14 Demonstration of Amplitude Modulation

Recommended Problems

P14.1

Consider the AM modulation system in Figure P14.1-1.

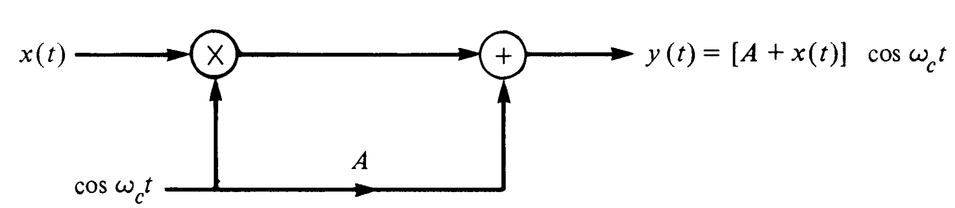

Figure P14.1-1

K/A is called the modulation index, where K is the maximum amplitude of $x(t)$. Parts (a)–(c) contain plots of $y(t)$ versus t for several different modulation indices, with $x(t) = B \cos \omega_0 t$. Find the modulation index for each signal.

(a)

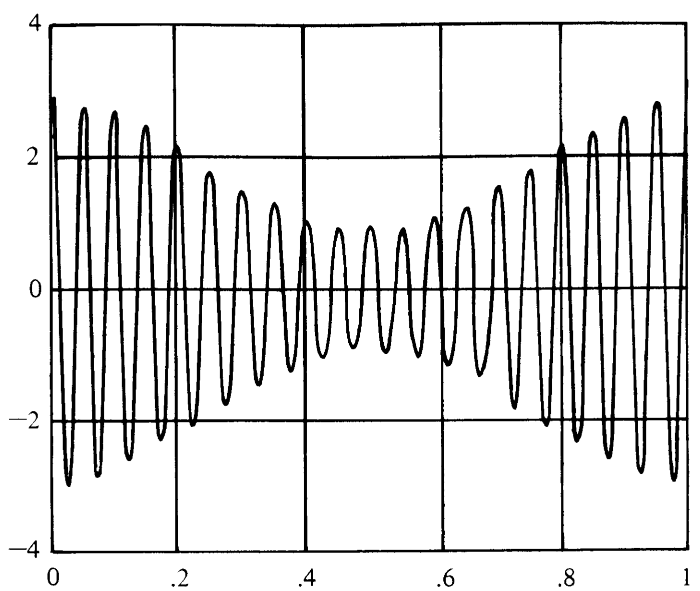

Figure P14.1-2

(b)

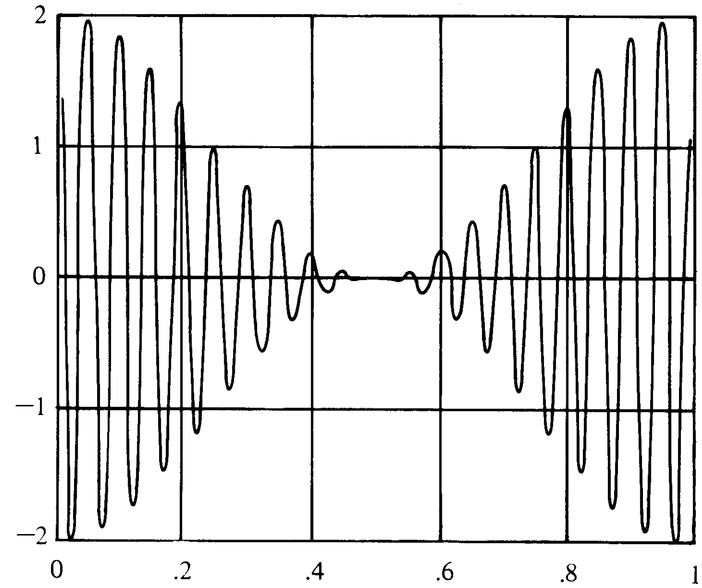

Figure P14.1-3

(c)

