ELEC 470 Communication and Information Systems Fall 2014

Project #1: NBFM and WBFM Spectra – due in class Friday, Oct. 31, 2014

In this project you will use Matlab to generate sampled FM signals using single-frequency message signals with varying frequencies and then plot their spectra using the fast Fourier transform.

***Assignment*:**

1. Write a function in Matlab that contains a sampled tone-modulated FM signal. Please name the vector generated by the function 'phiFM' to maintain consistency between m-files. The carrier frequency should be 1 MHz, and the FM waveform should be expressed in the following form:

$$\phi_{\mathrm{FM}}(t) = A\cos\left[\omega_c t + k_f a(t)\right],$$

   where $a(t)$ is the time integrated from of the message signal $m(t) = A_m \cos \omega_m t$, A_m is the amplitude, and ω_m is the radian frequency of the modulating tone. Thus, $a(t) = (A_m/\omega_m) \sin \omega_m t$. Use a sampling frequency of f_{samp} = 4 MHz to minimize the effects of aliasing, and sample the waveform for 0.25 seconds.

   The Matlab function should accept values for A, ω_c, k_f, A_m, ω_m, and f_{samp} as inputs and produce the vector 'phiFM' as the output.

2. Use your Matlab function to generate NBFM and WBFM waveforms with two different modulating tones (not two tones at the same time). The tone frequencies should be widely separated and lie somewhere in the range of 300 Hz to 10 kHz. The goal is to compare NBFM to WBFM spectra for low and high-frequency audio. Specific values of k_f are not specified, but they should be chosen to generate reasonable NBFM and WBFM waveforms for each audio tone, and they should be appropriate values given the amplitude A_m you choose.

   Use Matlab to calculate the FFT of each waveform and then plot the spectrum of the waveform. You may ignore the redundant upper half of the output vector of the FFT. Your spectrum plot should be zoomed in on the signal; do not plot the entire spectrum from 0 to $0.5f_{samp}$.

   Use Matlab to add enough annotations to your plots to distinguish them from each other. Do not annotate by hand. The additional information should include axis labels (and an appropriate unit for the frequency axis), the values of A, f_c, k_f, A_m, and f_m, and any other information you think would be helpful. If you can, adjust the font sizes and change to bold face as appropriate to make the plot more readable.

3. Print out the plots you generate for the cases considered in Part 2. Write a short paragraph that briefly explains the reasons for the important differences between the various plots. That is, write a short reflection that interprets your results and shows that you understand the difference between NBFM and WBFM and how they perform for various modulating tones.