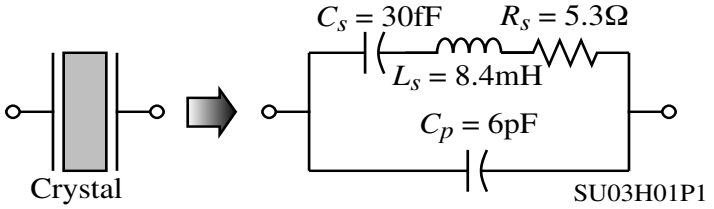
Homework Assignment No. 1

This homework assignment is due in class on Monday, May 19, 2003.

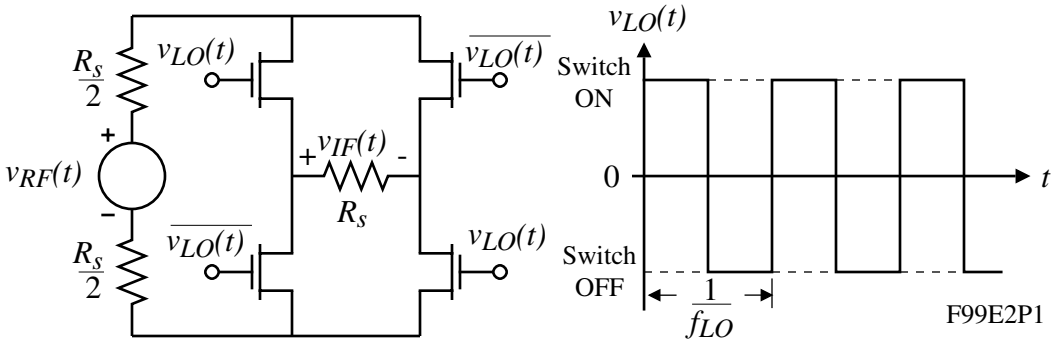
Problem 1 - (10 points)

Solve for and evaluate the series and parallel resonance frequencies of the crystal whose model is shown. It is suggested to make appropriate assumptions as the exact frequencies are difficult to achieve.



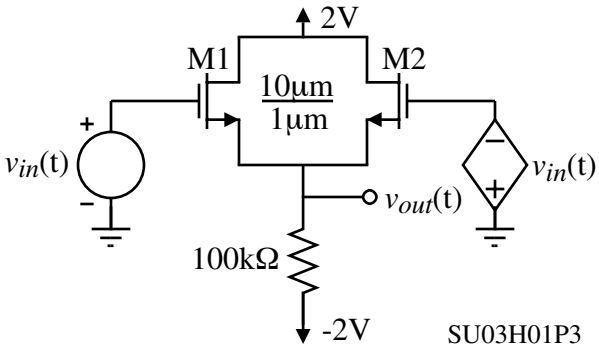
Problem 2 - (10 points)

A simple, doubly balanced passive CMOS mixer is shown along with the local oscillator waveform, $v_{OL}(t)$. Assume that $v_{RF}(t) = A_{RF}cos(\omega_{RF}t)$ and $v_{LO}(t)$ is the waveform shown below. (a.) Find the mixer gain, G_c, in dB if the switches are ideal. (b.) Find the mixer gain in dB if the switches have an ON resistance of $R_s/2$.



Problem 3 – (10 points)

Use SPICE to demonstrate that the following circuit is a frequency doubler. If $v_{in}(t)$ is a sinusoid of 10kHz and 1.5V peak, show $v_{in}(t)$ and $v_{out}(t)$ as a function of time. The model parameters of the MOSFETS are K_N' = 110μA/V^2, V_{TN} = 0.7V, and λ_N = 0.04V-1.



Problem 4 – (10 points)

An 10nH inductor has a Q of 5 and is used to create a tank circuit with a 10pF capacitor. Assume the capacitor is ideal. (a.) What is the resonant frequency of this circuit? (b.) What value of parallel negative resistance should be used to create an oscillator? (c.) If C is changed to 20 pF, what is the new value of the parallel negative resistance?

Problem 5 – (10 points)

Give a block diagram of simple brute-force coherent direct synthesizer that will generate 1.75f from f. The input frequency f is to vary from 12 MHz to 15MHz. Since f is variable, you cannot use frequency multipliers (integer frequency dividers and mixers are allowed) in your design. A simple design will receive more credit. What other frequencies will be present at the output