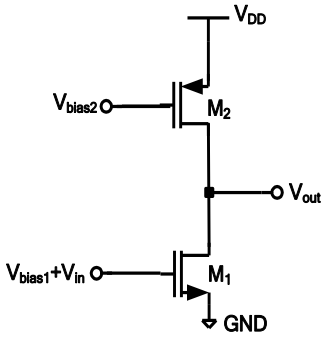
EECE 488: Analog CMOS Integrated Circuit Design
Assignment 2
Due: Thursday, March 1, 2012 at 9:30am

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

- V_{DD}=3V
- Transistor M_1 is in saturation
- The minimum possible output voltage to keep M_1 in saturation is 0.1V
- The maximum possible output voltage to keep M_2 in saturation is 2.9V
- Total power consumption of the amplifier is 0.3mW
- L=0.4μm for the transistor

The technology parameters are:
$\lambda_{(NMOS)} = 0.1V^{-1}$, $\lambda_{(PMOS)}=0.2V^{-1}$, $\gamma = 0$, V_{DD}=3V, $V_{TH(NMOS)} = 0.5V$, $V_{TH(PMOS)} = -0.6V$
$\mu_n C_{ox}$=1 mA/V^2, $\mu_p C_{ox}$=0.25 mA/V^2.

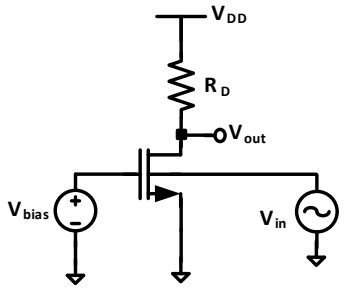


Assuming both transistors are in saturation, find the following values:
(**simplifying assumption:** only use λ when calculating the output resistance of the transistors and ignore it for DC calculations.)

a) DC level of the input, i.e., V_{bias1}
b) V_{bias2}
c) Width (W_1) of transistor M_1
d) Width (W_2) of transistor M_2
e) Small-signal gain of the circuit

f) Is the DC level of the output voltage well-defined?

2. It is possible to use the bulk terminal of a transistor as an input of an amplifier. Consider the single-stage NMOS amplifier shown below. For V_{bias}=1.5V:
a) What is the region of operation of the transistor?
b) Calculate the small-signal gain ($A_v=V_{out}/V_{in}$) of the amplifier. **Recall** that $g_{mb}=\eta g_m$.
Assume, $\lambda = 0$, η=0.2, $V_{TH(NMOS)}$= 0.5V, $\mu_n C_{ox}$=100 $\mu A/V^2$, R_D=1kΩ, $(W/L)_{NMOS}$= 20, and V_{DD}=3V. **Note: In this problem, the technology parameters are different from those of Question 1.**



3. Use HSPICE and our 0.35-μm CMOS technology to:
a) Plot the intrinsic gain (i.e., $g_m r_o$) versus V_{DS} for an NMOS transistor of size W/L=3.5μm/0.35μm with a gate-source voltage of $V_{GS}=V_{th}$+200mV.
b) Repeat part a for an NMOS transistor of size W/L=14μm/1.4μm.
c) Repeat parts a and b for a PMOS with $V_{SG}=|V_{th}|$+200mV.

Good luck!