EEE 51 Assignment 2

2nd Semester SY 2017-2018
Due: 5pm Tuesday, Feb. 6, 2018 (Rm. 220)

Instructions: Write legibly. Show all solutions and state all assumptions. Write your full name, student number, and section at the upper-right corner of each page. <u>Start each problem on a new sheet of paper</u>. Box or encircle your final answer.

1. **MOSFET Single Stage CS Amplifier with Source Degeneration.** Consider the circuit shown below. Provided that $V_{dd} = 5V$, $V_{out} = 2.5V$, $|V_{TH}| = 0.8V$, $R_L = 50k\Omega$, $R_S = 20k\Omega$, k=200 μA/V^2, $\lambda = 0.001V^{-1}$, determine the following:
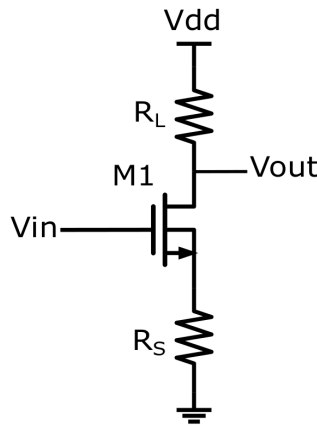

Figure 1: MOSFET Single Stage CS Amplifier

   (a) Compute for the I_D, V_{DS}, V_{GS} and V_{in}. State all necessary assumptions. [3 pts]
   (b) Draw the small-signal equivalent circuit with proper labels. [1 pts]
   (c) Compute for the small signal parameters of the MOSFET g_m, r_i and r_o. [1 pts]
   (d) Compute for the G_m, R_i, R_o and A_V of the circuit. [3 pts]

2. **BJT Single Stage Amplifier**. A BJT Q_1 with $\beta = 100$, $I_S = 10\,\text{fA}$, $V_{CE,sat} = 0.2\,\text{V}$ and $V_A = 200\,\text{V}$ is biased with resistors. The resistors used are $R_C = 500\,\Omega$, $R_B = 50\,\text{k}\Omega$, $R_E = 300\,\Omega$. The supply voltage V_{CC} is 5 V. An ideal, DC-blocked input is connected to the base, as shown in Figure 2a.
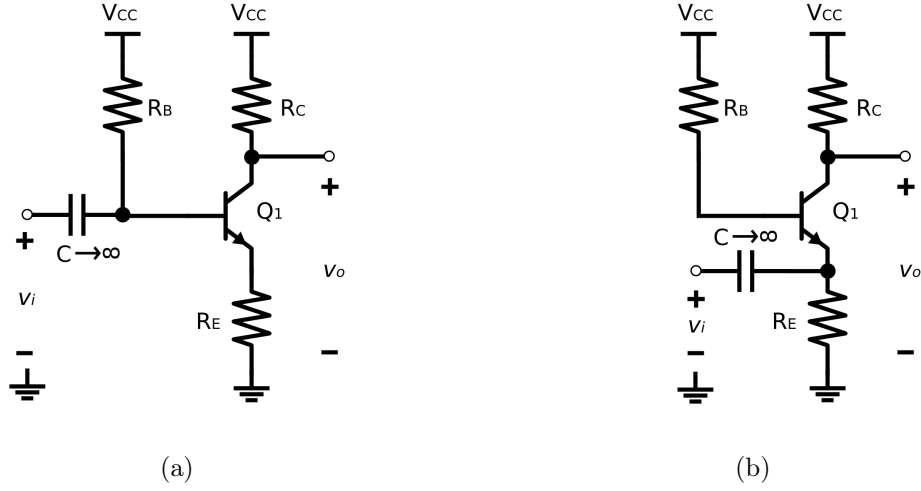
Figure 2: BJT Single-Stage Amplifier

(a) Determine I_C, V_{CE}, and V_{OUT}. Confirm that the biasing allows Q_1 to operate in forward active mode. From that, determine Q_1's parameters g_m, r_π, and r_o. State all necessary assumptions. [3 pts]

(b) With the way the input is connected, the amplifier is a common-emitter with emitter degeneration. Determine this amplifier's G_m, R_o, A_v, and R_i. State all necessary assumptions. [3 pts]

(c) The ideal, DC-blocked input is then disconnected, and reconnected at the emitter, as shown in Figure 2b. Determine this amplifier's G_m, R_o, A_v, and R_i. State all necessary assumptions. [3 pts]

3. **MOSFET Single Stage CD Amplifier**. In the circuit shown in Figure 3, the transistor is biased with an ideal current source $I_S = 0.82mA$. The voltage input to the transistor is a purely AC signal. Given that $|V_{TH}| = 3V$, k $= 400\,\mu A/V^2$ and $\lambda = 0.001V^{-1}$, assuming there is no body effect and ignoring channel length modulation in biasing, determine the following:
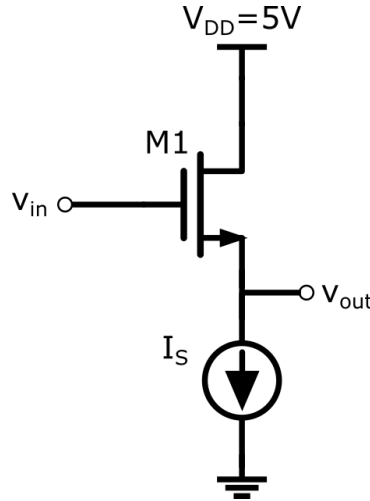

Figure 3: MOSFET Single Stage CD Amplifier

(a) What is the gate-to-source voltage of the transistor? State all necessary assumptions. [3 pts]

(b) Draw the small-signal equivalent circuit. Properly label all parameters, voltages, and terminal names. [1 pt]

(c) Determine the expression for the circuit's transconductance G_m, input and output resistances R_i and R_o, and voltage gain A_V in terms of the small signal parameters. [2 pts]

(d) Compute for G_m, R_o and A_v. Write your complete solution. [2 pts]

TOTAL: 25 points.