**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

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

was obtained by sampling a continuous-time signal

\[ x_c(t) = \cos (\Omega_0 t), \quad -\infty < t < \infty. \]

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.