Name:
Student ID:

Analog Electronics

Homework # 2

Due date:

Problem 1:

For the PMOS differential amplifier shown in Figure 1, let $V_{tp} = -0.8\ V$ and $k'_p W/L = 6\ mA/V^2$. Neglect channel-length modulation.

a) For $v_{G1} = v_{G2} = 0\ V$, find $|V_{OV}|$ and V_{SG} for each of Q_1 and Q_2. Also find V_S, V_{D1}, and V_{D2}.

b) If the current source requires a minimum voltage of $0.5\ V$, find the input common-mode range.

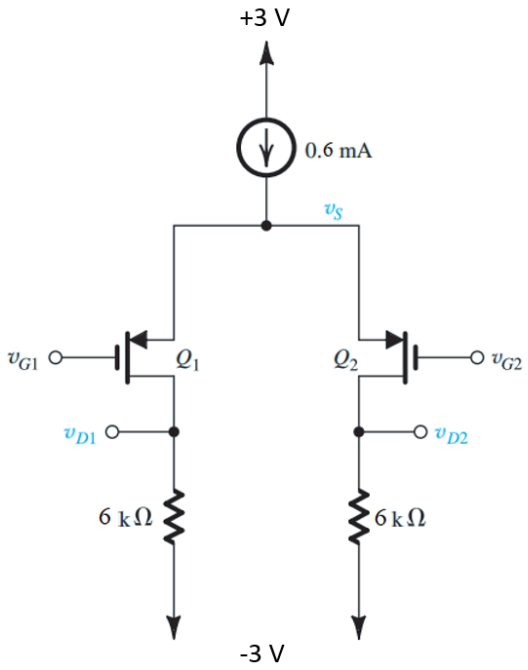

Figure 1

Problem 2:

Draw the differential half-circuit for the differential amplifier shown in Figure 2 and use it to derive an expression for the differential gain $A_d = v_{od}/v_{id}$ in terms of g_m, R_d, and R_S. Neglect the Early effect. What is the gain with $R_S = 0$? What is the value of R_S (in terms of $1/g_m$) that reduces the gain to half this value?

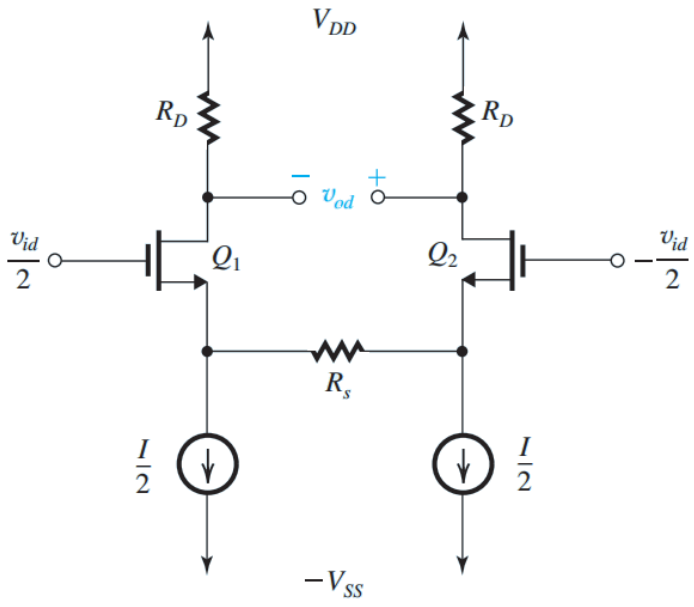

Figure 2

Problem 3:

An npn differential amplifier has $I = 0.5\ mA, V_{CC} = 3\ V, V_{EE} = -3\ V$, and $R_C = 4\ k\Omega$ utilizes BJTs with $\beta = 100$ and $v_{BE} = 0.7\ V\ if\ i_C = 1\ mA$. Assuming that the bias current is obtained by a simple current source that requires a minimum of $0.4\ V$ for proper operation. Also, all transistors require a minimum v_{CE} of $0.2\ V$ for operation in the active mode.

a) Find the common-mode range.

b) The differential input signal v_{id} is applied in a *complementary* (or *balanced*) manner. Draw the differential half-circuit and calculate $A_d = v_{od}/v_{id}$