Homework 1

ECE 5411 – CMOS Analog IC Design (Spring 2014)

Due on Tuesday, Jan 28, 2014.

Note:
1. Use Cadence schematic capture, layout and Spectre simulation tools, available on the AMS servers for the homework problems.
2. Unless otherwise stated, use the following MOSFET parameters for hand calculations. Use the $1\,\mu m$ CMOS models on the servers for corresponding simulations.

Table 1: Long-channel MOSFET parameters.

Parameter	NMOS	PMOS
Scale factor (L_{min})	$1\,\mu m$	
V_{DD}	5 V	
V_{THN} and V_{THP}	0.8	0.9
KP_n and KP_p	120 $\frac{\mu A}{V^2}$	40 $\frac{\mu A}{V^2}$
$C_{ox}^{'} = \frac{\epsilon_{ox}}{t_{ox}}$	1.75 $\frac{fF}{\mu m^2}$	

Problem 1- ECE 310 Review: An ideal opamp is used to design an AC amplifier in the circuit shown in Figure 1.

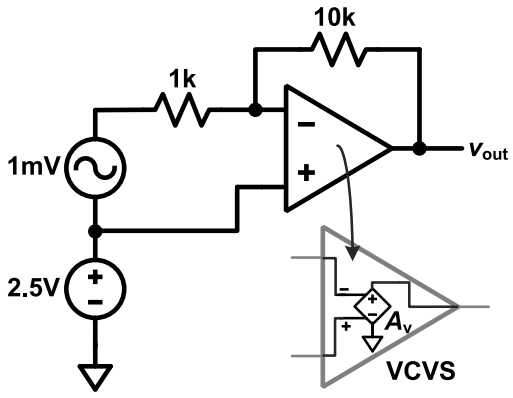

Figure 1

a) Calculate the DC and AC voltages in the circuit nodes. What is the AC gain of the amplifier?
b) What are the DC and AC currents (magnitude and direction) flowing across the resistors?
c) Verify your answers using simulations - (i) DC analysis to annotate operating points, (ii) transient as well as (iii) AC analyses to verify voltages, currents and gain of the amplifier. Use a voltage-controlled voltage source with a large open-loop gain (A_V) for modeling the opamp.

Problem 2: Using the TSMC 180nm Spectre models:
a) Generate all the I-V curves (i.e. I_D vsV_{GS}, V_{DS} and V_{SB}) for a 10/1 NMOS and a 10/1 PMOS. Remember that for this process: $L_{min} = 0.18\mu m$ and $V_{DD} = 1.8V$.
b) Do you expect long-channel or short-channel behavior from these devices? Generate Table 1 for this process.