Q 4.2

4.2. The sequence

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

was obtained by sampling the 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 Ω_0 that could have resulted in the sequence $x[n]$?

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Q 4.4

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.

Q 4.5

4.5. Consider the system of Figure 4.10, 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.

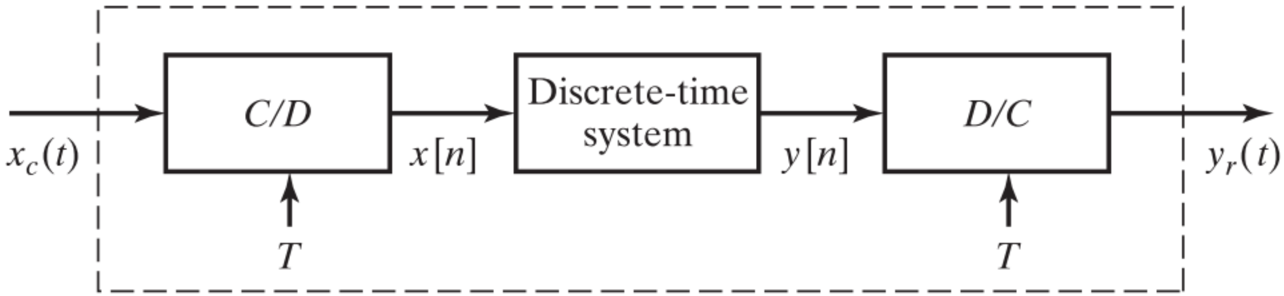

Figure 4.10 Discrete-time processing of continuous-time signals.

Q 4.25

4.25. Two bandlimited signals, $x_1(t)$ and $x_2(t)$, are multiplied, producing the product signal $w(t) = x_1(t)x_2(t)$. This signal is sampled by a periodic impulse train yielding the signal

$$w_p(t) = w(t) \sum_{n=-\infty}^{\infty} \delta(t - nT) = \sum_{n=-\infty}^{\infty} w(nT)\delta(t - nT).$$

Assume that $x_1(t)$ is bandlimited to Ω_1, and $x_2(t)$ is bandlimited to Ω_2; that is,

$$X_1(j\Omega) = 0, \qquad |\Omega| \geq \Omega_1$$

$$X_2(j\Omega) = 0, \qquad |\Omega| \geq \Omega_2.$$

Determine the *maximum* sampling interval T such that $w(t)$ is recoverable from $w_p(t)$ through the use of an ideal lowpass filter.