Chapter 1: Continuous-Time Signals and Systems

1.1[1] The signals in Figure 1 are zero except as shown.

(a) For the signal $x(t)$ of Figure 1(a), plot

(i)	$x(-t/3)$	**(iii)**	$x(3+t)$
(ii)	$x(-t)$	**(iv)**	$x(2-t)$

Verify your result by checking at least two points.

(b) Repeat (a) for the signal $x(t)$ of Figure 1(b)

(c) Repeat (a) for the signal $x(t)$ of Figure 1(c)

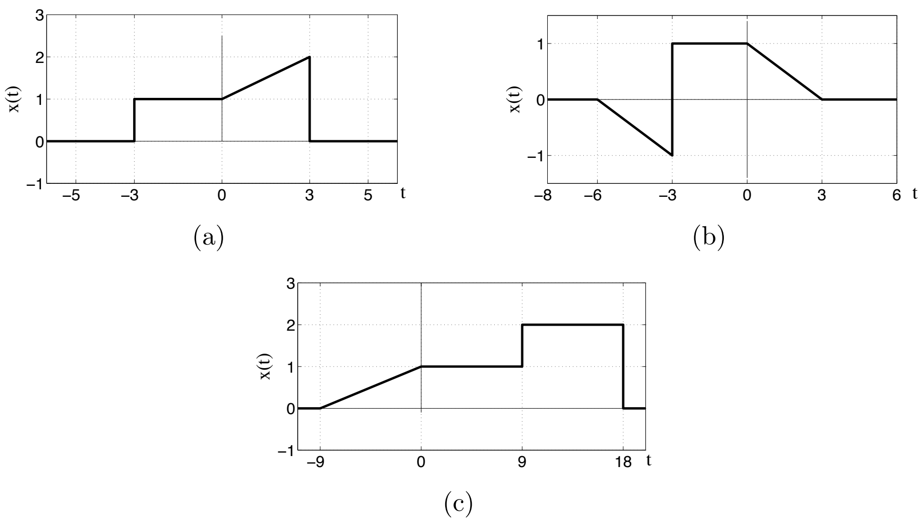


Figure 1: Three signals

[1] PPR 2.1 , Phillips, Parr & Riskin: Signals, Systems and Transforms, 4th ed.

1.2[2] The signals in Figure 1 are zero except as shown.

(a) For the signal $x(t)$ of Figure 1(a), plot

(i)	$4x(t) - 2$	**(iii)**	$2x(2t) + 2$
(ii)	$2x(t) + 2$	**(iv)**	$-4x(t) + 2$

Verify your result by checking at least two points.

(b) Repeat (a) for the signal $x(t)$ of Figure 1(b).

(c) Repeat (a) for the signal $x(t)$ of Figure 1(c).

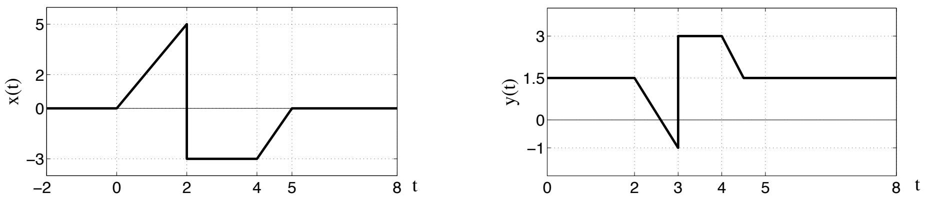
1.3[3] You are given the signals $x(t)$ and $y(t)$ in Figure 2.

a) Express $y(t)$ as a function of $x(t)$.

b) Verify your result by checking at least three points in time.

c) Express $x(t)$ as a function of $y(t)$.

d) Verify your result of part (c) by checking at least three points in time.



(a) Signal $x(t)$ (b) Signal $y(t)$

Figure 2: Two signals

1.4[4] Given

$$x(t) = 4(t+2)u(t+2) - 4tu(t) - 4u(t-2) - 4(t-4)u(t-4) + 4(t-5)u(t-5)$$

, find and sketch $x(2t-4)$.

[2] PPR 2.2
[3] PPR 2.4
[4] PPR 2.5

Chapter 2: Discrete-Time Signals and Systems

2.1[16] Determine which of the following discrete-time functions is different:

(a) $x_1[n] = u[n] + u[-1-n]$

(b) $x_2[n] = \sum_{k=-\infty}^{\infty} \delta[n-k]$

(c) $x_3[n] = u[n] + u[-n]$

(d) $x_4[n] = u[-n] + u[n-1]$

2.2[17] The signals in Figure 3 are zero except as shown.

