ECE 621 Winter 2008

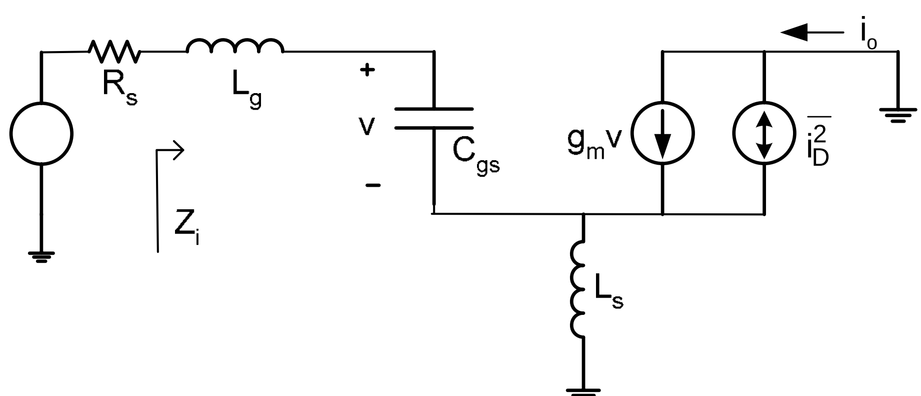
Homework #4 (Due Feb. 11)

1. Razavi's paper "Impact of Distributed Gate Resistance on the Performance of MOS Devices," shows that the distributed gate resistance can be modeled by a lumped resistance of value $R_g/3$ when the gate is contacted on one side. Show that the lumped resistance will be of value $R_g/12$ when the gate is contacted on both sides. Next consider a transistor with N fingers and the gate contacted on only one side. Show that the lumped gate resistance is given as below (R_{sq} is the sheet resistance, W is the transistor width and L is the channel length).

$$R_g = \frac{R_{sq}W}{3N^2L}$$

2. Consider a noise current source $\bar{i}_g^2$ between the G and S terminals of a MOSFET that is uncorrelated to $\bar{i}_d^2$. Derive the equivalent input noise voltage and current generators for the transistor in terms of $\bar{i}_g^2$, $\bar{i}_d^2$. You can ignore r_o but not C_{gs} for the transistor.

3. For the circuit shown below $\bar{i}_d^2 = 4KTg_{d0}\gamma\Delta f$. Derive the noise figure for the amplifier. Use the ratio of the short circuit noise currents at the output. Assume input matching, i.e., the input impedance $Z_i = R_s$ at the resonance frequency.



4. Given ω_0, Q, R_{in}, R_S, derive expressions that allow you to calculate C_1, C_2 and L for the tapped-capacitor resonator. The derivation is given in your book but you need to provide an explanation for each step.

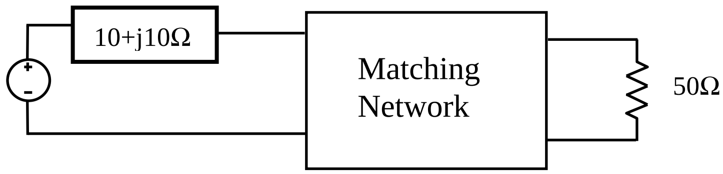
5. Problem 3.2 of textbook.

6. Problem 3.3 of textbook.

7. Problem 3.11 of textbook. Use SPICE to verify your design.

8. Problem 3.12 of textbook. Use SPICE to verify your design.

9. Design a matching network using the Smith chart to match a source with Z of 10+j10Ω to a 50Ω load at 50 MHz.



10. a) Using the software ASITIC (/usr/local/apps/bin/asitic on unix systems) (See paper on class website) design a 3nH inductor for an operating frequency of 2.4GHz. The technology file and a journal paper on ASITIC are available on the class webpage. What is the Q of the inductor?

    b) Design the same inductor using the software Coils (http://haydn.stanford.edu/inductor/) (See paper on class website) and compare the two designs.

    c) Use the spiral inductor calculator (http://smirc.stanford.edu/spiralCalc.html) (See paper on class website) to compute the approximate inductance value.