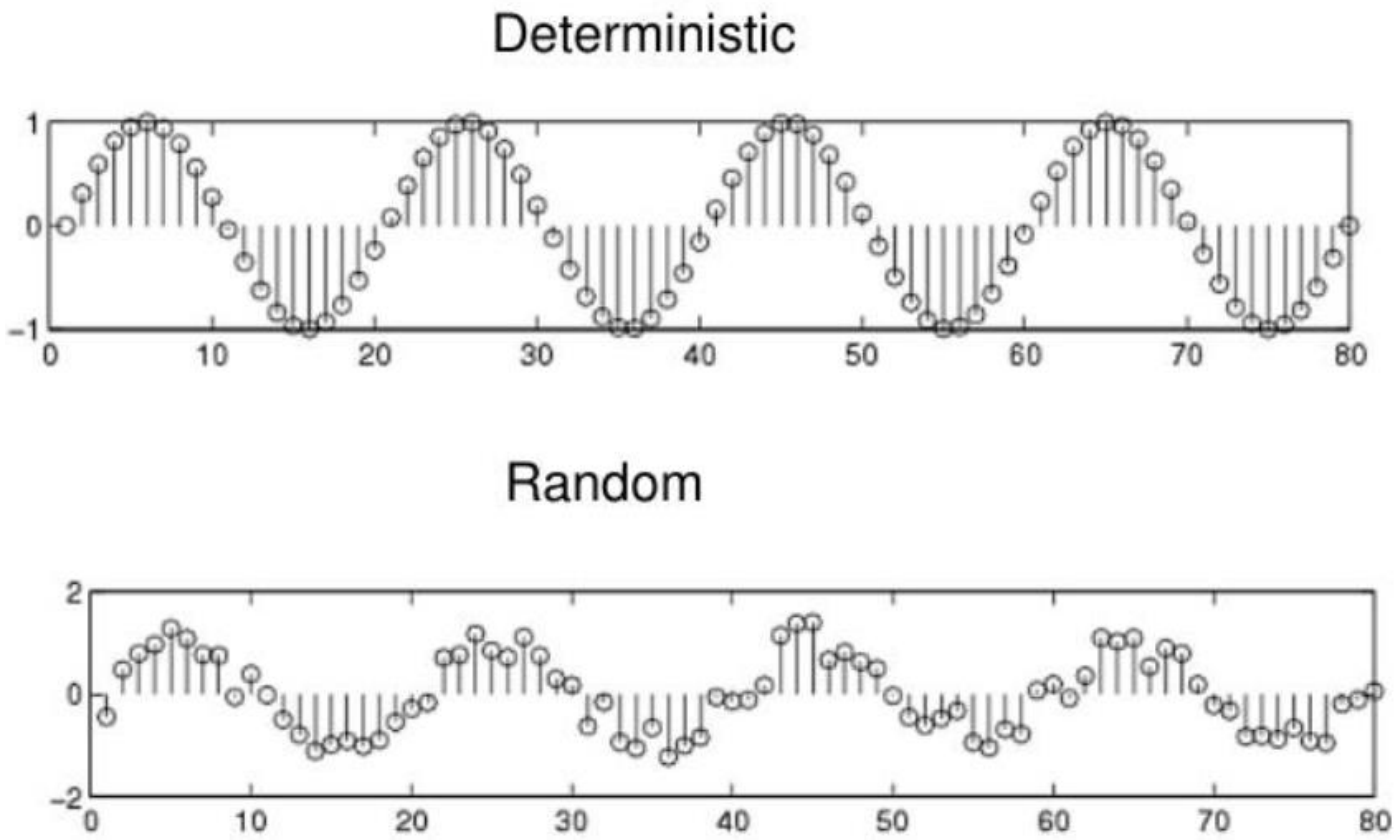
- Energy Signal: t -> infinity, f(t) -> 0.
- When the above condition is not true, a more meaningful measure of the signal size would be the time average of the energy to get power, if it exists.

