Class Exercises for Chapter 4

1. Suppose we want to process a speech signal using DSP techniques. Prior to digital processing, we pass the signal through an anti-aliasing filter with cutoff frequency of 8000 Hz. What is the minimum value of the required sampling frequency?

2. The continuous-time signal $x_c(t) = \sin(100\pi t + 1)$ is passed through an ideal CD converter with the sampling period $T = 1/50$ s to produce a discrete-time signal $x[n]$. Find $x[n]$. Can $x[n]$ uniquely represent $x_c(t)$?

3. Prove the multiplicative property of Fourier transform:

$$x_1(t) \cdot x_2(t) \leftrightarrow \frac{1}{2\pi} X_1(j\Omega) \otimes X_2(j\Omega) = \frac{1}{2\pi} \int_{-\infty}^{\infty} X_1(j\tau) X_2(j(\Omega - \tau)) d\tau$$

4. The continuous-time signal $x_c(t) = \sin(20\pi t) + \cos(40\pi t)$ is sampled at a sampling period T to obtain the discrete-time signal $x[n]$:

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

(a) Determine a possible value of T.

(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.

5. Determine the fundamental period of $x(t)$:

$$x(t) = 2\cos(10t + 1) - \sin(4t - 1)$$

6. Determine the Nyquist rate of the following signal:

$$x(t) = \frac{\sin(8000t)}{\pi t}$$