Communication Systems
(ECE4572)
Fall 2013

Homework 2
Assigned Sept. 12, due Sept. 18.

Objective: To experiment with amplitude modulation (AM).

Description: The modulating signal $u(t)$ consists of two low-frequency tones, one at f_1=200 Hz and another at f_2=2000 Hz. Their amplitudes are A_1=1 and A_2=0.1, respectively. The carrier frequency is f_c=10 kHz.

Preparation:

1. Sketch (by hand, on paper) the signal $u(t)$ and its spectrum $U(f)$. This will give you an idea of what to expect from computer-generated plots.

2. Do the same with the modulated signal $s(t)$.

Exercise:

1. Generate the signals $u(t)$ and $s(t)$ in Matlab. To do so, you will need to choose a sampling frequency f_s. For example, use $f_s = 4f_c$. Set the total signal duration to 0.01 s.

2. Plot the signals. Make sure that the time axis is labeled in seconds.

3. Generate the spectra $U(f)$ and $S(f)$ using the built-in Fast Fourier Transform (FFT) function `fft`. You can type "help fft" for a full description of this function. Hint: you can also check out the built-in function `fftshift`.

4. Plot the spectra (absolute values). Make sure that the frequency axis is labeled in Hertz. Hint: recall the relationship between the sample spacing in the frequency domain and the signal duration in the time domain.

5. Using the speakers on your computer, listen to the signals. To do so, you can use `sound` or `wavplay` commands. You can also increase the signal duration. Can you hear both $u(t)$ and $s(t)$? Why?

6. Experiment by changing the amplitudes of the modulating tones, and by adding a third tone to the modulating signal. First establish what you *expect*, then confirm by computer simulation. For example, ask yourself: What will happen if A_2 is increased? Then verify the answer numerically.

Report: Your typed report should include:

1. Figures that you generated in Matlab.
2. Short comments that address the following questions:
   - Which signal varies more rapidly in time, $u(t)$ or $s(t)$?
   - What is the relationship between the envelope of $s(t)$ and the envelope of $u(t)$? Do your plots confirm this relationship?
   - What is the relationship between the spectrum $S(f)$ and the spectrum $U(f)$? Do your plots confirm this relationship?
   - How do the sounds change when you increase the amplitude A_2 relative to A_1? How does the spectrum of $u(t)$ change at the same time?
3. Matlab code as an appendix.