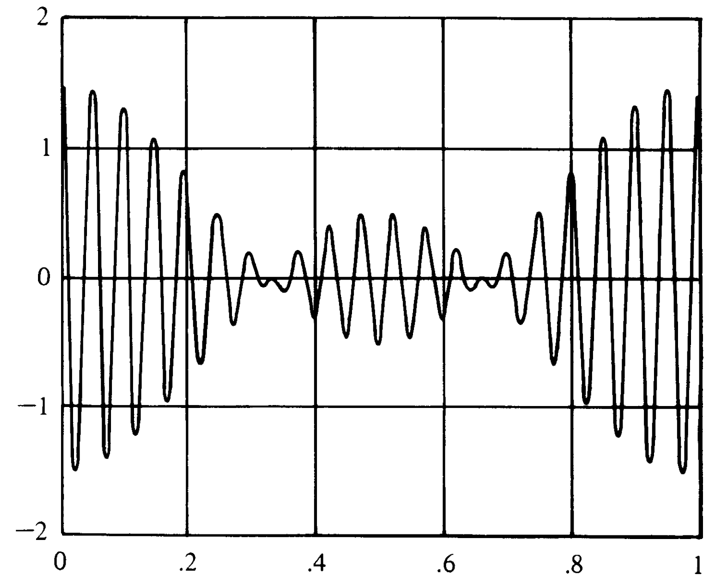

Figure P14.1-4

P14.2

(a) Consider the signal $x(t)$ in Figure P14.2-1.

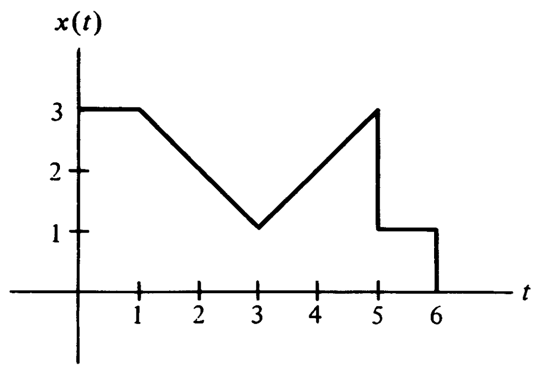

Figure P14.2-1

Draw $y(t)$ for each of the following systems.

(i)

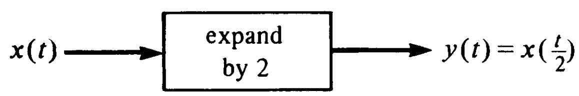

Figure P14.2-2

(ii)

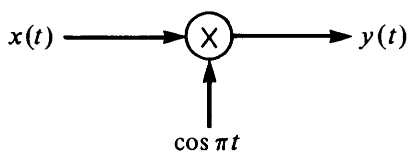

Figure P14.2-3

(iii)

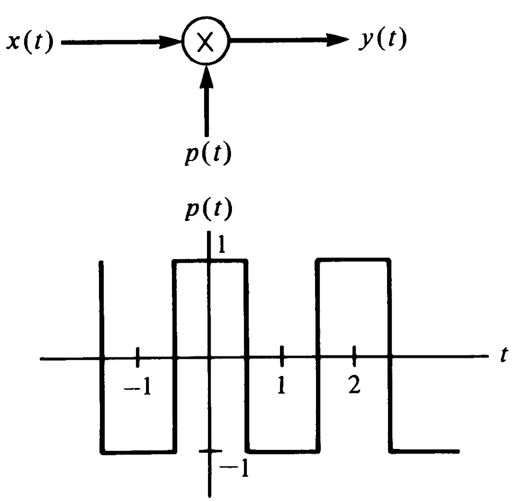

Figure P14.2-4

(b) Suppose that $x(t)$ has the Fourier transform shown in Figure P14.2-5. Find $Y(\omega)$ for each case in part (a).

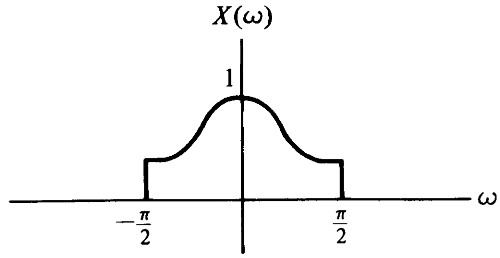

Figure P14.2-5

P14.3

For each of the time waveforms (a)–(j) (Figures P14.3-1 to P14.3-10), match its possible spectrum (i)–(x) (Figures P14.3-11 to P14.3-20).

