ECEN 326 HOMEWORK # 2
(Due date: Tuesday, Feb. 11, 2014)

1. For the below circuit, calculate the small signal differential gain ($A_{dm}$), common-mode gain ($A_{cm}$), common-mode rejection ratio (CMRR), differential input resistance ($R_{id}$) and common-mode input resistance ($R_{ic}$). Assume $\beta = 200$, $r_o = \infty$, and the current sources have an equivalent AC output resistance of 10 MΩ.

![Circuit Diagram](image1)

2. For the differential amplifier below find $A_{dm}$, $A_{cm}$, CMRR, $R_{id}$ and $R_{ic}$. Also, find the cut-off frequency of the differential amplifier. Assume $\beta = 200$, $V_{A1} = V_{A2} = \infty$, $V_{A3} = V_{A4} = 200V$.

![Circuit Diagram](image2)
3. Determine the input offset voltage of the below source-coupled pair where $I_{\text{TAIL}} = 50 \, \mu\text{A}$, $R_{\text{TAIL}} = \infty$, $W = 10 \, \mu\text{m}$, $L = 1 \, \mu\text{m}$, $k'_{\text{n}} = 200 \, \mu\text{A/V}^2$. Assume that the worst-case $W/L$ mismatch is 2 percent and the device thresholds and load resistances are identical.

4. For the below differential amplifier assume $\beta = 100$, $V_{A,\text{nnp}} = 120\text{V}$, $V_{A,\text{ppp}} = 80\text{V}$.

(a) Find the value of the current source $I$, if the voltage across $R_1$ and $R_2$ is 80 mV.
(b) Calculate the small signal differential gain ($A_{\text{dm}}$) for $C = 0$ and $C = 10\text{pF}$.
5. A two-stage amplifier is shown below. Calculate the low-frequency, small-signal voltage gain $\frac{v_o}{v_i}$. Assume $\beta = 200$, $r_o = \infty$, and $V_{BE(on)} = 0.6V$.