(a) For the signal $x_a[n]$ of Figure 3, plot the following

(i)	$x_a[3n]$	**(iv)**	$x_a[3-n]$
(ii)	$x_a[-n/3]$	**(v)**	$x_a[n-3]$
(iii)	$x_a[-n]$	**(vi)**	$x_a[-3-n]$

(b) Repeat (a) for the signal $x_b[n]$ of Figure 3.

(c) Repeat (a) for the signal $x_c[n]$ of Figure 3.

(d) Repeat (a) for the signal $x_d[n]$ of Figure 3.

2.3[18] The signals in Figure 3 are zero except as shown.

(a) For the signal $x_a[n]$ of Figure 3(a), plot the following

(i)	$2-3x_a[n]$	**(iv)**	$3-x_a[n]$
(ii)	$2x_a[-n]$	**(v)**	$1+2x_a[-2+n]$
(iii)	$3x_a[n-2]$	**(vi)**	$2x_a[-n]-4$

(b) Repeat (a) for the signal $x_b[n]$ of Figure 3(b).

(c) Repeat (a) for the signal $x_c[n]$ of Figure 3(c).

(d) Repeat (a) for the signal $x_d[n]$ of Figure 3(d).

[16] PPR 9.1
[17] PPR 9.2
[18] PPR 9.3

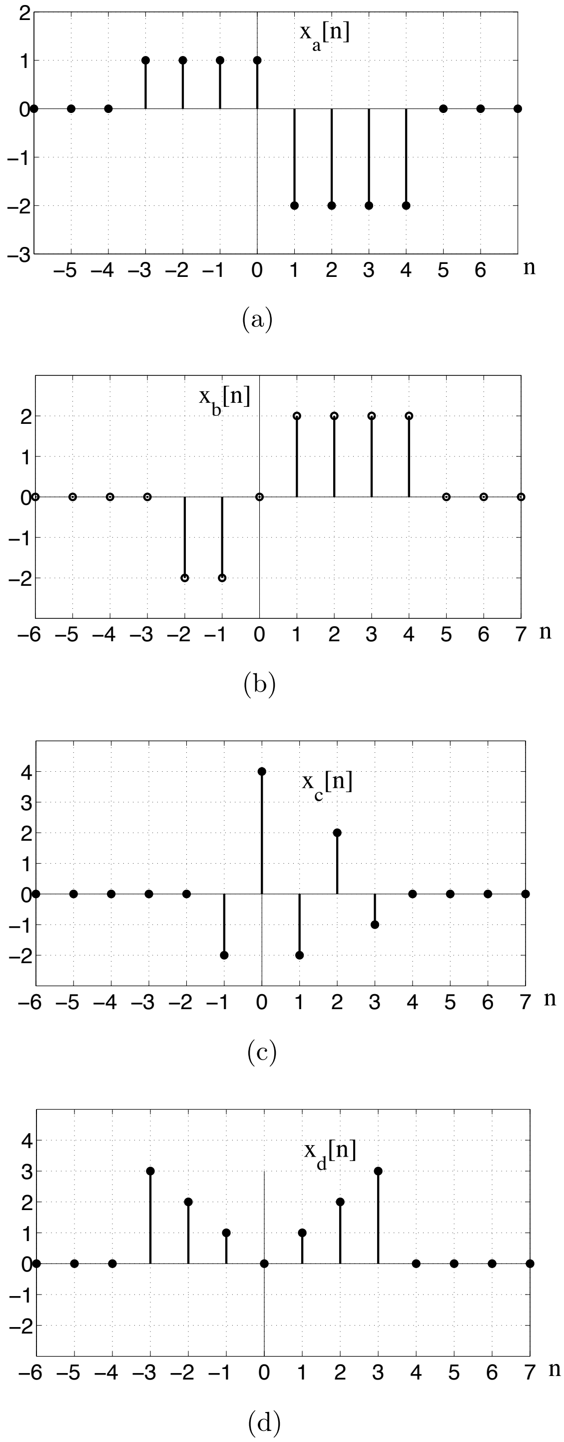


Figure 3: Discrete Signals

Chapter 3: Continuous-Time LTI Systems

3.1[28] Consider the integrator in Figure 6. This system is described in Example 3.1 (PPR) and has the impulse response $h(t) = u(t)$

(a) Using the convolution integral, find the system response when the input signal $x(t)$ is

(i)	$u(t-2)$	**(iii)**	$u(t)$
(ii)	$e^{5t}u(t)$	**(iv)**	$(t+1)u(t+1)$

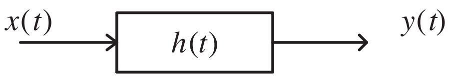
(b) Use the convolution integral to find the system's response when the input $x(t)$ is

