Problems for Signals and Systems

Chapter 1 signals and systems

- **Basic Transforms of Signals**

1. A continuous-time signal $f(t)$ is shown in Figure 1.1. Sketch and label carefully each of the following signals.

(a) $f(2t+2)$

(b) $f(2-\frac{t}{3})$

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

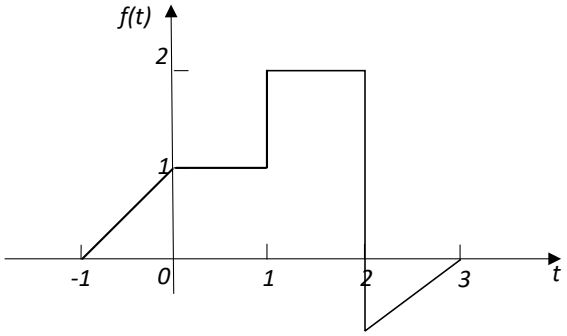


Figure 1.1

2. A discrete-time signal $f(n)$ is shown in Figure 1.2. Sketch and label carefully each of the following signals.

(a) $f(3-n)$

(b) $f(3n+1)$

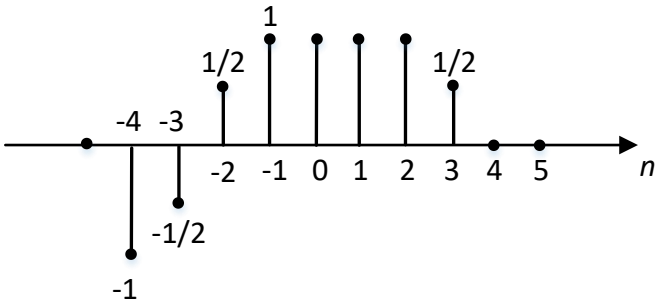


Figure 1.2

- **Typical Signals**

Complex exponential signal:

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

(a) $f(t) = [\cos\left(2t - \frac{\pi}{3}\right)]^2$

(b) $f(t) = \ e^{j(\pi t - 1)}$

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

(a) $f(n) = \ \cos(\frac{n}{4})\cos(\frac{\pi n}{4})$

(b) $f(n) = \ e^{j(\frac{n}{8} - \pi)}$

(c) $f(n) = 2\cos\left(\frac{\pi n}{4}\right) + \sin\left(\frac{\pi n}{8}\right) - 2\cos(\frac{\pi n}{2} + \frac{\pi}{6})$

(d) $f(n) = \ \cos(\frac{\pi}{8}n^2)$

The step and impulse signals:

5. Plot graphs of the following functions:

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

(b) $(\mathrm{t} - 2)[\mathrm{u}(\mathrm{t} - 2) - \mathrm{u}(\mathrm{t} - 3)]$

6. Plot waveforms of the following functions:

(a) $f(t) = sin\, 3\pi t[u(t) - u(t-2)]$

(b) $f(t) = (1 + cos\, \pi t)\,[u(t+1) - u(t-1)]$

7. Plot graphs of the following sequences:

(a) $f(n) = 3^n u(n)$

(c) $f(n) = 3^{n-1}u(n-1)$

8. Plot graphs of the following sequences:

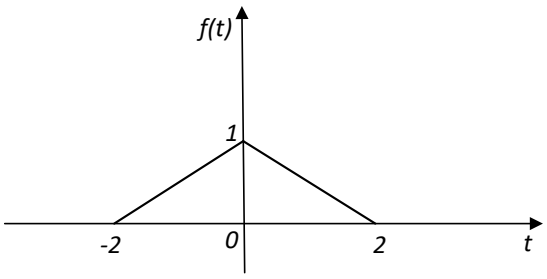
(a) $f(n) = \ u(n+3) - u(n-4)$

(b) $f(n) = \ u(-n-4) - u(-n+3)$

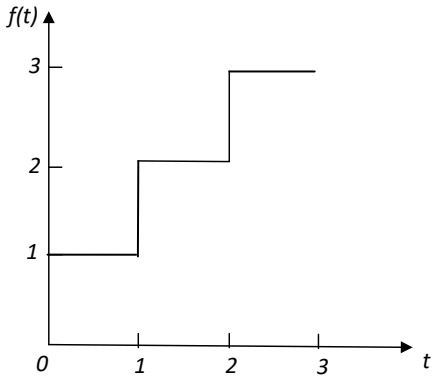
(c) $f(n) = (n^2 + 3n + 1)[\delta(n+1) - \delta(n) + \delta(n-1)]$