$$E = \int_{-\infty}^{\infty} \left|\mathbf{f}(t)\right|^2 \, dt$$

$$P = \lim_{T \to \infty} \frac{1}{T} \int_{-\frac{T}{2}}^{\frac{T}{2}} \left|\mathbf{f}(t)\right|^2 \, dt$$



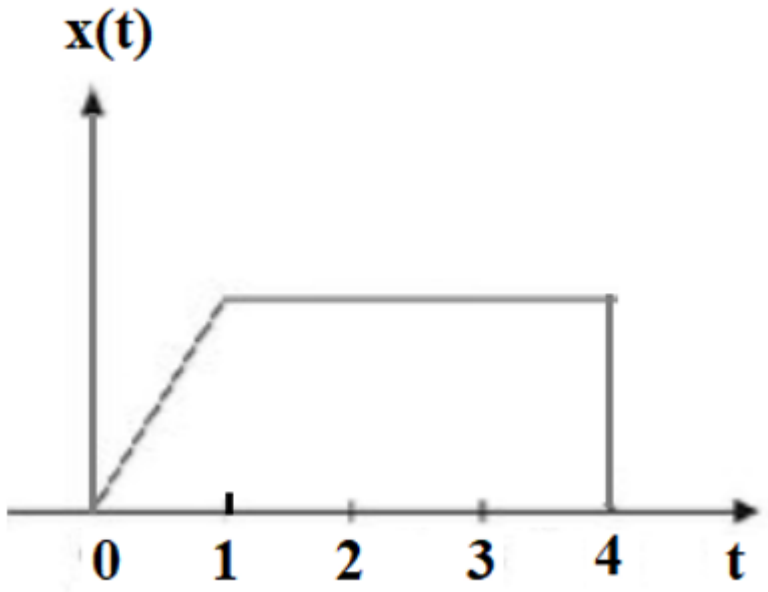
Deterministic and Random Signals



Deterministic Signal:
No uncertainty with respect to its value at any instant of time.
Or, signals which can be defined exactly by a mathematical formula.

Exercise 1:

- Given the signal x(t) below, draw the waveform of x(-t).



Exercise 1 Solution:

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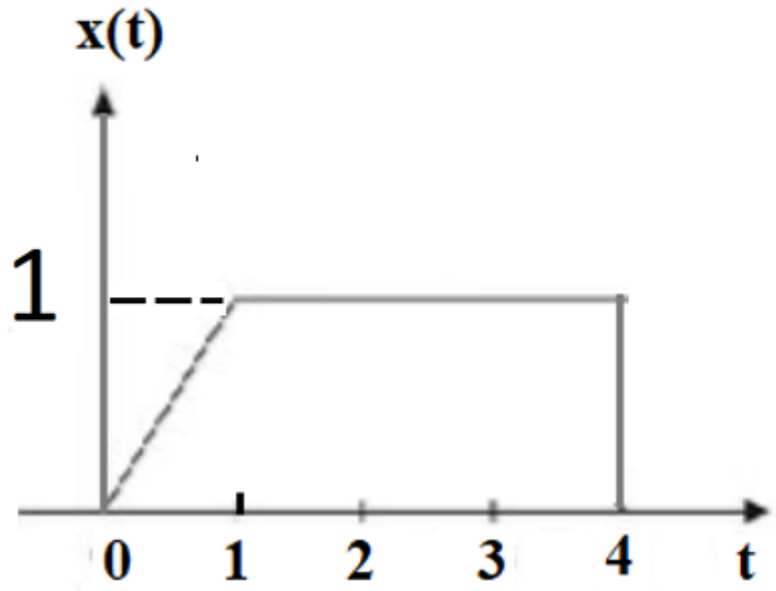
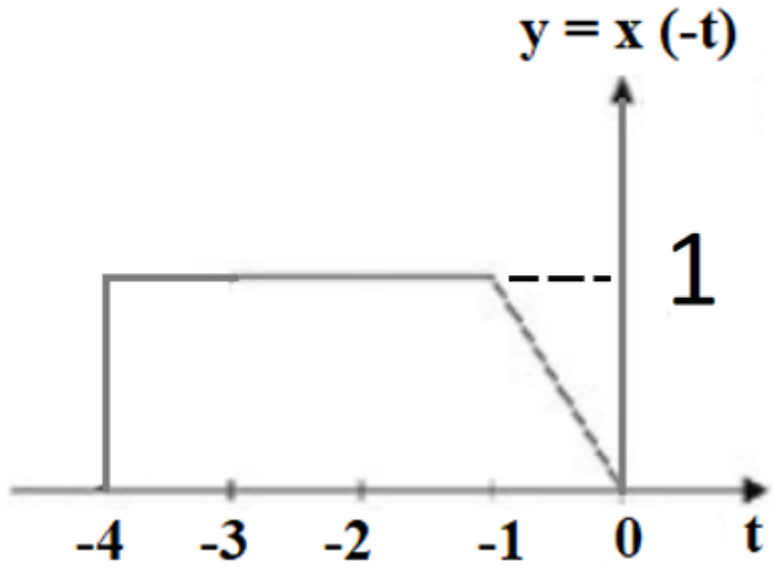
		t=0	t=-1	t=-2	t=-3	t= -4
y = x(-t)		y =x(0)	y=x(1)	y=x(2)	y=x(3)	y=x(4)
		=0	= 1	= 1	= 1	= 1