(i)	$-tu(t)$	**(iii)**	$(t-1)u(t-1)$
(ii)	$e^{-5t}u(t)$	**(iv)**	$u(t) - u(t-2)$

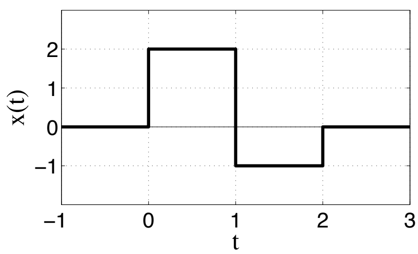
(c) Verify the results of part (a) and (b), using the system equation $y(t) = \int_{-\infty}^{t} x(\tau)d\tau$.

Figure 6: Ideal integrator: $y(t) = \int_{-\infty}^{t} x(\tau)d\tau$

3.2[29] Suppose that the system of Figure 7(a) has the input $x(t)$ given in Figure 7(b). The impulse response is the unit step function $h(t) = u(t)$. Find and sketch the system output $y(t)$.



(a) System



(b) Input signal $x(t)$

Figure 7:

[28]PPR 3.1
[29]PPR 3.2

3.3[30] For the system of figure 7(a), the input signal is $x(t)$, the output signal is $y(t)$, and the impulse response is $h(t)$. For each of the cases that follow, find and plot the output $y(t)$. The referenced signals are given in Figure 8.

(a) $x(t)$ in Fig (a), $h(t)$ in Fig (b)

(b) $x(t)$ in Fig (a), $h(t)$ in Fig (c)

(c) $x(t)$ in Fig (a), $h(t)$ in Fig (d)

(d) $x(t)$ in Fig (a), $h(t)$ in Fig (a)

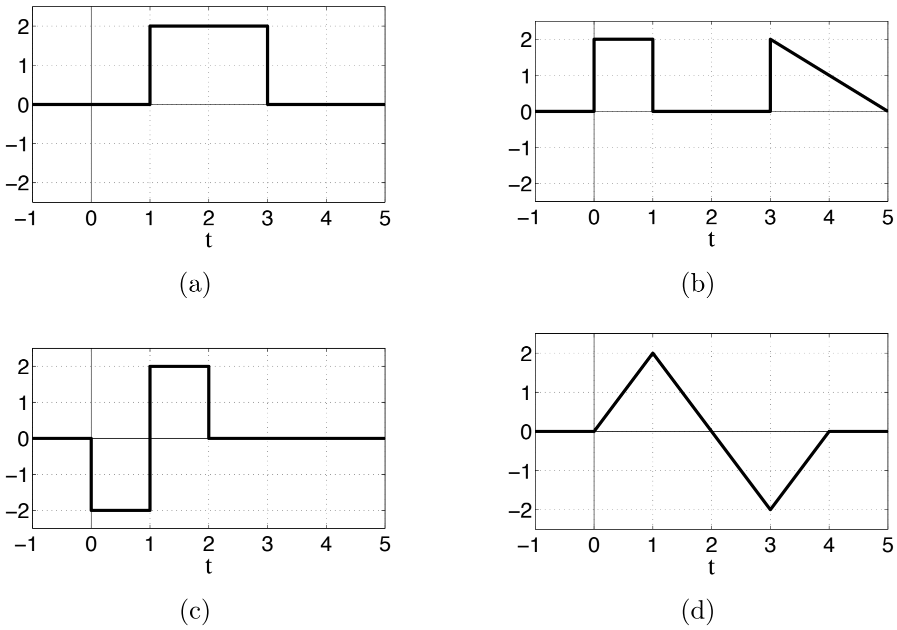


Figure 8: Signals

~~**3.4**[31] For the system of figure 7(a), suppose that $x(t)$ and $h(t)$ are identical and are as shown in Figure 8(c).~~

~~**(a)** Find the output $y(t)$ only at the times t=0, 1, 2, and 2.667 s. Solve this problem by inspection.~~

~~**(b)** To verify the result in part (a), solve for and sketch $y(t)$ for all times.~~

~~**3.5**[32] For the system of figure 7(a), the input signal is $x(t)$, the output signal is $y(t)$, and the impulse response is $h(t)$. For each of the following cases, find the output $y(t)$.~~

[30] PPR 3.4
[31] PPR 3.5
[32] PPR 3.7

Chapter 4: Discrete-Time LTI Systems

4.1[41] Consider the convolution sum

$$y[n] = x[n] \star h[n] = \sum_{k=-\infty}^{\infty} x[k]h[n-k] \ .$$

Show that this sum also can be expressed as

$$y[n] = h[n] \star x[n] = \sum_{k=-\infty}^{\infty} h[k]x[n-k] \ .$$

(*Hint*: Use a change of vaiables.)

