# PROBLEMS

## Basic Problems with Answers

**4.1.** The signal

$$x_c(t) = \sin(2\pi(100)t)$$

was sampled with sampling period $T = 1/400$ second to obtain a discrete-time signal $x[n]$. What is the resulting signal $x[n]$?

**4.2.** The sequence

$$x[n] = \cos\left(\frac{\pi}{4}n\right), \qquad -\infty < n < \infty,$$

was obtained by sampling a continuous-time signal

$$x_c(t) = \cos(\Omega_0 t), \qquad -\infty < t < \infty,$$

at a sampling rate of 1000 samples/s. What are two possible positive values of $\Omega_0$ that could have resulted in the sequence $x[n]$?

**4.3.** The continuous-time signal

$$x_c(t) = \cos(4000\pi t)$$

is sampled with a sampling period $T$ to obtain a discrete-time signal

$$x[n] = \cos\left(\frac{\pi n}{3}\right).$$

**(a)** Determine a choice for $T$ consistent with this information.
**(b)** Is your choice for $T$ in Part (a) unique? If so, explain why. If not, specify another choice of $T$ consistent with the information given.

**4.4.** The continuous-time signal

$$x_c(t) = \sin(20\pi t) + \cos(40\pi t)$$

is sampled with a sampling period $T$ to obtain the discrete-time signal

$$x[n] = \sin\left(\frac{\pi n}{5}\right) + \cos\left(\frac{2\pi n}{5}\right).$$

**(a)** Determine a choice for $T$ consistent with this information.
**(b)** Is your choice for $T$ in Part (a) unique? If so, explain why. If not, specify another choice of $T$ consistent with the information given.

**4.5.** Consider the system of Figure 4.11, with the discrete-time system an ideal lowpass filter with cutoff frequency $\pi/8$ radians/s.
**(a)** If $x_c(t)$ is bandlimited to 5 kHz, what is the maximum value of $T$ that will avoid aliasing in the C/D converter?
**(b)** If $1/T = 10$ kHz, what will the cutoff frequency of the effective continuous-time filter be?
**(c)** Repeat Part (b) for $1/T = 20$ kHz.

**4.6.** Let $h_c(t)$ denote the impulse response of a linear time-invariant continuous-time filter and $h_d[n]$ the impulse response of a linear time-invariant discrete-time filter.