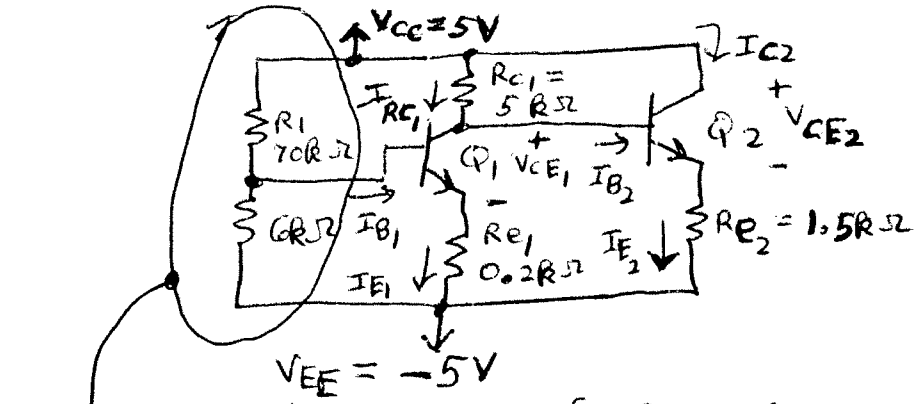
ECE250 Two-BJT Circuit Analysis Example (Part A for Finite β_F / Part B for $\beta_F \to \infty$)

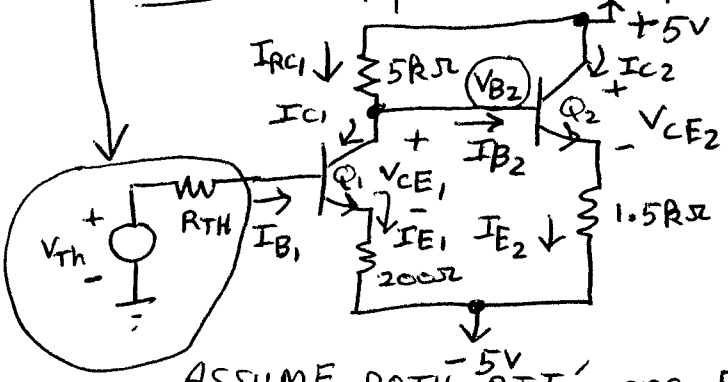


Both BJT's have $\beta_F = 125$

$(V_{BE})_{ON} = 0.7V$

$(V_{CE})_{SAT} = 0.1V$

A. Find Q points of Q_1 and Q_2 (V_{CE1}, I_{C1}; V_{CE2}, I_{C2})



① Find V_{Th} by writing a Node Voltage eqn:

$$\frac{V_{Th}-5}{70R} + \frac{V_{Th}-(-5)}{6R} = 0 \Rightarrow V_{Th} = -4.211V$$

② Find $R_{Th} = \frac{1}{\frac{1}{70R}+\frac{1}{6R}} = 5.526R\Omega$

ASSUME BOTH BJT's are FWD Active

③ Find I_{B1} by KVL around b-e loop of Q_1:

$$V_{Th} = I_{B1}R_{TH} + 0.7V + 200(\beta_F+1)I_{B1} + (-5V) \Rightarrow I_{B1} = 2.912\mu A$$

④ Write equations for V_{B2} (V_{B2} can be calculated 2 different ways; Solve Simultaneously)

(a) $V_{B2} = +5V - (\beta_F I_{B1} + I_{B2})5R$

(b) $V_{B2} = 0.7V + I_{B2}(\beta_F+1)1.5R\Omega + (-5V)$

$\Rightarrow$ $I_{B2} = 38.56\mu A$, $V_{B2} = 2.987V$

⑤ $V_{CE1} = [5V - (\beta_F I_{B1} + I_{B2})(5R\Omega)] - [(\beta_F+1)I_{B1}(200\Omega) + (-5V)]$

$V_{CE1} = 7.91V$ $\quad I_{C1} = \beta_F(I_{B1}) = 0.364mA$

⑥ $V_{CE2} = [5V] - [(\beta_F+1)I_{B2}\cdot(1.5R\Omega) + (-5V)] = 2.713V$ $\quad I_{C2} = \beta_F \cdot I_{B2} = 4.82mA$

B. Repeat for $\beta_F \to \infty$ $\Rightarrow$ $I_B = \frac{I_C}{\infty} = 0$, and thus $I_E = I_C$ (For Both BJT's)

① $I_{E1} = I_{C1} = \frac{(V_{Th}-0.7V)-(-5V)}{200\Omega} = 0.447mA$ (Note: since $I_{B1}=0$, there is No voltage drop across R_{TH}.)

② $V_{B2} = 5V - I_{C1}\cdot 5R\Omega = 2.763V$

③ $I_{E2} = I_{C2} = \frac{(V_{B2}-0.7V)-(-5V)}{1.5R\Omega} = 4.71mA$

④ $V_{CE1} = (5 - I_{C1}\cdot 5R\Omega) - (V_{Th}-0.7V) = 7.679V$

⑤ $V_{CE2} = 5 - (V_{b2}-0.7V) = 2.933V$

Note: Part B ($\beta_F \to \infty$) is easier, and results are $\approx$ close to Part A ($\beta_F = 125$)