ELEC 470 Communication and Information Systems Fall 2014

Homework Assignment #1 – due in class Wednesday, Oct. 1, 2014

***Instructions, notes, and hints*:**

You may make reasonable assumptions and approximations in order to compensate for missing information, if any. Provide the details of all solutions, including important intermediate steps. You will not receive credit if you do not show your work.

Prob. 4.2-5. In part a, note that there are twice as many windings in the secondary as in the primary of the transformer. Thus, the input voltage $\phi(t)$ is repeated across each half of the secondary winding. Also, assume that the diodes act as ideal open circuits when they are reverse biased. For part b, you are asked to indicate where the incoming RF signal and the LO signal should be connected to the circuit as part of the problem in addition to showing mathematically why the circuit would work as a demodulator.

Prob. 4.2-7: Part c is asking you to show a block diagram of a possible receiving system. It could include oscillators, multipliers, filters, summers, and/or splitters and perhaps other stages. Be sure to indicate the operating frequency of oscillators, the bandwidth of filters, etc.

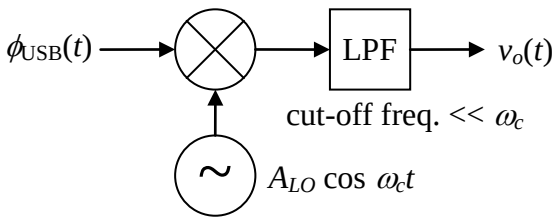
***Assignment*:**

Probs. 4.2-5, 4.2-7, 4.3-2, 4.3-8, and 4.4-7, plus the following additional problems:

1. A tone-modulated USB signal experiences Doppler and phase shifts so that it can be expressed as

$$\phi_{\text{USB}}(t) = A_{RF}\left\{\cos\left[(\omega_c + \Delta\omega)t + \theta\right]\cos\omega_m t - \sin\left[(\omega_c + \Delta\omega)t + \theta\right]\sin\omega_m t\right\}$$

   where $\Delta\omega$ accounts for the Doppler shift, θ is the phase shift relative to the local oscillator, and ω_m is the angular frequency of the modulating tone. Note that sin $\omega_m t$ is the Hilbert transform of cos $\omega_m t$. As shown in the block diagram below, a demodulator has been built to extract the original tone signal from the USB signal. The local oscillator generates the signal A_{LO} cos $\omega_c t$ and sets the reference phase. Find an expression for the USB demodulator's output voltage $v_o(t)$ in the presence of $\Delta\omega$ and θ. *Hint*: The output voltage should be a frequency and phase-shifted version of the message (tone) signal $m(t)$ = cos $\omega_m t$.



2. Sketch the output voltage waveform of an envelope detector applied to part c of Prob. 4.3-2.