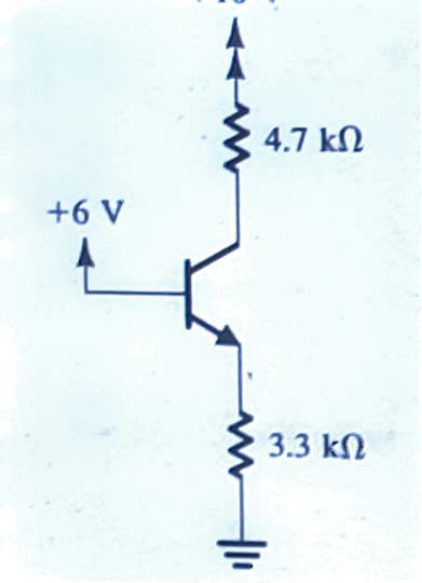
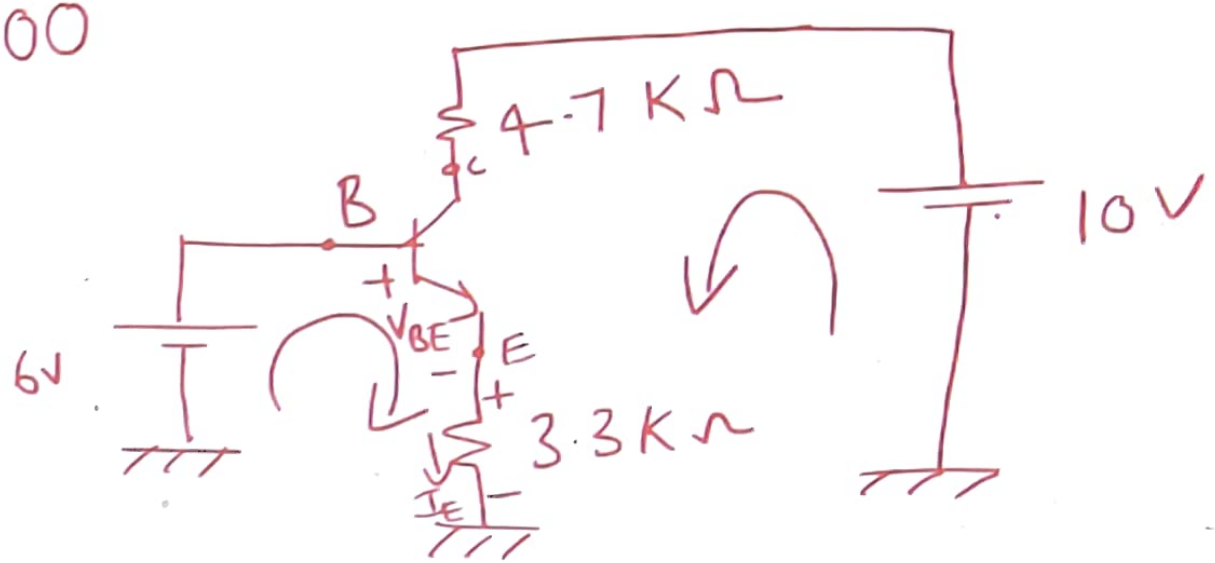


$\beta = 100$



$$-6 + 0.7 + (3.3\,K)I_E = 0 \Rightarrow I_E = 1.6\ mA$$

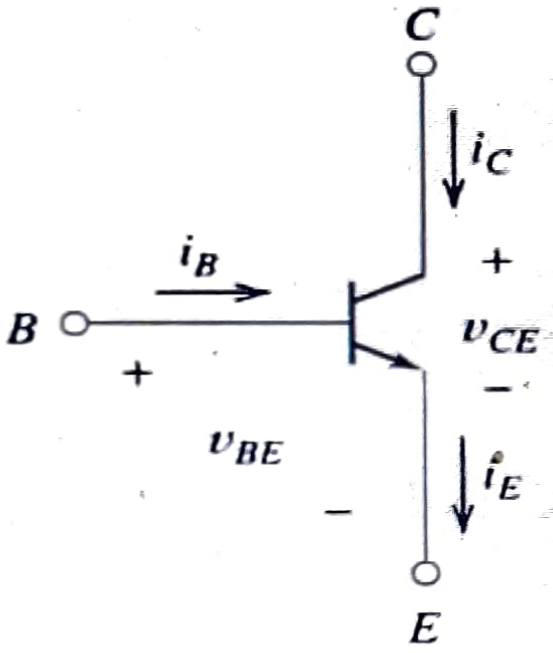
$$I_E \doteq I_B + I_C = I_B + \beta I_B = (1+\beta) I_B$$

$$I_B = 15.84\ \mu A\ ,\ I_C = 1.58\ mA$$

Problem

Suppose that a certain *npn* transistor has V_{BE} = 0.7 V for I_E =10 mA. Compute V_{BE} for I_E = 1 mA.