(a)

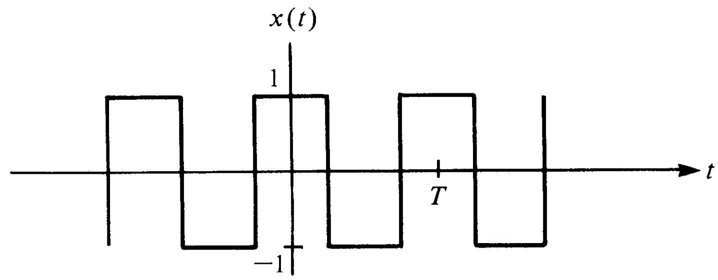

Figure P14.3-1

(b)

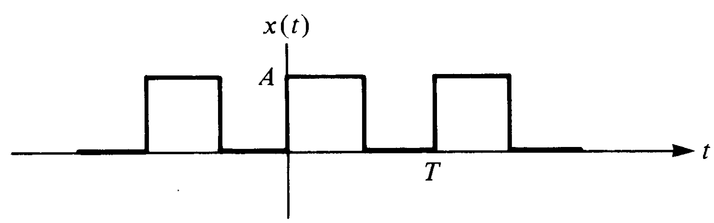

Figure P14.3-2

(c)

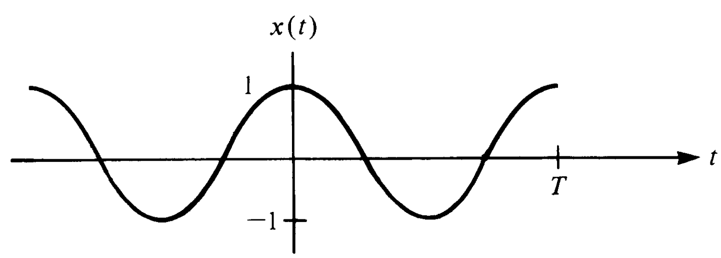

Figure P14.3-3

(d)

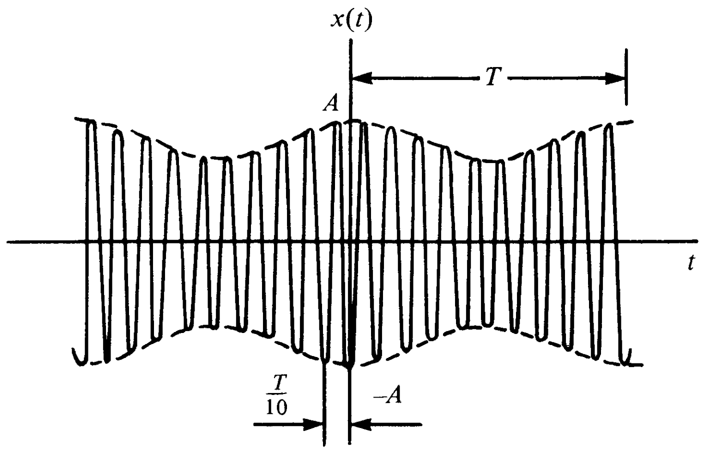

Figure P14.3-4

(e)

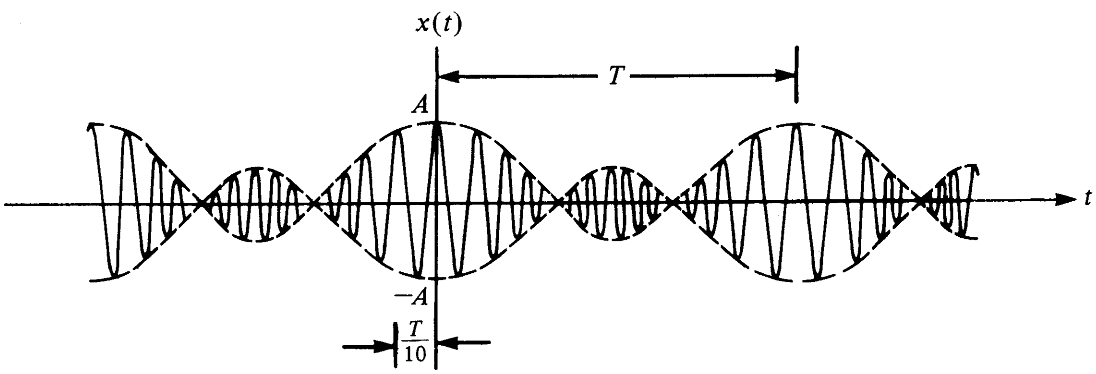

Figure P14.3-5

(f)

