

Name: _____ (please print)

Signature: _____

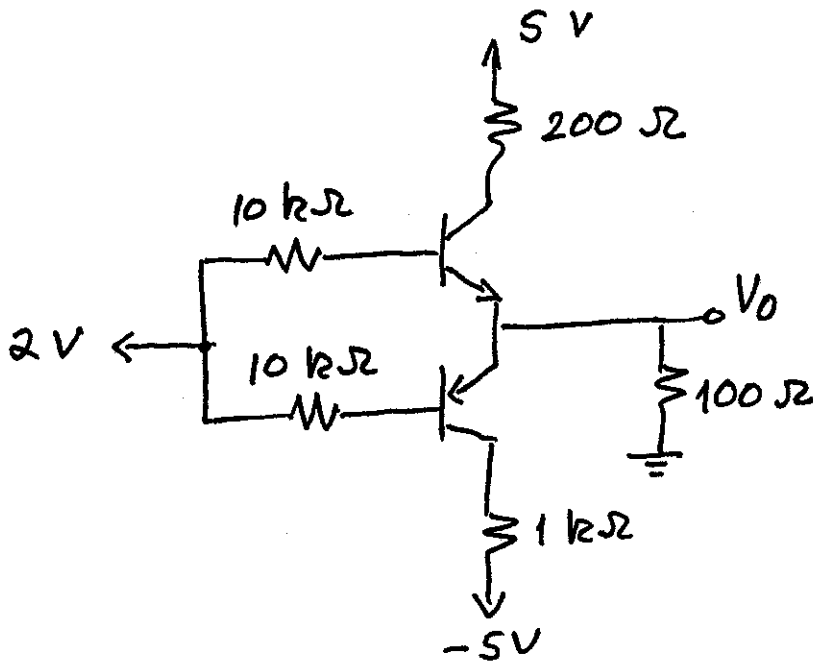
ECE 3455
Quiz #5
November 13, 2007

Quiz duration: 30 minutes

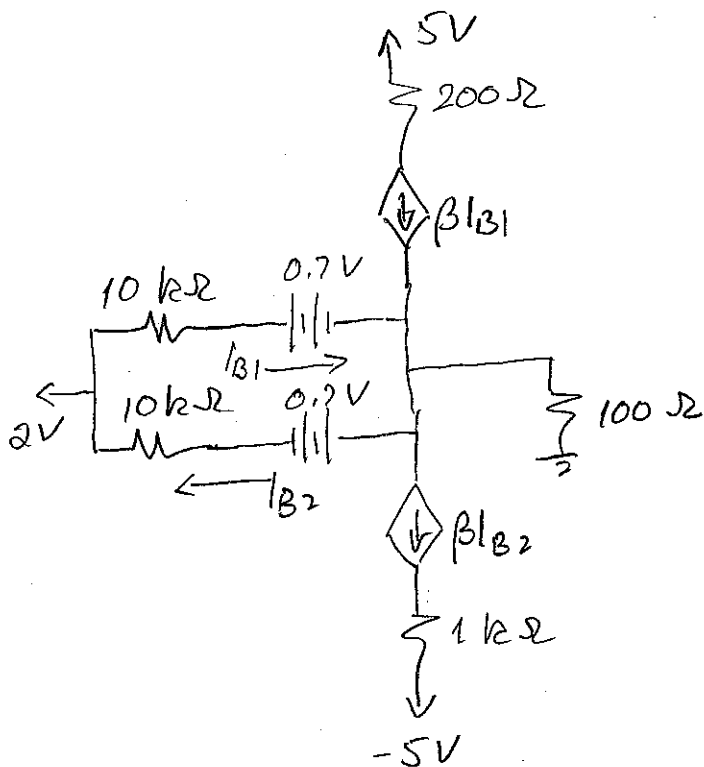
1. You may have one 8 ½ x 11 in. “crib” sheet, written on both sides, during the quiz. You may have any calculator you choose, but no computers. No other notes or materials will be allowed.
2. Show all work necessary to complete the problem on these pages. A solution without the work shown will receive no credit.
3. Show units in intermediate and final results, and in figures.
4. If your work is sloppy or difficult to follow, points will be subtracted.

_____ /20

In the circuit below, both BJT's have $\beta = 50$ and $V_{CE,SAT} = 0.3 \text{ V}$. Find V_O .



