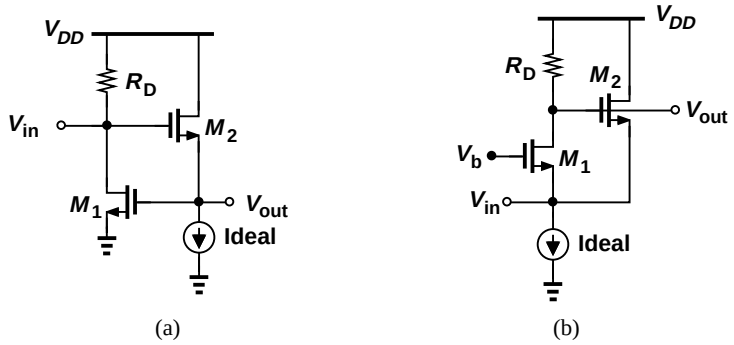
Homework #2

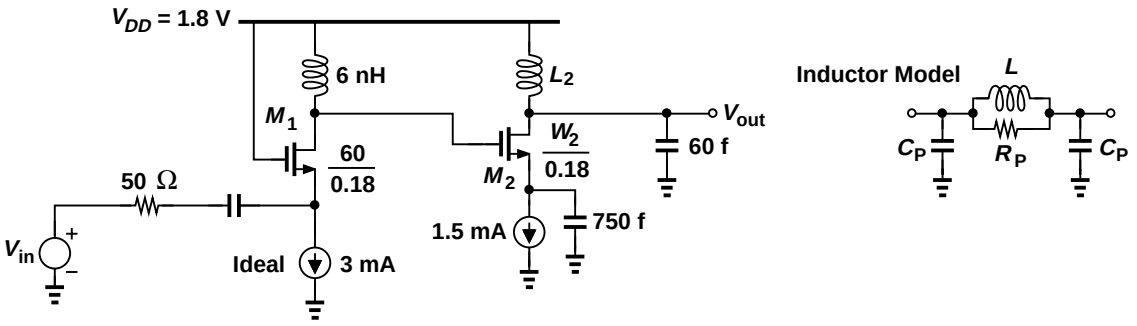
Due Thur., Jan. 24, 2013

1. (a) Neglecting device capacitances, calculate the noise figure of each circuit with respect to a source resistance R_S. Assume devices operate in saturation and $\lambda = \gamma = 0$. What happens to the noise figure if $R_D \to \infty$? Can you explain these results intuitively?
(b) Now suppose $g_{m2} \to 0$ while $R_D \neq \infty$. What happens to the noise figure?



(a) (b)

2. In this problem , we use Cadence to study the noise behavior of a two-stage amplifier similar to that introduced in Homework #1:



(a) Choose the value of L_2 and the width of M_2 to create resonance at 5.2 GHz at the drain of M_1 and preferably at the drain of M_2. Note that the two stages interact through Miller multiplication of C_{GD2}. The inductor must be modeled as shown, where R_P is chosen to give a Q of 4 at the frequency of interest and $C_P = 5$ fF for every nanohenry of inductance. The choice of these two components is not unique, but you should bear in mind that the capacitance contributed by M_2 to the output node is negligible with respect to the entire capacitance at this node and hence the width of M_2 should not affect the output resonance frequency significantly.
(b) Find the transistor transconductances and output resistances from Cadence and calculate the noise figure of the first stage by hand. Compare the result with that obtained by simulation. (The first stage is always loaded by the second stage.)
(c) Using Cadence, find the noise figure of the overall amplifier. What is the contribution of the second stage to the NF (i.e., the NF with and without the second stage)? (The first stage is always loaded by the second stage!)