

Name: _____ (please print)

Signature: _____

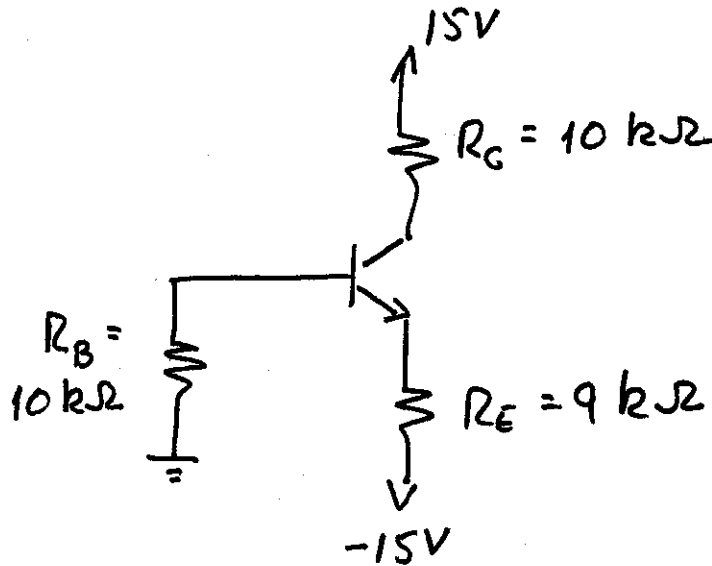
ECE 3455
Quiz 5
April 16, 2008

Quiz duration: 30 minutes

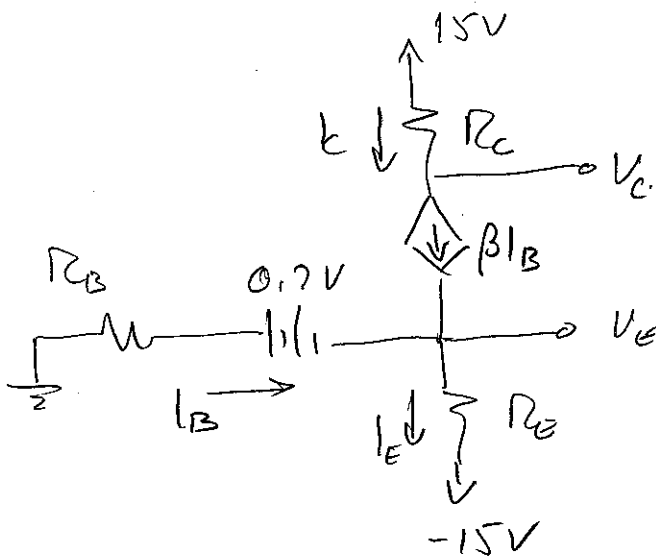
1. You may have one 8 ½ x 11 in. “crib” sheet, written on both sides, during the quiz. You may have any calculator you choose, but no computers. No other notes or materials will be allowed.
2. Show all work necessary to complete the problem on these pages. A solution without the work shown will receive 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

The BJT is intended to operate in the forward-active region. If β gets too large, the bias region will change to saturation. Find the largest value of β the BJT can have and still be in forward-active region. The BJT has $V_{CESAT} = 0.3 \text{ V}$.



We put the device in active mode, and set $V_{CE} = 0.3 \text{ V}$, i.e., it is about to leave active mode.



Room for Extra Work

$$V_{CE} = 0.3 = (15 - \beta I_B R_C) - [(\beta + 1) I_B R_E - 15]$$

$$\Rightarrow \beta I_B R_C + (\beta + 1) I_B R_E = 29.7 \quad (1)$$

$$I_B R_B + 0.7 + (\beta + 1) I_B R_E - 15 = 0$$

$$\Rightarrow I_B = \frac{14.3}{R_B + (\beta + 1) R_E} \quad (2)$$

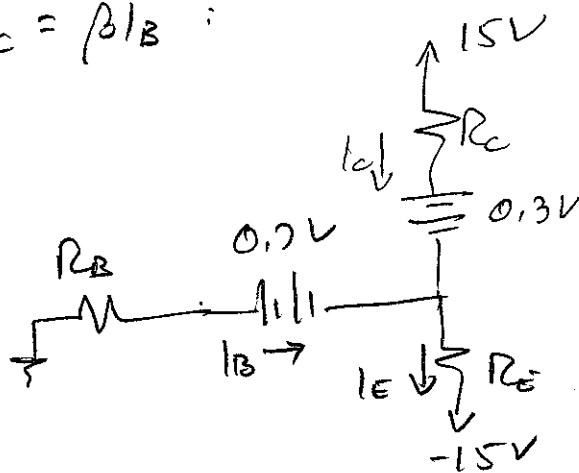
So

$$\frac{14.3 \beta R_C}{R_B + (\beta + 1) R_E} + \frac{14.3 (\beta + 1) R_E}{R_B + (\beta + 1) R_E} = 29.7$$

$$14.3 \beta R_C + 14.3 (\beta + 1) R_E = 29.7 R_B + 29.7 (\beta + 1) R_E$$

This gives $\beta = 99$

We could also put the device in saturation and set $I_C = \beta I_B$:



Room for Extra Work

$$I_B R_B + 0.7 - 0.3 - \beta I_B R_C + 15 = 0$$

$$\Rightarrow I_B R_B - \beta I_B R_C = -15.4 \text{ V} \quad (1)$$

$$I_B R_B + 0.7 + (\beta + 1) I_B R_E - 15 = 0$$

$$\Rightarrow I_B = \frac{14.3}{R_B + (\beta + 1) R_E} \quad (2)$$

$$\frac{14.3 R_B}{R_B + (\beta + 1) R_E} - \frac{14.3 \beta R_C}{R_B + (\beta + 1) R_E} = -15.4$$

$$\Rightarrow 14.3 R_B - 14.3 \beta R_C = -15.4 R_B - 15.4 (\beta + 1) R_E$$

$$-14.3 \beta R_C + 15.4 (\beta + 1) R_E = -15.4 R_B - 14.3 R_B$$

This also gives $\beta = 99$

In both approaches, we have put the device at the boundary between saturation and active modes,