Question 1:

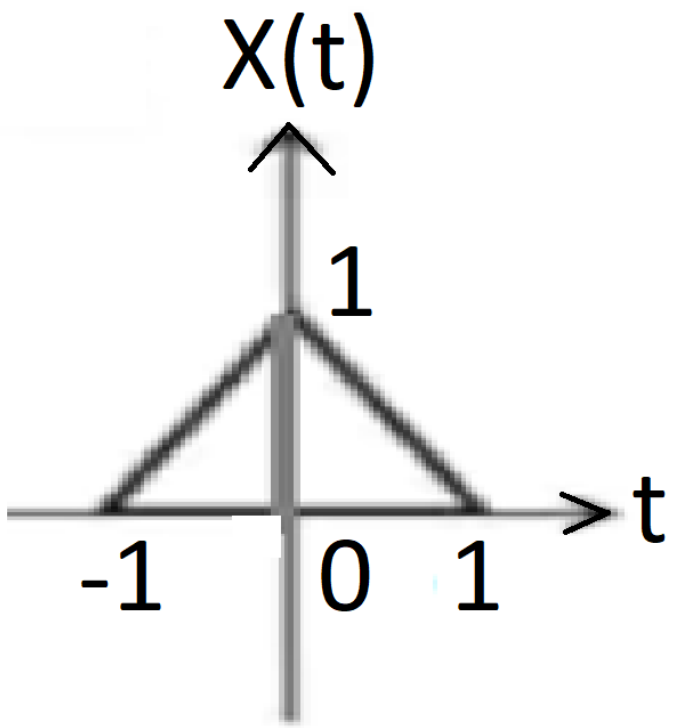
- What is the time reversal operation of x(t) ?

Answer 1:

- The time reversal operation of x(t) is:
- $x(-t)$ 

Exercise 2:

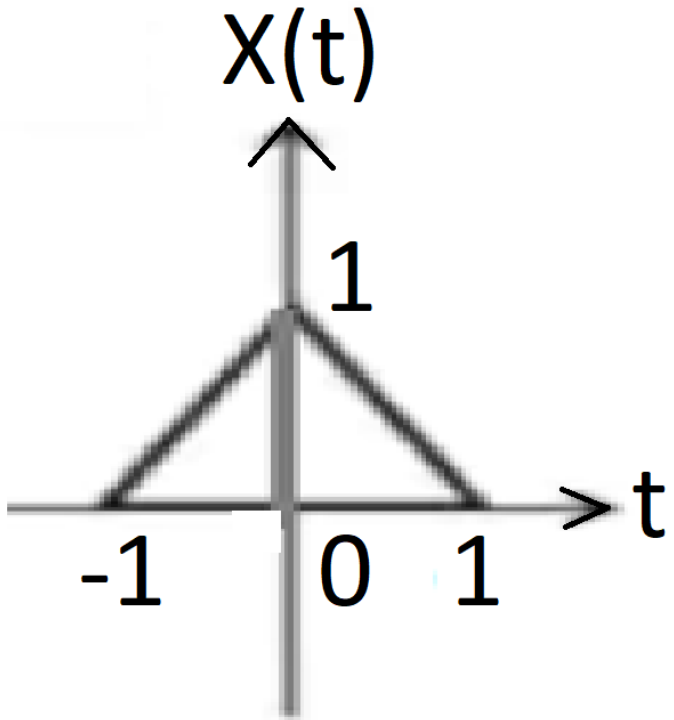
Given the signal x(t) below, draw the waveform of x(t + 3).

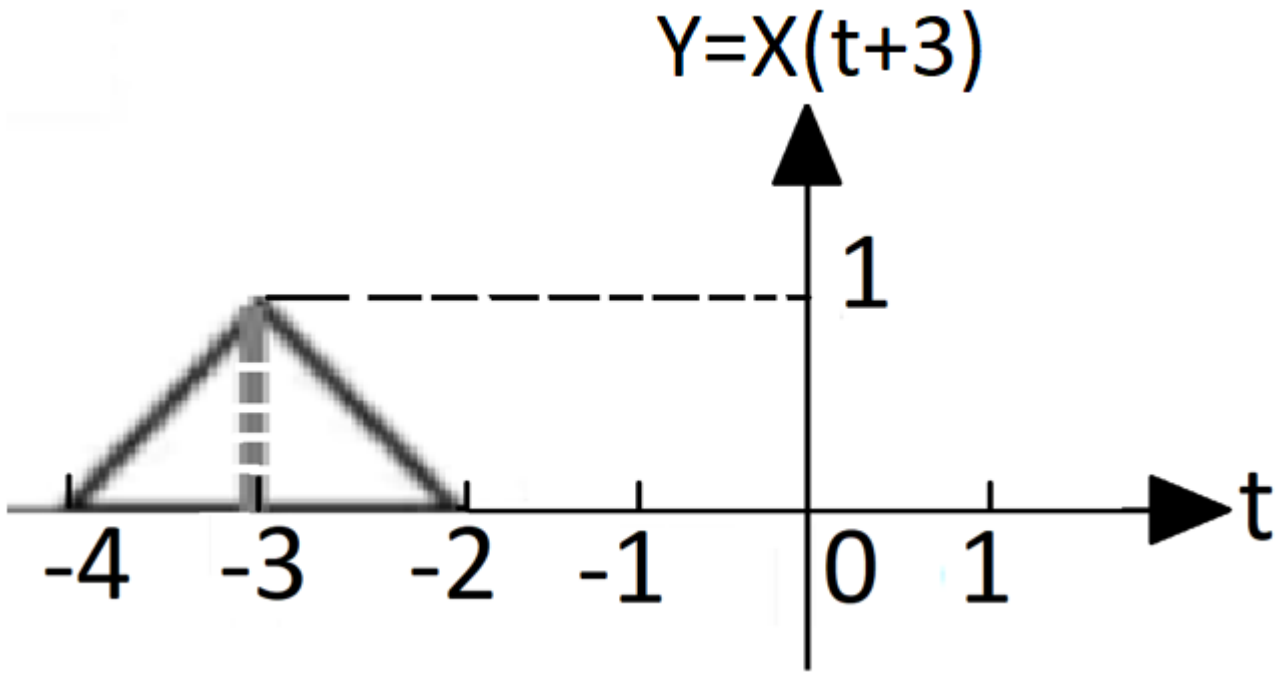


Exercise 2 Solution:

