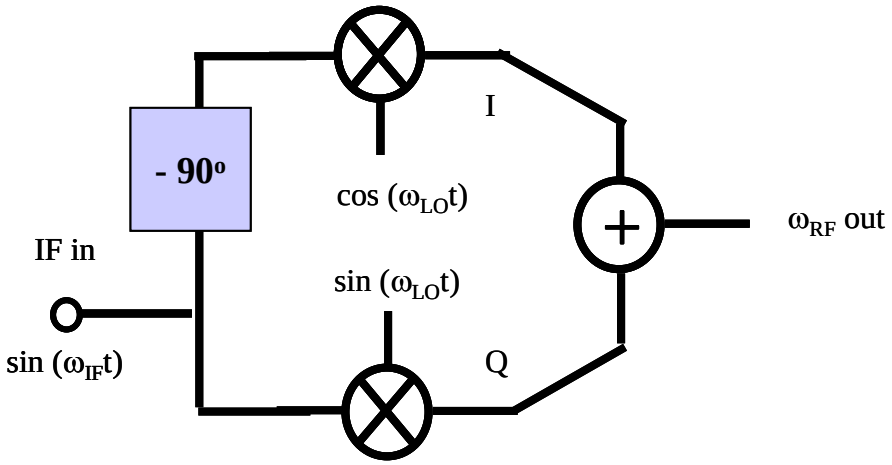
ECE145B/ECE218B Homework #3 Winter 2011
Due 2/4/2011 at homework box, 3rd floor

1. a. The block diagram illustrates an upconverting mixer architecture. Using the 3 dimensional graphical method illustrated in class, determine whether this mixer produces a upper or lower sideband output. Assume $f_{IF} << f_{LO}$.



b. Show what would happen if you moved the -90° phase shifter from the input of the I mixer to the input of the Q mixer.

2. Use the ADS harmonic balance and the behavioral model library components (ie. ideal mixer, phase shifter, 90 degree hybrid, etc.) along with single frequency voltage sources to simulate the mixers in parts a. and b. above. Use f_{IF} = 100 MHz and f_{LO} = 1 GHz.

3. A tapped capacitor resonator is used as an input preselector for a mixer and as an impedance transformer. The mixer has an input impedance of 200Ω with 1pF in parallel. At a frequency of 400 MHz, design a tapped C network to perform this transformation with a 3 dB bandwidth of 40 MHz. The unloaded Q of the inductor is 100. Verify your result using ADS.

4. Design a fixed frequency (100 MHz) common collector Colpitts oscillator using the 2N5179 BJT. Data sheet is on the course web page, and there is an ADS model in the Analog Transistor Library (pb_mot_2N5179_19921211). The oscillator design is related to the circuit described in Stanford notes Sect. 4-7.4 and 4-9.1 included in the supplemental reading. Assume the unloaded inductor Q is 100. Use these specs from ECE145B Lab 2:

Supply voltage	+5 V
Output power	-3 to 0 dBm in 50 ohm load
Second and third harmonic	-20 dBc minimum

a. Perform a hand analysis of the open loop oscillator to determine loop gain as a function of bias current and tapped capacitor ratio (C1+C2)/C1 = N. Do a small-signal open loop AC analysis in ADS and compare the results with your hand analysis.
b. Use transient analysis or harmonic balance to perform a large signal simulation of the oscillator and compare with the hand calculation. Show that the design is current limited, not voltage limited.
c. Take the output of the oscillator from the emitter, and design a buffer amplifier using the 2N5179 BJT that will provide approximately 0 dBm into a 50 ohm load. Simulate the combination and determine whether the oscillator-amplifier meet the harmonic distortion spec.