Looking at the base and emitter biases, it appears that both BC junctions are reverse-biased. So one possibility is that both are in the linear region:



A KVL around the loop containing the base regions shows immediately that this is not right:

$$10k(I_{B1} + I_{B2}) + 1.4 = 0$$

$$\Rightarrow I_{B1} + I_{B2} < 0$$

BAD
GUESS

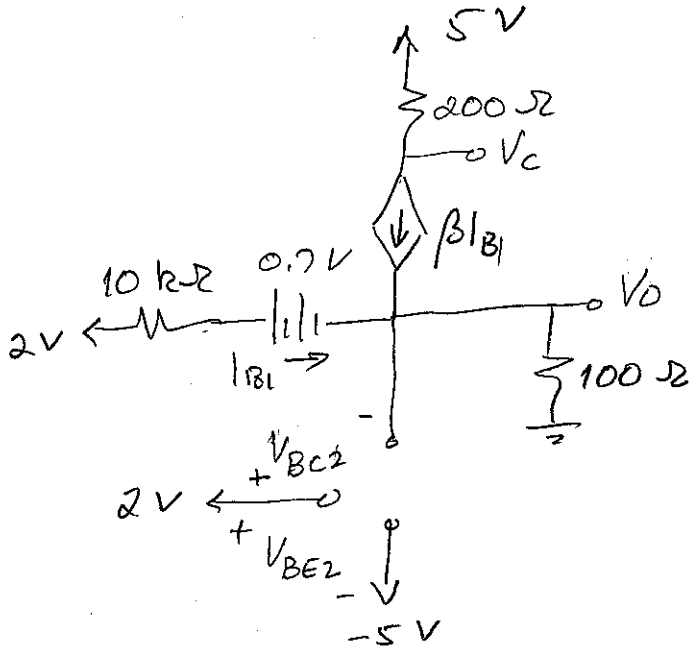
$$\text{Also, } (\beta + 1)I_{B1} = (\beta + 1)I_{B2}$$

$$\Rightarrow I_{B1} = I_{B2}$$

So both base currents are negative!

Room for Extra Work

Another possibility is that one BJT is in cut-off.



KVL:

$$-2 + 10000 I_{B1} + 0.7 + (\beta + 1) I_{B1} \cdot 100 = 0$$

$$\Rightarrow I_{B1} = 86.09 \mu A \quad \checkmark$$

$$\therefore V_o = (51) I_{B1} \cdot 100 = 0.439 V$$

For linear region, we also need

$$V_c - V_o > 0.3 V$$

$$V_c - V_o = (5 - 200 \beta I_{B1}) - 0.439$$

$$= 3.70 V \quad \checkmark$$

For cut off we test for reverse bias on both junctions

$$V_{BE2} = 2 - (-5) = 7 V > -0.5 V \quad \checkmark$$

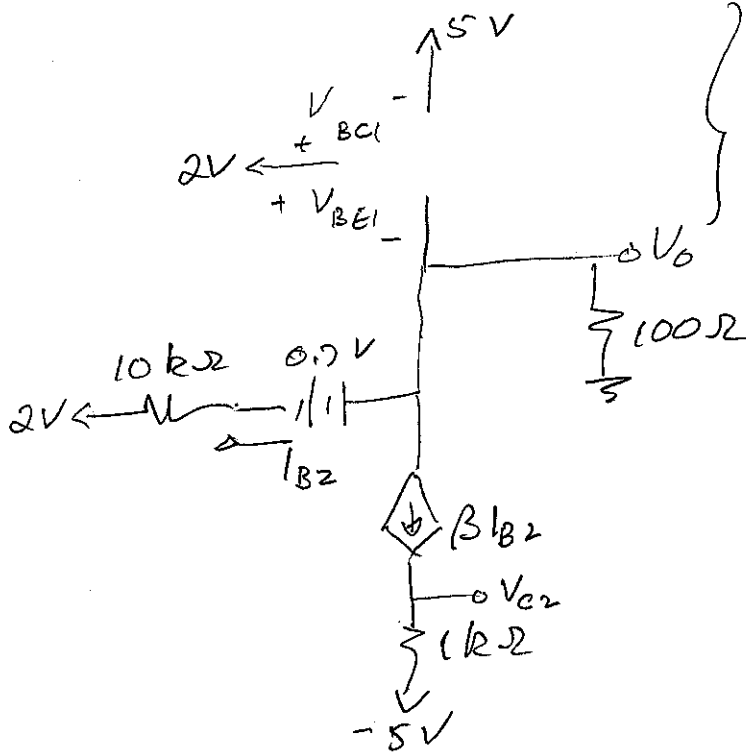
$$V_{BC2} = 2 - 0.439 = 1.56 > -0.5 V \quad \checkmark$$

So this is the correct guess and

$$\underline{\underline{V_o = 0.439 V}}$$

Room for Extra Work

What if we turn off the upper and turn on the lower BIT?



$V_{BC1} < 0.5V$
 $V_{BC} = -3V$ ✓
 $V_{BE1} < 0.5V$ (see below)
 $V_{BC1} = 2 - V_C$
 $= 2 - (-0.912)$
 $= 2.912V$ X
 So this doesn't work

$$-2 - 10k I_{B2} - 0.7 - (\beta + 1) I_{B2} \cdot 100 = 0$$

$$I_{B2} = \frac{2.7}{10000 + 5100} = 178.8 \mu A$$

$$V_{C2} = \beta I_{B2} \cdot 1000 - 5 = 3.94V$$

$$V_{E2} = V_C = -(\beta + 1) I_{B2} \cdot 100 = -0.912V$$

Both off doesn't work either since then

$$V_{BE1} = 2 - 0 = 2V$$
 X