Given the signal x(t) below, draw the waveform of x(t + 3).

		t= -4	t= -3	t= -2	
y = x(t+3)		y =x(-1)	y=x(0)	y=x(1)	
		= 0	= 1	= 0	





Question 2:

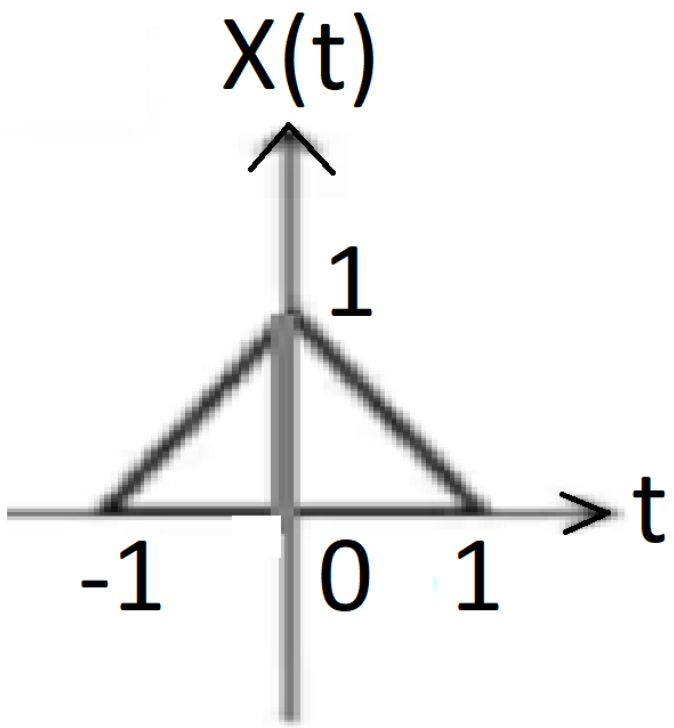
- What is the left shift by t0 signal for x(t) ?

Answer 2:

- The left shift by t0 signal for x(t) is:
- $x(t+t0)$ 

Exercise 3:

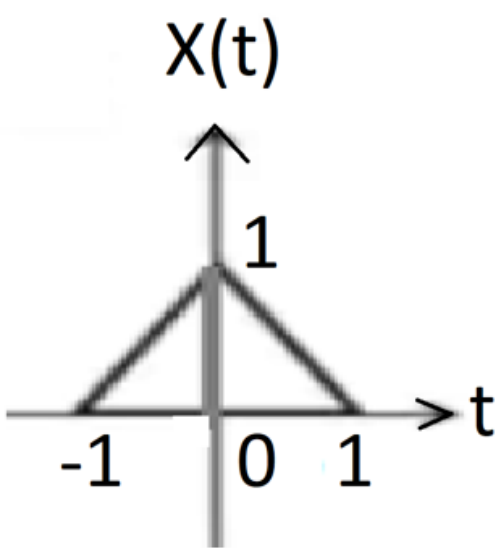
Given the signal x(t) below, draw the waveform of x(t - 3).