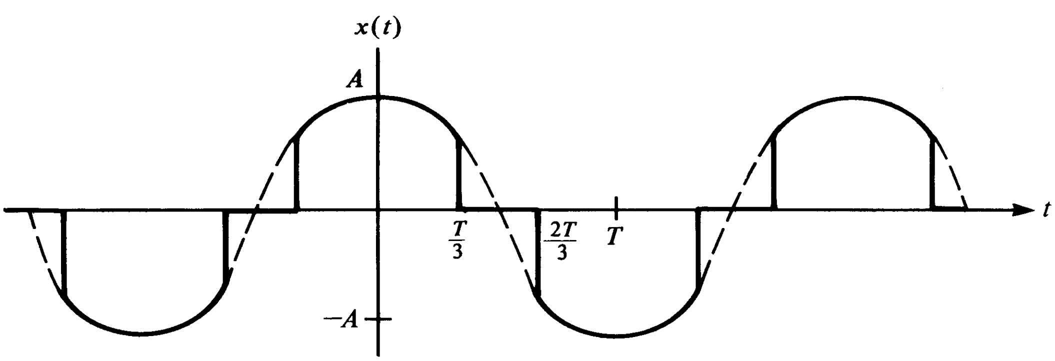

Figure P14.3-6

(g)

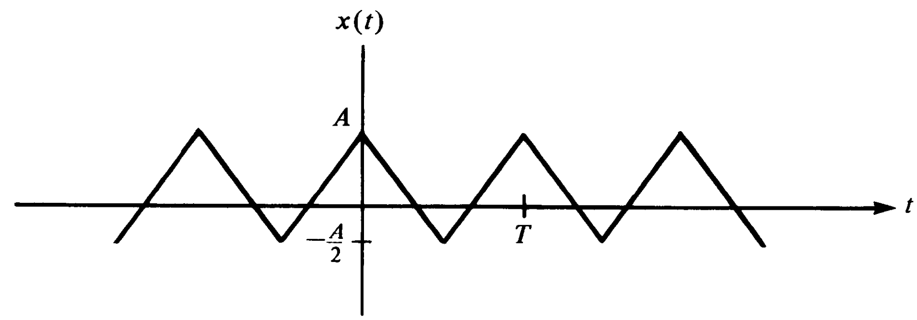

Figure P14.3-7

(h)

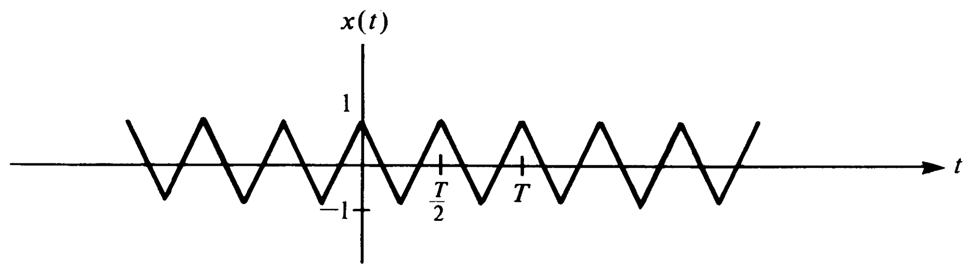

Figure P14.3-8

(i)

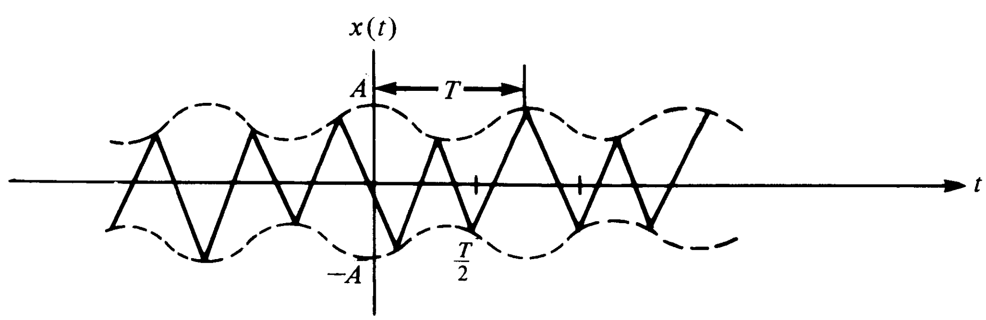

Figure P14.3-9

(j)