(d) $f(n) = \sum_{m=-\infty}^{n}[u(m+2) - u(m-3)]$

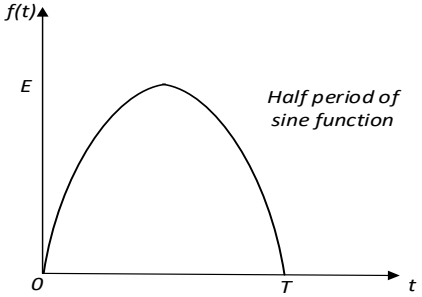
9. Write down the function expression of each waveform shown in Figure 1.3 (a), (b), (c).



(a)



(b)



(c)

Figure 1.3

10. A discrete-time signal $f(n)$ is shown in Figure 1.4. Sketch and label carefully each of the following signals.

(a) $f(n-2)\delta(n-2)$

(b) $f(n)u(3-n)$

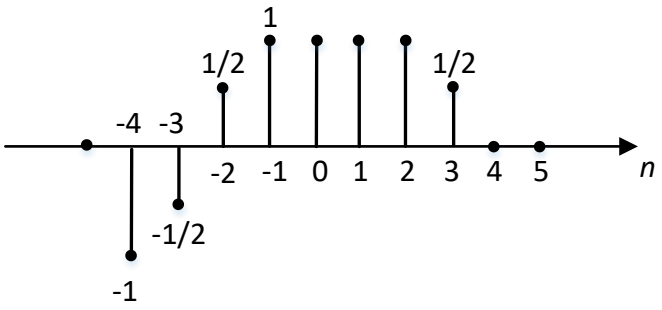


Figure 1.4

11. Calculate function values of the following expressions:

(a) $f(t) = e^{-3t-1}\delta(t)$;

(b) $f(t) = \int_{-\infty}^{t} e^{-\tau}\delta'(\tau)d\tau$;

(c) $f(t) = \int_{-\infty}^{\infty} \delta(t^2-4)dt$。

- **Basic Properties of Systems**

12. For each of the following continuous-time systems, $x(t)$ is its input, $y(t)$ is its output, and $T[x(t)]$ represents the system' response to $x(t)$.

Determine whether or not each of the following systems is

(1) linear system; (2) time-invariant system; (3) causal system; (4) stable system.

(a) $y(t) = x(t-1) - x(1-t)$

(b) $y(t) = \begin{cases} 0, & t < 0 \\ x(t) + x(t-100), & t \geq 0 \end{cases}$

(c) $y(t) = x\left(\frac{t}{2}\right)$

13. For each of the following discrete-time systems, $x(n)$ is its input, $y(n)$ is its output, and $T[x(n)]$ represents the system' response to $x(n)$.

Determine whether or not each of the following systems is

(1) linear system; (2) time-invariant system; (3) causal system; (4) stable system.

(a) $y(n) = nx(n)$

(b) $y(n) = \sum_{m=n-3}^{n+3} x(m)$

(c) $y(n) = \begin{cases} x(n), & n \geq 1 \\ 0, & n = 0 \\ x(n+1), & n \leq -1 \end{cases}$

14. Determine if each of the following systems is invertible. If it is ,construct the inverse system. If it is not, find out two input signals to the system that have the same output.

(a) $y(t) = x(t-4)$

(b) $y(t) = \cos[x(t)]$

(c) $y(n) = x(n)x(n-1)$

(d) $y(n) = x(1-n)$