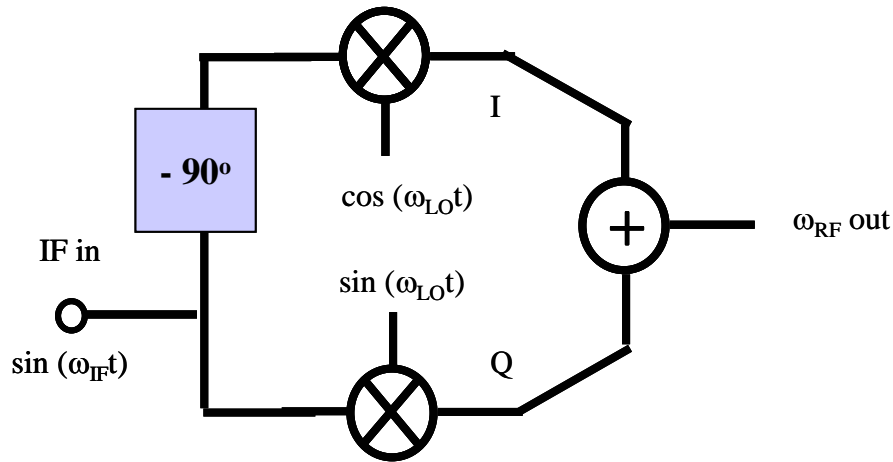


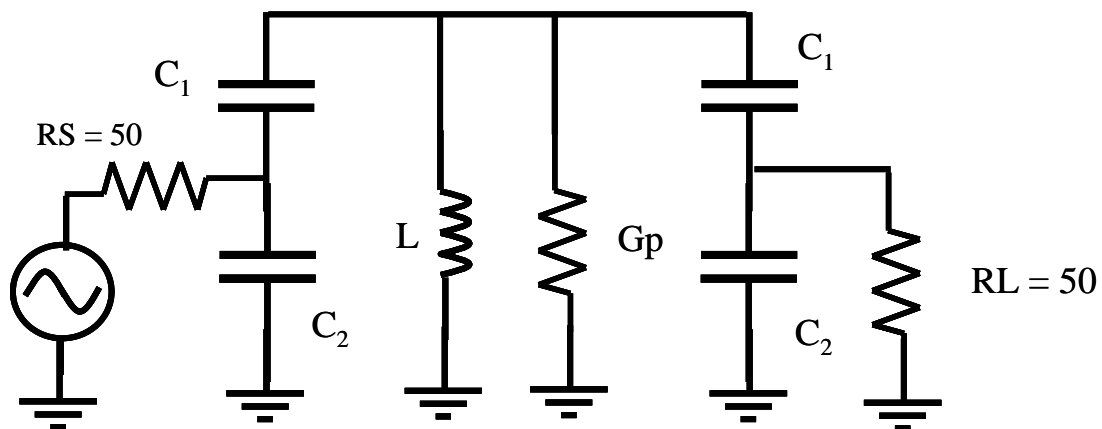
1. a. The block diagram illustrates an upconverting mixer architecture. Using the 3 dimensional graphical method illustrated in class, determine whether this mixer produces a upper or lower sideband output. Assume  $f_{IF} \ll f_{LO}$ .



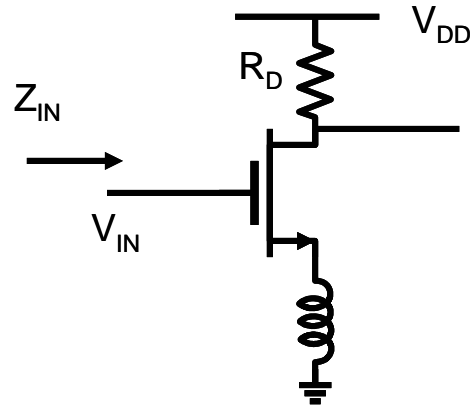
- b. Show what would happen if you moved the  $-90^\circ$  phase shifter from the input of the I mixer to the input of the Q mixer.

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. A tapped C resonator is to be used as a filter. Design this for a center frequency of 80 MHz and 3dB bandwidth of 10 MHz. The inductor has an unloaded Q of 30 at this frequency. Transform the 50 ohm source and load resistance up to 450 ohms for this filter. Calculate the insertion loss.



- b. Use the equivalent circuit model for the closest 0603CS Coilcraft inductor value and simulate the frequency response of this circuit. The inductor models can be found on the course webpage under tutorials and extra material.
- c. Assume the inductor has a temperature coefficient of  $+100 \text{ ppm}/^\circ\text{C}$ . Find an appropriate combination of capacitors with C0G (NP0) and X7R (BX) dielectrics to reduce the frequency drift with temperature to zero.
4. a. Derive the voltage gain and input impedance of this circuit. Use a simple model of the device including only  $C_{gs}$  and the  $g_m$   $V_{gs}$  dependent source.



- b. If the source inductor were replaced by a capacitor, what effect would this have on the  $Z_{in}$ ? Under what conditions could you observe a negative resistance? What might this do to circuit stability?