

ECE 3050 Analog Electronics Quiz 5

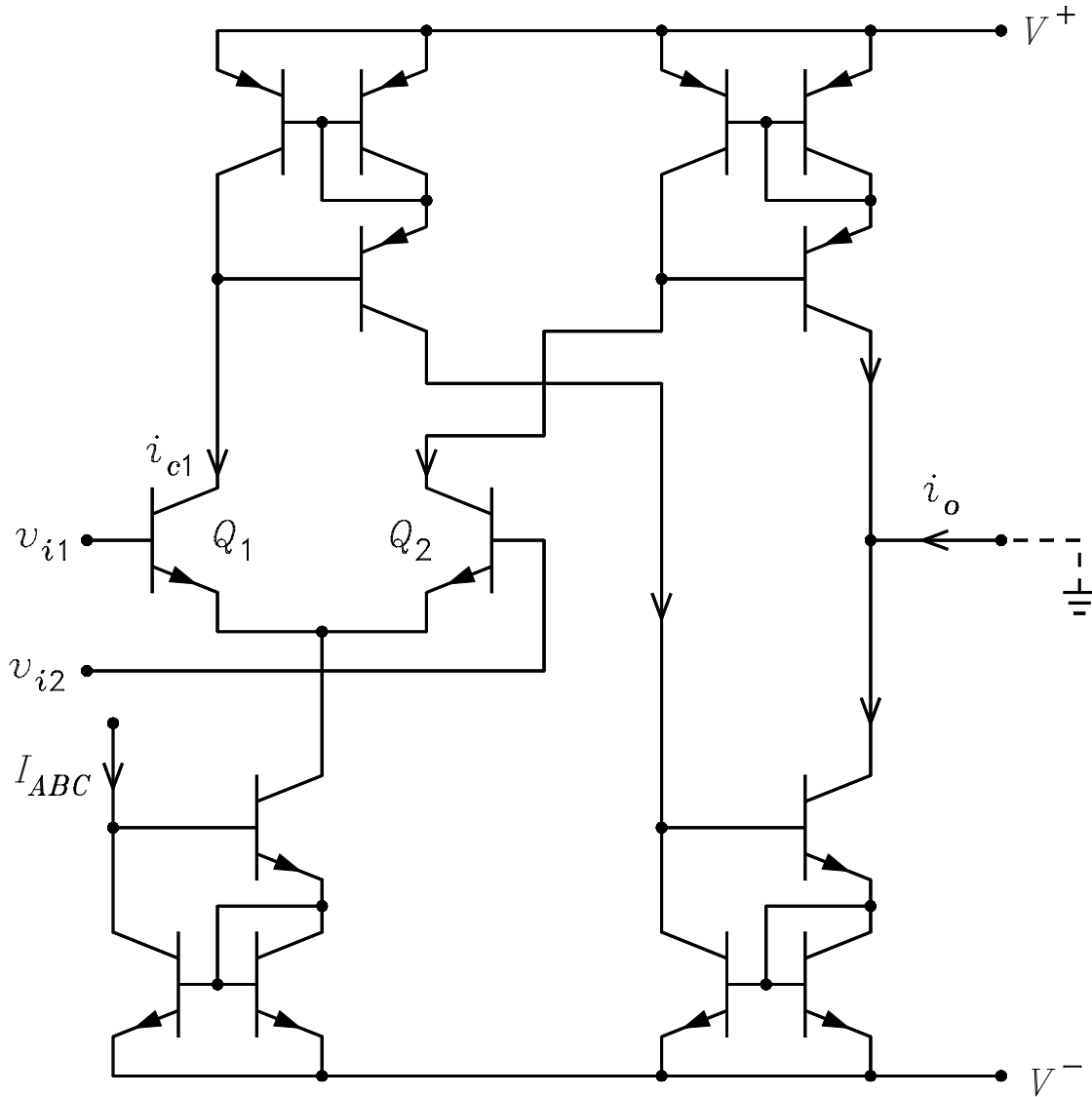
June 23, 2010

Professor Leach

Name _____

Instructions. Print your name in the space above. **Honor Code:** *I have neither given nor received help on this quiz.* Initials _____

1. Shown is the circuit diagram of a transconductance amplifier. Assume all transistors are matched, $\beta = \infty$, $\alpha = 1$, and $r_0 = \infty$. Next to the arrows, label the small-signal current in terms of i_{c1} and solve for i_o in terms of i_{c1} .

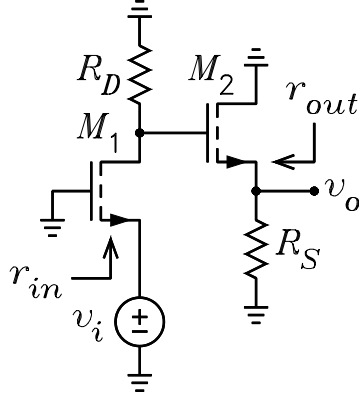


$i_o = 2i_{c1}$ see class notes for solution

2. The ac signal circuit of a CG/CD amplifier is shown. Given $R_D = 20\text{ k}\Omega$, $R_S = 1.6\text{ k}\Omega$, $g_m = 2.5\text{ mS}$, and $r_0 = \infty$.

(a) Solve for the numerical value of the voltage gain $A_v = v_o/v_i$, the input resistance r_{in} , and the output resistance r_{out} .

(b) Solve for the new answers if the body of each transistor is connected to signal ground (rather than to the transistor source) and $\chi = 0.25$.



(a)

$$\begin{aligned}
 r_{is1} &= r_{is2} = \frac{1}{g_m} = 400\ \Omega \\
 \frac{v_o}{v_i} &= \frac{i_{s1}}{v_i} \times \frac{i_{d1}}{i_{s1}} \times \frac{v_{tg2}}{i_{d1}} \times \frac{v_o}{v_{tg2}} \\
 &= -\frac{1}{r_{is1}} \times 1 \times -R_D \times \frac{R_S}{r_{is2} + R_S} \\
 &= \frac{1}{400} \times 20000 \times \frac{1600}{400 + 1600} \\
 &= 40 \\
 r_{in} &= r_{is1} = 400\ \Omega \\
 r_{out} &= r_{s2} \parallel R_S = 320\ \Omega
 \end{aligned}$$

(b)

$$\begin{aligned}
 r_{is1} &= r_{is2} = \frac{1}{(1 + \chi) g_m} = 320\ \Omega \\
 \frac{v_o}{v_i} &= \frac{i_{s1}}{v_i} \times \frac{i_{d1}}{i_{s1}} \times \frac{v_{tg2}}{i_{d1}} \times \frac{v_o}{v_{tg2}} \\
 &= -\frac{1}{r_{is1}} \times 1 \times -R_D \times \frac{1}{1 + \chi} \frac{R_S}{r_{is2} + R_S} \\
 &= \frac{1}{320} \times 20000 \times \frac{1}{1.25} \frac{1600}{320 + 1600} \\
 &= 41.7 \\
 r_{in} &= r_{s1} = 320\ \Omega \\
 r_{out} &= r_{is2} \parallel R_S = 266.7\ \Omega
 \end{aligned}$$