4.2[42] Show that, for any function $g[n]$,

$$g[n] \star \delta[n] = g[n] \ .$$

4.3[43] Given the LTI system of Figure 10, with the input $x[n]$ and the impulse response $h[n]$, where

$$x[n] = \begin{cases} 1, & 1 \le n \le 6 \\ 0, & \text{otherwise} \end{cases} \qquad h[n] = \begin{cases} 2, & -2 \le n \le 1 \\ 0, & \text{otherwise} \end{cases}$$

Parts (a), (b) and (c) are to be solved without finding $y[n]$ for all n.

(a) Solve the system output at $n = 5$, that is find $y[5]$.

(b) Find the maximum value for the output $y[n]$.

(c) Find the value of n for which the output is maximum.

(d) Verify the results by solving for $y[n]$ for all n.

(e) Verify the results of this problem by using Matlab.

[41] PPR 10.1
[42] PPR 10.2
[43] PPR 10.3

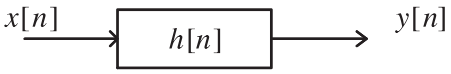


Figure 10: Discrete system.

4.4[44] Given the LTI system of Figure 10, with the impulse response $h[n] = \alpha^n u[n]$, where α is a constant. This system is excited with the input, $x[n] = \beta^n u[n]$, with $\beta \neq \alpha$ and β constant.

(a) Find the system response $y[n]$. Express $y[n]$ in closed form, using the formulas for geometric series (Appendix C in PPR).

(b) Evaluate $y[4]$ using the result of part (a).

(c) Verify the result of part (b) by expanding the convolution sum for $y[4]$.

4.5[45] Consider the discrete time LTI system of Figure 10. This system has the impulse response $h[n] = u[n+2) - u[n-2]$ and the input signal $x[n] = (0.7)^n u[n]$.

(a) Sketch $h[n]$.

(b) Find the system output $y[n]$.

4.6[46] For the LTI system of Figure 10, the input signal is $x[n]$, the output signal is $y[n]$, and the impulse response is $[h[n]$. For each of the cases that follow, find the output signal $y[n]$. The referenced signals are given in Figure 11. (The signals are zero except as shown.)

(a) $x[n]$ in (a), $h[n]$ in (b)
(b) $x[n]$ in (a), $h[n]$ in (c)
(c) $x[n]$ in (a), $h[n]$ in (d)
(d) $x[n]$ in (b), $h[n]$ in (c)
(e) $x[n]$ in (b), $h[n]$ in (f)
(f) Verify your results Matlab

[44] PPR 10.4
[45] PPR 10.6
[46] PPR 10.8

4.10[50] Consider an LTI system with the input and output related by

$$y[n] = 0.5x[n-1] + 0.7x[n] \; .$$

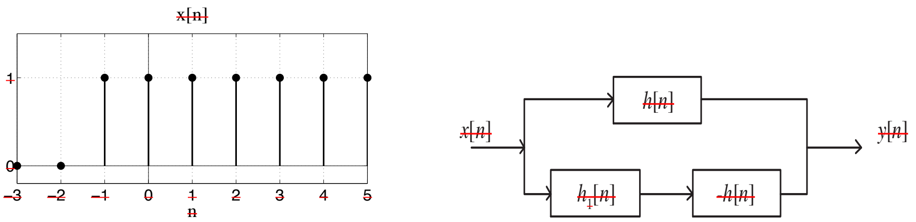
(a) Find the system impulse respons $h[n]$.

(b) Is the system causal ? Why?

(c) Determine the system response $y[n]$ for the input shown in Figure 13(a) ($x[n] = 1,\ n \geq 5,\ x[n] = 0,\ n < -4$).

(d) Consider the interconnections of the LTI systems given in Figure 13(b), where $h[n]$ is the function found in part (a) and $h_1[n] = \delta[n-1]$. Find the impulse response of the total system.

(e) Solve for the response of the system of part (d) for the input of part (c).



(a) Signal

(b) System

Figure 13:

4.11[51] Consider a system described by the equation

$$y[n] = e^n x[n]$$

(a) Is this system linear?

(b) Is this system time invariant?

(c) Determine the impulse response $h[n]$.

(d) Determine the response to the input $x[n] = \delta[n-1]$.

(e) Can a linear time varying system be described by its impulse response? Why?

[50] PPR 10.14

[51] PPR 10.15