Repeat for I_E = 1 μA. Assume that V_T = 26 mV.



$$I_E = I_{ES}\left(\exp\left(\frac{V_{BE}}{V_T}\right) - 1\right) \approx I_{ES}\exp\left(\frac{V_{BE}}{V_T}\right)$$

$$10\,\text{mA} = I_{ES}\exp\left(\frac{0.7}{0.026}\right) \quad \textit{and} \quad 1\,\text{mA} = I_{ES}\exp\left(\frac{V_{BE}}{0.026}\right)$$

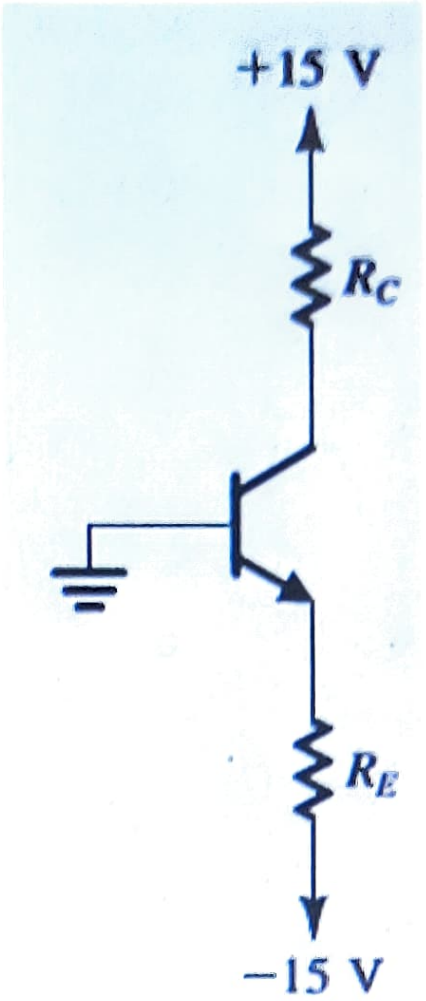
$$\textit{divide the above} \Rightarrow 10 = \exp\left(\frac{0.7 - V_{BE}}{0.026}\right)$$

$$\Rightarrow 0.026 \times \ln 10 = 0.7 - V_{BE}$$

$$\therefore V_{BE} = 0.7 - 0.026 \times \ln 10 = 0.64\,\text{V}$$

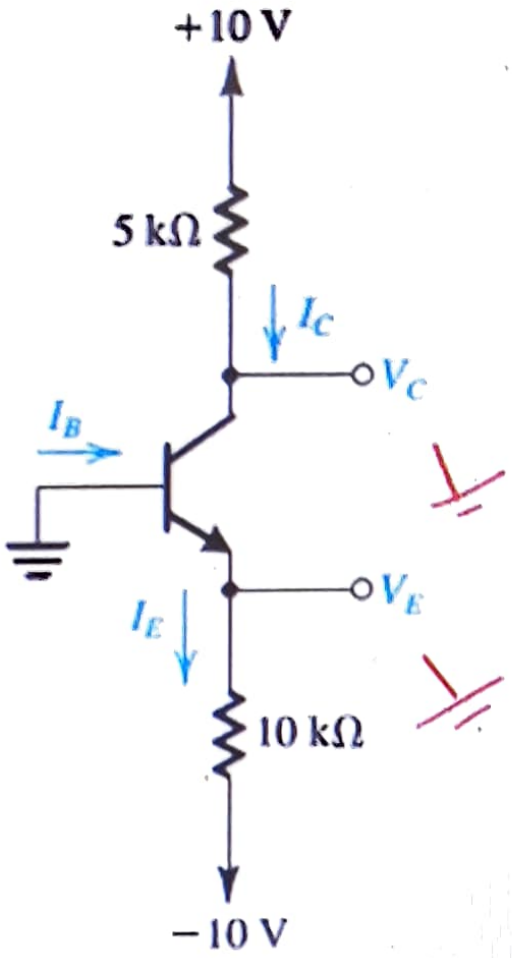
Problem

- The transistor in the circuit of Fig. has $\beta = 100$ and exhibits a v_{BE} of 0.7 V at i_C = 1 mA. Design the circuit so that a current of 2 mA flows through the collector and a voltage of +5 V appears at the collector.