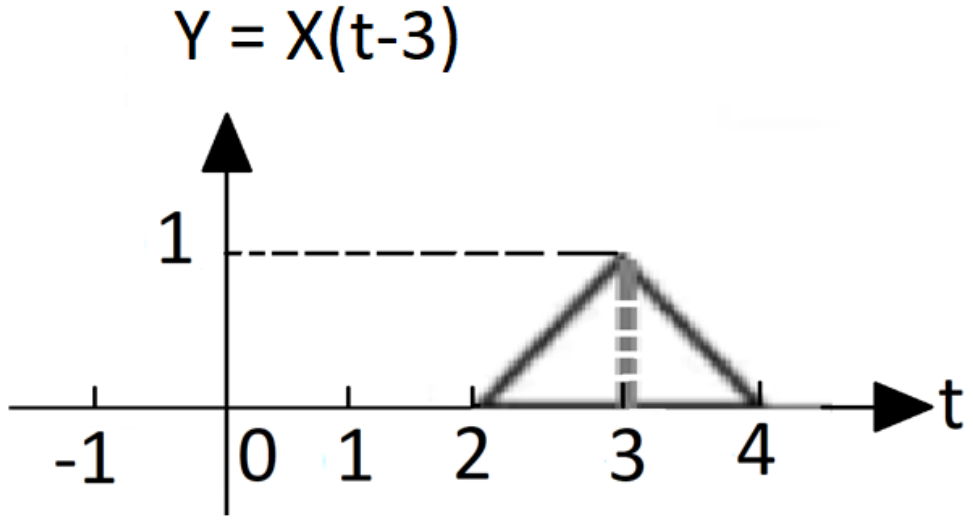


Exercise 3 Solution:

Given the signal x(t) below, draw the waveform of x(t - 3).

		t= 2	t= 3	t= 4
y = x(t-3)		y =x(-1)	y=x(0)	y=x(1)
		= 0	= 1	= 0





Question 3:

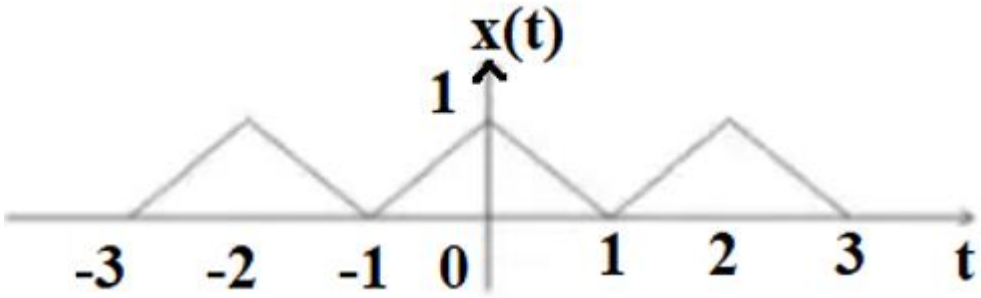
- What is the right shift by t0 signal for x(t) ?

Answer 3:

- The right shift by t0 signal for x(t) is:
- X(t-t0) 

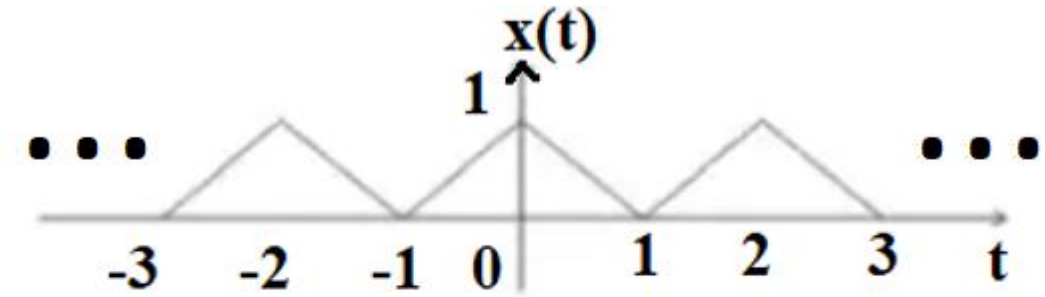
Exercise 4:

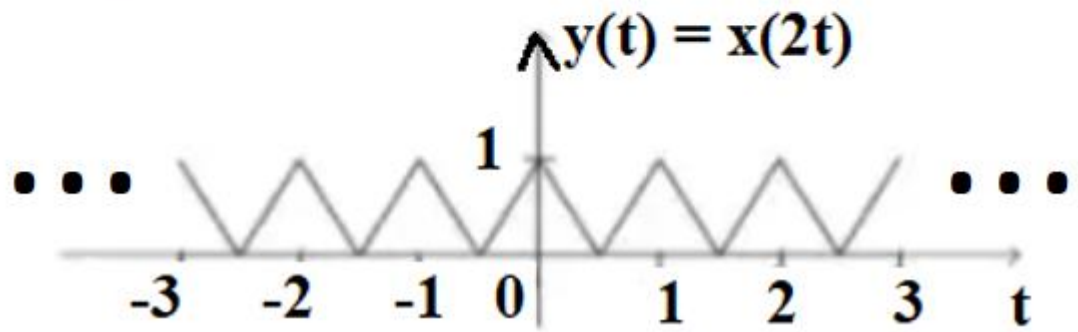
Given the periodic signal x(t) below, draw the waveform of x(2t).



Exercise 4 Solution:

Given the periodic signal x(t) below, draw the waveform of x(2t).





		t= -0.5	t= 0	t= 0.5
y = x(2t)		y=x(-1)	y =x(0)	y=x(1)
		= 0	= 1	= 0

Question 4:

- What is the relationship between the signals x(t) and x(2t)?

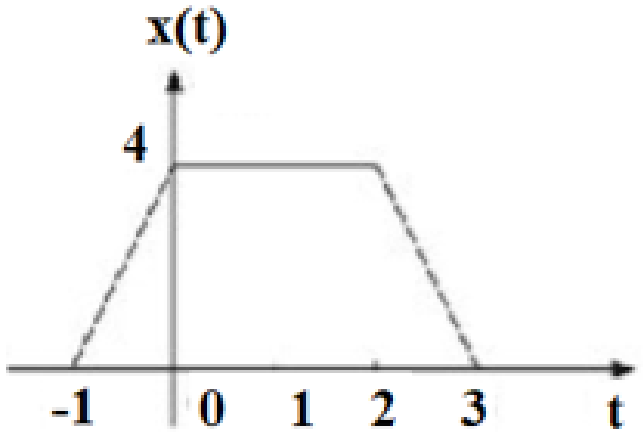
Answer 4:

- The signal x(2t)
- shrinks 

x(t) by half in the time scale.

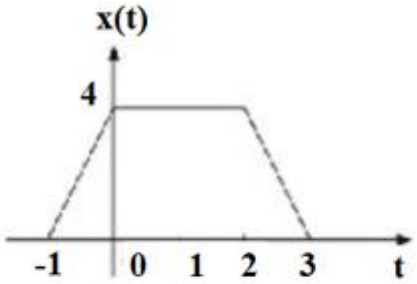
Exercise 5:

Given the periodic signal x(t) below, draw the waveform of x(t/2).

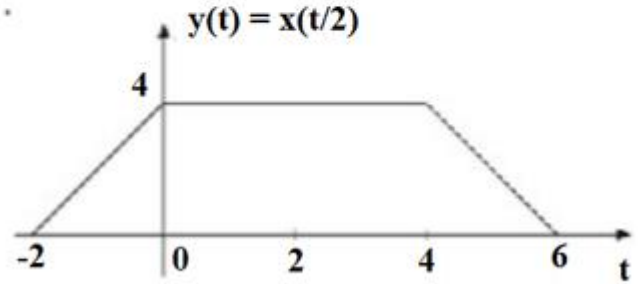


Exercise 5 Solution:

Given the signal x(t) below, draw the waveform of x(t/2).



(a). x(t) waveform



(c). y(t) = x(t/2) waveform

		t= -2	t= 0	t= 2	t=4	t= 6
y = x(2t)		y=x(-1)	y =x(0)	y=x(1)	y=x(2)	y=x(3)
		= 0	= 4	= 4	= 4	= 0

Question 5:

- What is the relationship between the signals x(t) and x(t/2)?

Answer 5:

- The signal x(t/2)
- expands 

x(t) by 2 in the time scale.