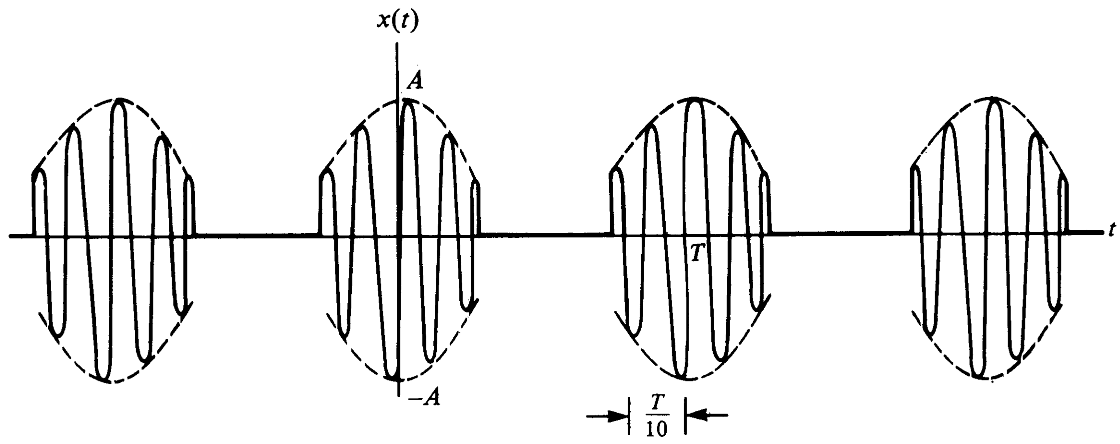

Figure P14.3-10

(i)

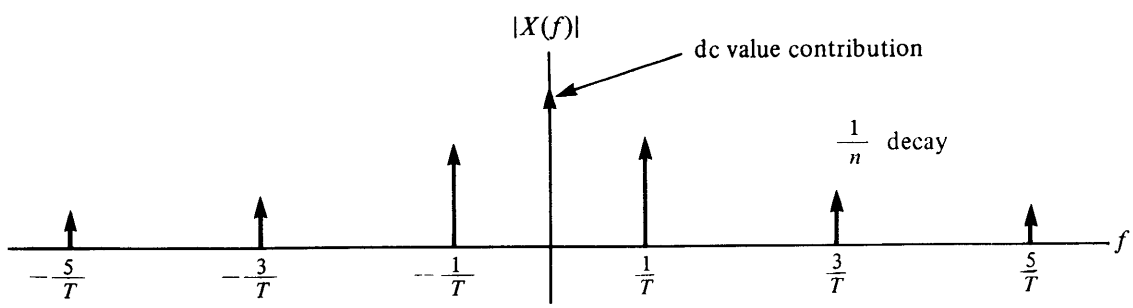

Figure P14.3-11

(ii)

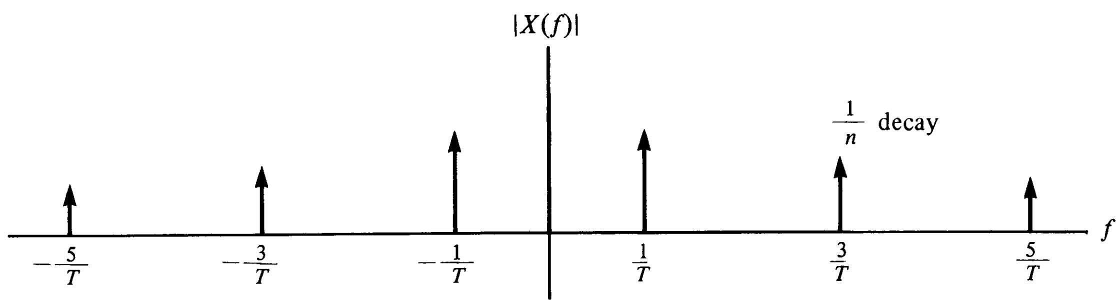

Figure P14.3-12

(iii)

