Problem Set #5: Quadrature & Phase Demodulation

DUE: Wednesday, 2014-03-19 at 5:00 PM **as a Sakai assignment attachment**. Attach all code used to implement your algorithms and generate your plots!

1. **Quadrature Demodulation**

   We introduced the RLC divider in PS 3 as a circuit to detect changes in capacitance. Referring to the RLC circuit in PS 3,

   (a) Plot several cycles of an input sinusoid at a frequency of 1000 krad/s with a peak-to-peak amplitude of $\pm$ 2 V. Plot the output signals from your RLC divider for capacitances of 0.95 nF and 1.05 nF ($\pm$ 0.05 nF from the notch of the divider) on the same plot.

   (b) Express each output signal in decibels relative to the input amplitude.

   (c) Plot 10 cycles of an input sinusoid signal that linearly increases in amplitude from $\pm$ 2 V to $\pm$ 4 V over 10 cycles. Plot the same output signals as in (a) for this input signal.

   (d) Using the quadrature demodulation algorithm presented in lecture, plot the in-phase (I) and quadrature (Q) signals of each output signal from (c) on the same plot, with a separate plot for each output signal. Add a third line to each plot that represents the envelope of the output signal, as computed from I and Q.

2. **Phase Demodulation**

   Problem 1 should convey the fact that the magnitude of the amplitude is related to the capacitance change, but this quantity does delineate if the capacitance has increased or decreased relative to the notch capacitance. The sign of the phase of the output signal relative to the input signal will indicate this increase / decrease.

   (a) Using the phase demodulation present in lecture, calculate the sign of the relative phase of the output compared to the input signal for each capacitance change in Problem 1(a).

   (b) Your algorithm in 2(a) should have included low pass filter, which you could have implemented numerically with an algorithm of your choice. Plot the output of your phase demodulator before and after this low pass filtering operation and comment on the effectiveness of its performance.

   (c) Plot the phase change for each output signal for the linear amplitude change in the input signal in Problem 1(c). Comment on this plot.