Homework 6

Due: Friday, 7 March 2014 at 1pm

This is an individual assignment!

PROBLEM 1 (10pts):
In this problem, you will create a midterm problem, from the material we have covered in the course so far. Since the midterm will be 50min long, you should design a problem that will take an average student about 10min to solve. After you design the problem, you will post it on Piazza as a pdf file. You will also submit the problem statement and the solution as part of Homework 6 so we can grade your problem and the solution. Problems that are too hard and too easy will score poorly.
When posting on Piazza, be sure to tag your submission with "**midterm_exam**" folder tag and make your name visible for the post.

PROBLEM 2 (10pts):
Derive the expressions for the common-mode (A_{cm}) and differential-mode (A_{dm}) gain of the BiC-MOS amplifier in Figure 2, as a function of transistor small-signal parameters. Ignore the body effect. Assume that current source I_{TAIL} has finite output impedance R_{TAIL}, and that I_{BIAS} has infinite output impedance.

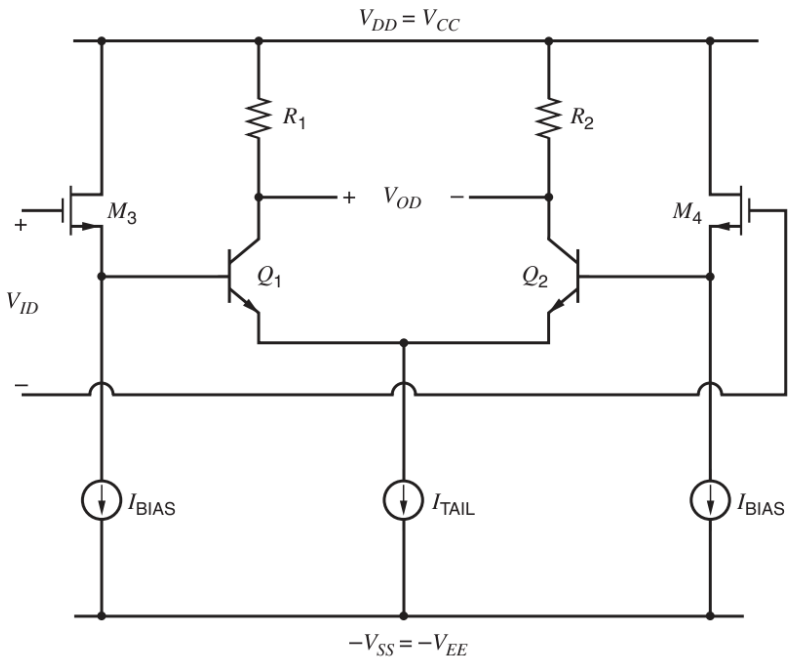

Figure 2

PROBLEM 3 (20pts):
Figure 3 shows a two-stage differential amplifier.
a) Calculate the DC operating points including the current flowing through each branch and DC voltage at each node. The DC value of the input nodes is set at zero. Calculate transistor small-signal parameters (i.e. g_m, r_o).

b) Draw the differential-mode and common-mode half-circuits for the amplifier and provide expressions and calculate the numerical values for the output resistance, R_{out} and gain.
BJT parameters:
$V_{BE(on)} = 0.7V$, $\beta = 100$, $V_A = 50V$, $V_{CC} = 6V$, $V_T = 25mV$, $I_C = 1mA$.

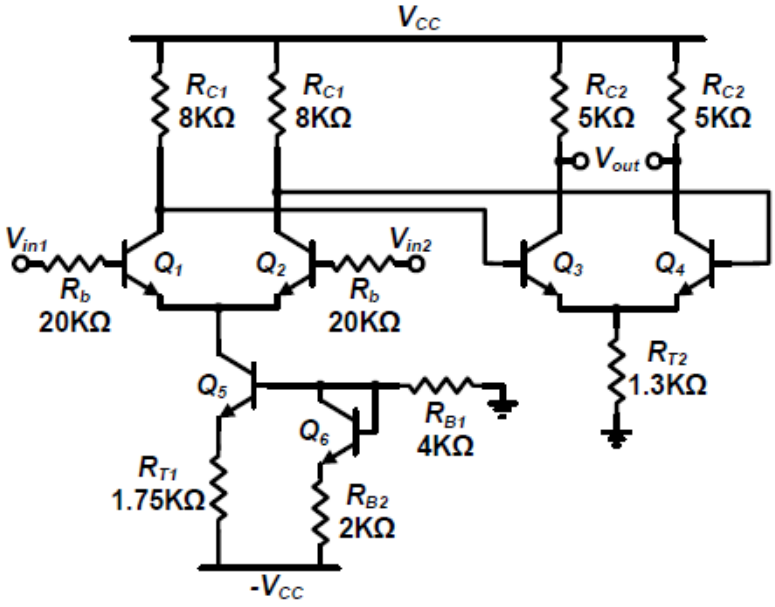

Figure 3

EXTRA PROBLEM FOR EE 240A STUDENTS:
PROBLEM 4 (20pts):

The circuit shown in Figure 4 is a two stage op amp employing cascoding. Assume the two halves of the circuit are symmetric.
a) Find the values of the bias voltages $V_{b1\text{-}5}$ as a function of I_{SS}, V_{DD}, $V_{in,CM}$, and transistor sizes over which all transistors remain in saturation, and maximize voltage swing at nodes X and Y of V_X-V_Y = +/-2ΔV. Assume M1-4, M6-8 and M9-12 are identical.
b) Calculate the overall differential voltage gain $(V_{out2}\text{-}V_{out1})/V_{in}$.

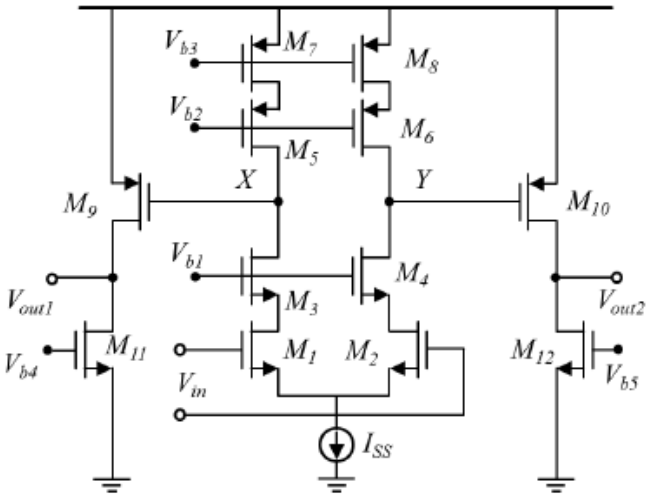

Figure 4