Chapter 2
MATLAB Problems

2.1   Real signals have finite time durations which are approximated by a finite time
      window. Given the spectrum of $x(t) = \cos 2\pi 50t$ that has been created using a
      sampling rate of 1000 Hz. Show how its spectrum is affected by convolving the
      sinusoidal wave with a rectangular window of widths $T/2$, T, $5T$, and $10T$.
      How does the width of the rectangle affect the spectrum?

2.2   Repeat 2.1 using a gaussian window with $\sigma = T/2$, T, $5T$, and $10T$. Which type
      of window better represents the signal's spectrum?

2.3   Simulate the system of Example 2.3-2 with $f_c = 1000$ Hz.

2.4   Write a program to show the values of time delay(s) t_d such that
      $\sin(2\pi f_0 t)$ is orthogonal to $\cos[2\pi f_0 (t - t_d)]$. Then relate time delay to
      distance. Let $f_0 = 50$.

2.5   Write a program to show that the terms of a Fourier series are orthogonal. As a
      test case, use the first two terms of a square wave.

2.6   Write a program to plot the waveform and spectrum of a raised cosine pulse. Let
      $f = 1$ and $\tau = 0.5$.

2.7   Write a program to show that the DFT for a gaussian pulse is also gaussian.

2.8   Write a program to plot the DFT of a single occurrence of a rectified sinusoidal
      wave. Compare the values for the coefficients of the Fourier series of its periodic
      version. What conclusions can you draw from this comparison?

2.9   Write a program to convolve two rectangular pulses of width τ. Then add to this
      program to convolve four and then eight pulses. What would you expect the
      convolution of an infinite number of pulses to converge to? How is the resultant
      pulse width affected by the number of convolutions.

2.10 Given the following a system with input $x(k) = 2e^{-(k-40)^2/10} + 4e^{-(k-60)^2/10}$ and
      impulse response function $h(k) = e^{-(k-50)^2/20}$ with $k = 1:128$. Determine the
      output function $y(k) = x(k) * h(k)$ using (a) the definition of discrete convolution
      given by Eq. (7) of Sect. 2.6, and (b) a 128 point FFT.