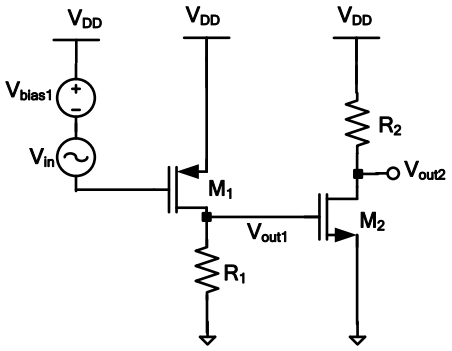
EECE488 Analog CMOS Integrated Circuit Design
Assignment 3
Due: Thursday October 24th, 2013 at 8:00am

1. In the following circuit, assume that $\lambda=\gamma=0$, $V_{DD}=3V$, $V_{TH(NMOS)}=0.5V$, $V_{TH(PMOS)}=-0.5V$, $\mu_nC_{ox}=200\ \mu A/V^2$, $\mu_pC_{ox}=100\ \mu A/V^2$. Furthermore, assume that V_{in} is a small-signal source and V_{bias1} and the DC level of V_{out1} and V_{out2} are all equal to $V_{DD}/2$. Also, the bias current of M_1 and M_2 are equal.

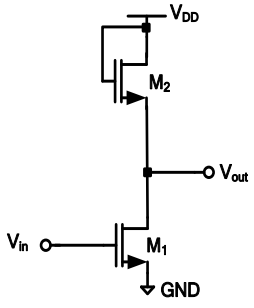


a) What is the region of operation of M_1 and M_2.
b) If the overall power consumption is 3mW, find R_1, R_2, $(W/L)_1$ and $(W/L)_2$.
c) What is the overall gain of the system, i.e., V_{out2}/V_{in}.

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

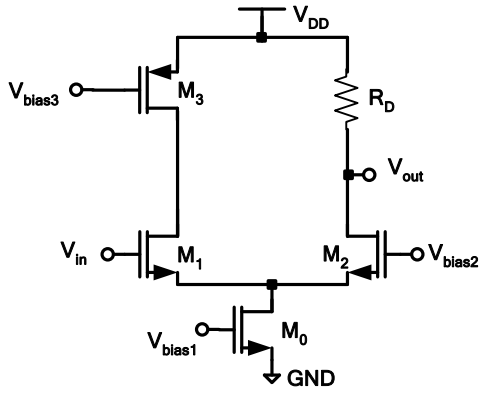
- Transistor M1 is in saturation
- The minimum possible output voltage to keep M1 in saturation is 0.2V
- Total power consumption of the amplifier is 3mW
- Both transistors have L=0.5μm and for transistor M_2 we have W2=1 μm

The technology parameters are:
$\lambda(NMOS) = 0$, $\gamma = 0$, $V_{DD}=3V$, $V_{TH}(NMOS) = 0.5V$, $\mu_nC_{ox}=1\ mA/V^2$



Find the following values:
a) DC level of the input **[5 marks]**,
b) DC level of the output **[5 marks]**,
c) width (W_1) of transistor M_1 **[5 marks]**,
d) small-signal gain**[5 marks]**
e) Maximum output signal swing for a symmetric output signal **[5 marks]**.

3. The input impedance of a common-gate amplifier is typically low. To solve this problem one can use a buffer before the common-gate amplifier. For the following circuit (cascade of a common-drain amplifier and a common-gate amplifier), find the small-signal gain, input and output impedance. Assume that at the frequencies of interest all the device parasitic capacitances can be ignored. Also, assume:
$\lambda_{(NMOS)}=0\ V^{-1}$, $\lambda_{(PMOS)}=0V^{-1}$, $\gamma=0$, $V_{DD}=1.8V$, $V_{TH(NMOS)}=|V_{TH(PMOS)}|=0.4V$, $\mu_nC_{ox}=1mA/V^2$, $\mu_pC_{ox}=0.5\ mA/V^2$, $(W/L)_0 = 32$, $(W/L)_1 = 16$, $(W/L)_2 = 16$, $(W/L)_3 = 32$, $R_D = 1k\Omega$.



Good luck!