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. The figure shows a basic two-BJT current mirror.

    (a) Assume the two transistors are identical and that the Early effect can be neglected, i.e., $V_A = \infty$. Label the branch currents and derive the equation for the output current I_O.

    (b) If the Early effect is not neglected, what would be the output resistance r_0?
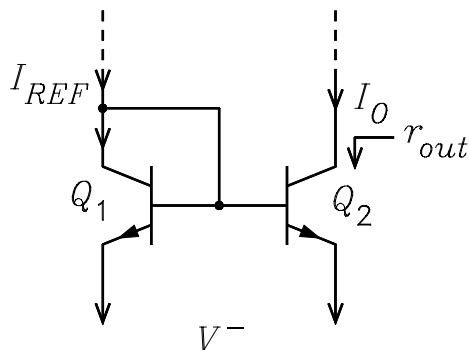
$$I_{REF} = I_O + \frac{I_O}{\beta} + \frac{I_O}{\beta} \implies I_O = \frac{I_{REF}}{1 + 2/\beta} \qquad r_{out} = r_{02}$$

2. The figure shows a Wilson current mirror.

    (a) Assume the two transistors are identical and that the early effect can be neglected, i.e., $V_A = \infty$. Making use of the results of Problem 1, label the branch currents and derive the equation for the output current I_O.

    (b) Aside from the difference in the equation for I_O, what is the major difference between the Wilson mirror and the two-BJT current mirror?
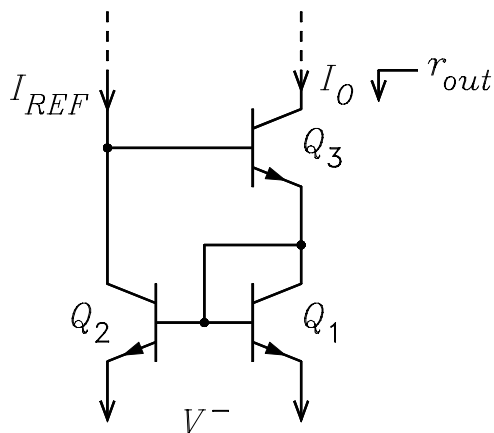
Make use of the answer for Problem 1 to solve for I_{C2}.

$$I_{REF} = \frac{I_O}{\beta} + \frac{I_O/\alpha}{1 + 2/\beta} \implies I_O = \frac{I_{REF}}{\frac{1}{\beta} + \frac{1/\alpha}{1 + 2/\beta}}$$

The output resistance is much higher than for the two-BJT current mirror. This is caused by a positive feedback effect.