Problem 1: Text problem 2.12, choose any four of the six

Problem 2: Text problem 2.13

Problem 3:

a) Derive the Fourier transform for \( \text{Cos}(2\pi f_0 t) \); (see Table 2.1 for the answer, but provide the derivation!)

b) Suppose \( f_0 = 10 \), and that the signal is sampled at sampling rate of 30 samples per second. Sketch the frequency response of the sampled signal and show how a low-pass filter can recover the original signal.

c) Now suppose that the signal is sampled at a rate of 15 samples per second; sketch the frequency response of the sampled signal.

Note: In your sketches, you can limit yourselves to a bandwidth of 40Hz.

Problem 4: Text problem 2.40 (part 1 only). Instead of \( x(.005) \), solve for \( x(.01) \).

Problem 5: Matlab Exercise

a) Generate a sinusoidal waveform with two frequency components, 5 Hz and 10 Hz. Since Matlab only uses discrete (sampled, not continuous) signals, a sampling rate must be chosen to properly produce the waveform without aliasing. Any rate above 20 Hz will suffice, so use 30 Hz. Produce a one second plot of the waveform.

b) We next will find the frequency spectrum of the signal from part a. To do so, first use the Fast Fourier Transform function (fft) to bring the signal into the frequency domain. Use the fftshift function to produce a plot that will zero center the signal.

c) Now, create a lowpass filter to recover the 5 Hz component of the signal. Produce a plot of the filter and the filtered signal in the frequency domain.

d) With the filtered signal, take the Inverse Fast Fourier Transform (ifft) to bring the signal back into the time domain. Produce a plot with one second of the signal to show that the 5 Hz signal was recovered. Hint: ifft needs the signal to be in the same form as the output of the fft, so if you were working with the shifted signal, you will need to shift it again before inputting it to the ifft.

Be sure to turn in commented code and clearly labeled plots.

Usage information with examples on the Fast Fourier Transform (fft) is located at http://www.mathworks.com/access/helpdesk/help/techdoc/math/brentm1-1.html (same as located in the Matlab documentation).

For information on the Inverse Fast Fourier Transform function (ifft), see Matlab documentation for usage details.