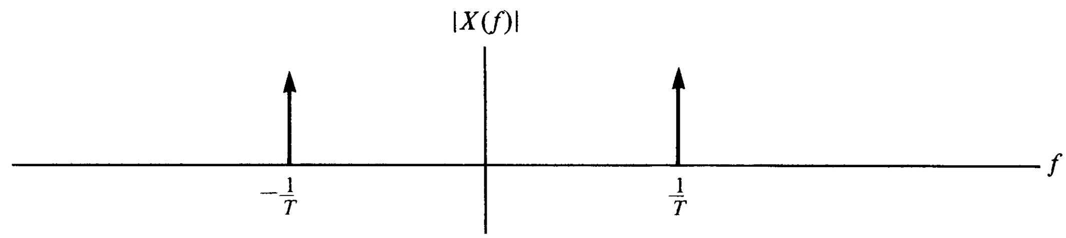

Figure P14.3-13

(iv)

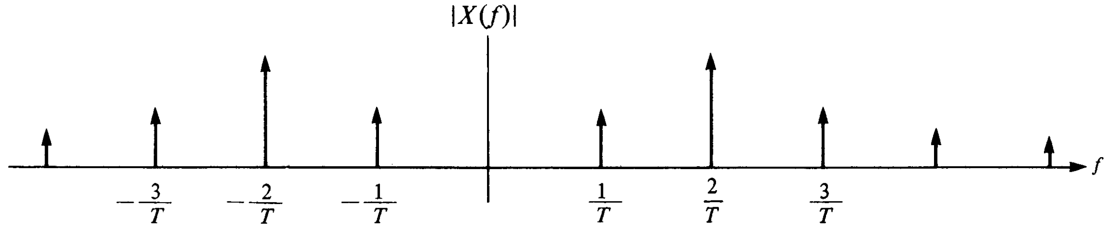

Figure P14.3-14

(v)

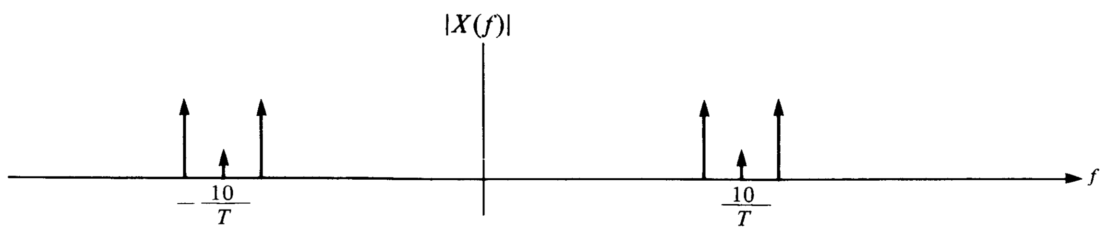

Figure P14.3-15

(vi)

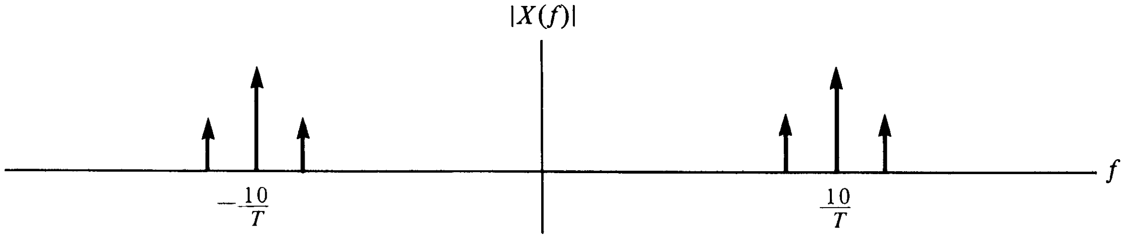

Figure P14.3-16

(vii)

