Analog Circuit Design (ACD) – ECE520

Home Assignment - 6

Total Marks: 10 Submission Deadline: 16.11.2013

Instructions:

- **Answer all the questions.**
- **Please adhere to institute's plagiarism policy.**
- **Submit before 5:00pm on the submission day. No late submission allowed.**

Q1. [4 marks] In the following circuit assume that:

$\lambda_{NFET}=\lambda_{PFET}=0$, and $\Upsilon=0$, $V_{DD}=1.8V$, $I_{bias}=50\mu A$, $V_{TN}=|V_{TP}|=0.4V$, $\mu_n C_{ox}=1mA/V^2$, $\mu_p C_{ox}=0.5\ mA/V^2$.

Furthermore, assume that:

$(W/L)_0=(W/L)_1=(W/L)_2=(W/L)_3=10$

$(W/L)_4=(W/L)_5=(W/L)_6=(W/L)_8=(W/L)_9=20$

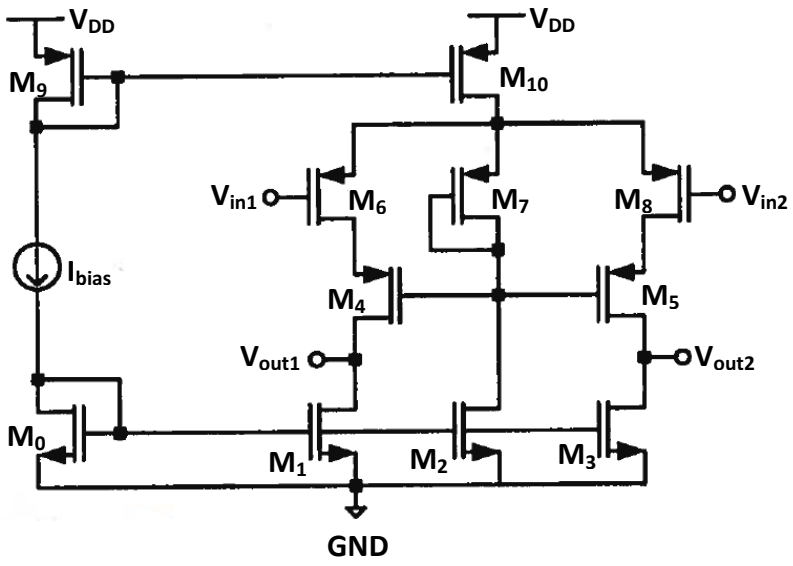
$(W/L)_7=5$, and $(W/L)_{10}=60$.

Given that the dc level of the inputs (i.e., input common mode) is 1.2V:

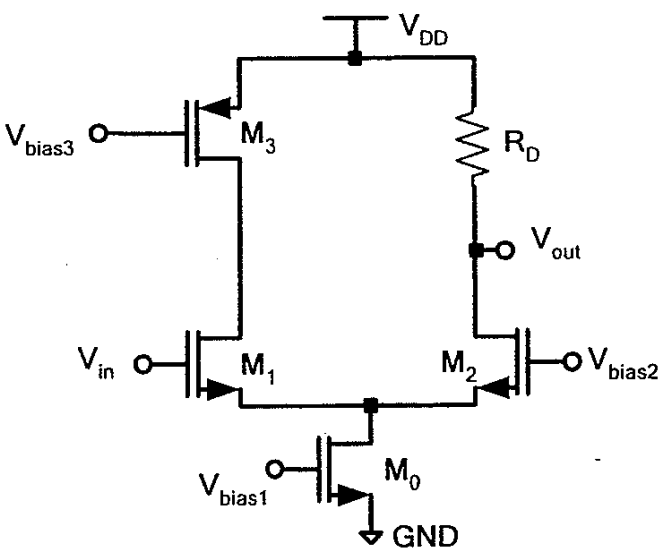
(a) Find the maximum and minimum voltage of V_{out1} and V_{out2} for which all the devices stay in saturation.

(b) What is the differential output voltage swing?

(c) Assuming that the circuit is driven by a differential signal, find the magnitude of the differential gain of the circuit, when a resistor of value 10 kΩ is connected between V_{out1} and V_{out2}.



Q2. [4 marks] For the following circuit, assume that at the frequencies of interest all the device parasitic capacitances can be ignored. Also, assume:
$\lambda_{NFET}=\lambda_{PFET}=0$, and $\Upsilon=0$, $V_{DD}=1.8V$, $I_{bias}=50\mu A$, $V_{TN}=|V_{TP}|=0.4V$, $\mu_n C_{ox}=1mA/V^2$, $\mu_p C_{ox}=0.5\ mA/V^2$, $(W/L)_0=32$, $(W/L)_1=16$, $(W/L)_2=16$, $(W/L)_3=32$, $R_D=1\ k\Omega$, $V_{bias1}=0.65V$, and $V_{bias3}=1.15V$.



(a) Find the minimum required V_{bias2}.
(b) What is the small-signal voltage gain of the circuit?
(c) Calculate (low frequency) input and output impedance of the circuit.

Q3. [2 marks] Calculate the gain of the following circuit (i.e., provide an expression of the gain in terms of circuit parameters):
(a) at very low frequencies
(b) at very high frequencies.
In this problem, neglect all other capacitances that are not shown in the circuit and assume Υ **= 0** for all three transistors, while $\lambda_0=\lambda_1=0$ and $\lambda_2 \neq 0$.