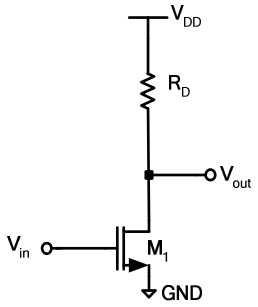
EECE488 Analog CMOS Integrated Circuit Design
Assignment 2
Due: Thursday February 24th, 2011 at 9:30am

1. a) Use HSPICE and the 0.35µm CMOS technology library used in our class to plot I_D versus V_{DS} of an NMOS transistor with W=7µm and L=0.35 µm when its V_{GS} is 1V or 2V. For each V_{GS} use two difference V_{BS} of 0V and -1V.
b) Assuming that long channel quadratic equations for I_D holds, use the information from the I_D plots in part (a) to calculate a rough estimate of the process parameters V_{th0}, $\mu_n C_{ox}$, γ and λ for the transistor you used in part (a).
c) For V_{BS}=0, calculate g_m of the transistor in part (a) for each value of V_{GS} based on your estimated process parameters in part b and long channel equations discussed in class. Compare the estimated g_m values with those calculated by HSPICE (using gmo) and calculate the relative error.

2. Design a common-source amplifier with a resistive load based on the schematic shown below with the following design specifications:

- Transistor M1 is in saturation
- The minimum possible output voltage to keep M1 in saturation is 0.2V
- Total power consumption of the amplifier is 3mW
- Absolute value of gain of 15
- L=0.5µm for the transistor

The technology parameters are:
λ(NMOS) = 0, γ = 0, V_{DD}=3V, V_{TH}(NMOS) = 0.5V, $\mu_n C_{ox}$=1 mA/V^2



Find the following values:
a) DC level of the input,
b) width (W_1) of transistor M_1,
c) R_D,
d) nominal dc level (bias level) of the output node, and
e) Maximum output signal swing for a symmetric output signal.

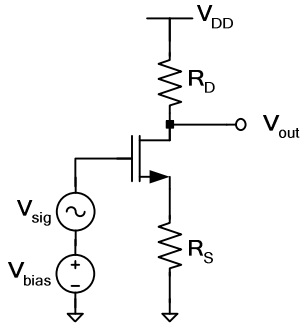
3. In the following circuit, assuming that the transistor is operating in the saturation region:

a) Find the required V_{bias} for which the dc value of the V_{out} is 1.44V.

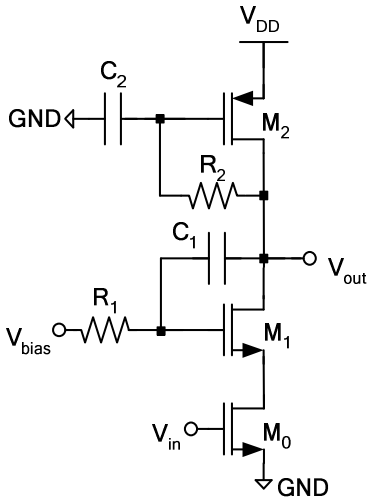
b) Is the assumption that the transistor is in the saturation region correct?

c) Find the small-signal gain V_{out}/V_{sig}.

Assume $\lambda = 0$, $\gamma = 1V^{1/2}$, $2\Phi_F$=0.64V, V_{TH0}= 0.4V, $\mu_n C_{ox} = 800\ \mu A/V^2$, $(W/L)_{NMOS} = 20$, $R_D = R_S = 0.5k\Omega$, and V_{DD}=1.8V.



4. Calculate the gain of the following circuit at very low and very high frequencies. Neglect all other capacitances that are not shown in the circuit and assume $\lambda = \gamma = 0$.



Good luck!