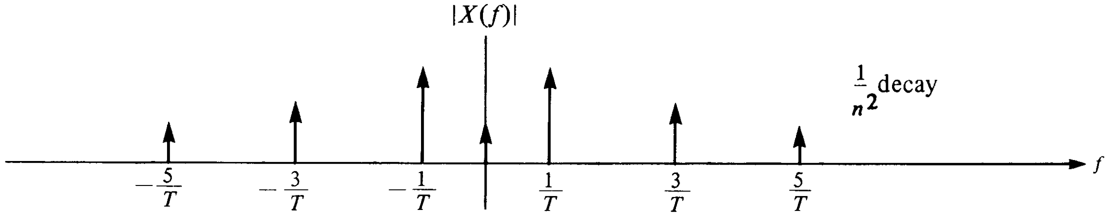

Figure P14.3-17

(viii)

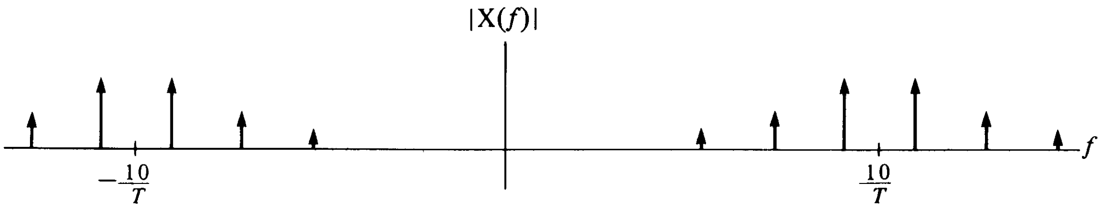

Figure P14.3-18

(ix)

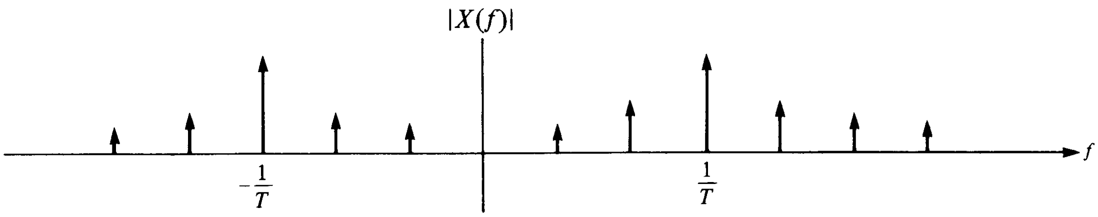

Figure P14.3-19

(x)

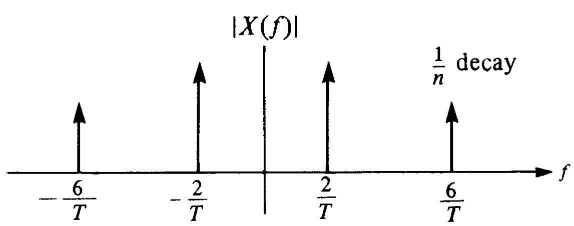

Figure P14.3-20

P14.4

The spectrum analyzer discussed in the lecture computed the estimate of the magnitude of the Fourier transform of $x_s(t)$ by taking samples of $x_s(t)$ at equally spaced intervals T, stopping after N samples, and computing the discrete-time Fourier transform of the N-point sequence.

Thus,

$$X(\Omega) = \sum_{n=0}^{N-1} x[n]e^{-j\Omega n}, \qquad \text{where } x[n] = x_s(nT)$$

(a) Suppose $x_s(t) = \cos \omega_0 t$. Find and sketch $|X(\Omega)|$.

(b) In any practical system, $X(\Omega)$ can be explicitly calculated only at a finite set of Ω. A common choice is

$$\omega_k = \frac{2\pi k}{N} \qquad \text{for } K = 0, \ldots, N-1$$

For the following situations, sketch

$$\left|X\left(\frac{2\pi k}{N}\right)\right| \qquad \text{for } K = 0, \ldots, N-1$$

if $x_s(t) = \cos \omega_0 t$.

(i) $N = 5, \quad \omega_0 = \frac{2\pi}{T}\left(\frac{2}{5}\right)$

(ii) $N = 5, \quad \omega_0 = \frac{2\pi}{T}\left(\frac{3}{10}\right)$