Homework #6

due Thursday March 15

1. *Building a square wave.* Download the files fourier_tutorial.doc and SqWave.xls and fill out Part I of the tutorial. (Don't do Part II about the electron.)

2. Hirose and Lonngren Chapter 13 #3

3. *Amplitude modulation.* Use the excel spreadsheet AMwave.xls to show that the waveforms generated using the two functions:

$$f(t) = A(1 + a\cos\omega_a t)\sin\omega_c t$$

$$g(t) = A\sin\omega_c t + 0.5aA[\sin(\omega_c - \omega_a)t + \sin(\omega_c + \omega_a)t]$$

   are identical. Use an acoustic frequency of f_a=440 Hz and a carrier frequency of f_c=6800 Hz (arealistic carrier frequency for AM radio would be 680 kHz, but that is too tedious to graph), and A=1.0, a=0.5 in arbitrary units.

   In the spreadsheet you should caluclate hte appropraite values in the labeled columns to generate three graphs, which you will print out and turn in for this problem. The first graph should show $f(t)$, $\sin\omega_c t$ and $1 + a\cos\omega_a t$. The second graph should show $g(t)$, $\sin(\omega_c - \omega_a)t$ and $\sin(\omega_c+\omega_a)t$ on the same axes. The third graph should show $g(t)-f(t)$, with the vertical axis expanded x100.

   For the second graph, explain how the sum of three waves causes the maxima and minima in amplitude to occur. What frequencies will appear in the fourier spectrum of the amplitude modulated wave? (see Chapter 13, example 4 in Hirose and Lonngren).

4. *Waveform analysis.*The fourier transform (frequency spectrum) is shown in the graph in the file FourierSpectrum.jpg.

   (a) Estimate the frequencies and relative intensities from the graph and write the waveform as a fourier series (assume all components are cosine functions).

(b) If you want to measure the waveform that corresponds to this signal for a limited amount of time, what is the smallest amount of time you can measure and still capture most of the information in the signal?

5. Hirose and Lonngren Chapter 13 #2