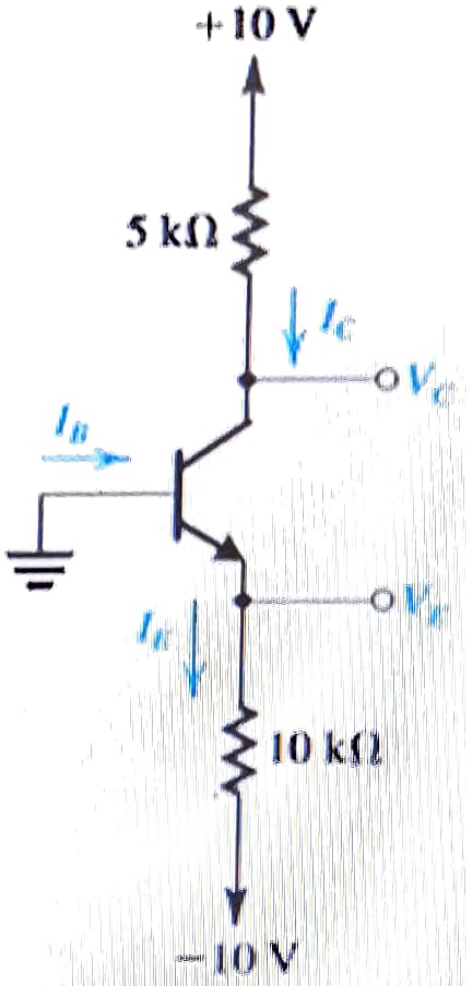
Problem

- In the circuit shown in Fig., the voltage at the emitter was measured and found to be –0.7 V. If $\beta = 50$, find I_E, I_B, I_C, and V_C.



Problem

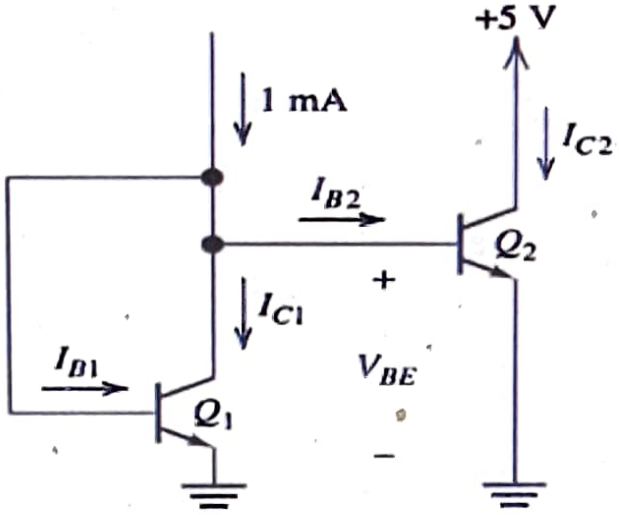
- In the circuit shown in Fig., measurement indicates V_B to be +1.0 V and V_E to be +1.7 V. What are α and β for this transistor? What voltage V_C do you expect at the collector?



Problem

Consider the circuit shown in Figure. Transistors Q_1 and Q_2 are identical, both having $I_{ES} = 10^{-14}A$ and $\beta = 100$. Calculate V_{BE} and I_{C2}. Assume that $V_T = 26mV$ for both transistors.

Hint: Both transistors are operating in the active region.
Because the transistors are identical and have identical values of V_{BE}, their collector currents are equal.



$$I_{B1} + I_{B2} + I_C = 1mA \quad \& \quad I_C = \beta I_B$$

$$\Rightarrow \quad I_C\left(\frac{2}{\beta}+1\right) = 1mA \quad \Rightarrow \quad I_C = \frac{1mA}{1.02} = 0.98\,mA$$

$$I_E = \left(1+\frac{1}{\beta}\right) I_C = 0.99\,mA$$

$$\text{since} \quad I_E \approx I_{ES}\exp\left(\frac{V_{BE}}{V_T}\right) \quad \textit{we have}$$

$$\therefore V_{BE} = V_T \ln\frac{I_E}{I_{ES}} = 0.026\times\ln\left(0.99\times10^{11}\right) = 0.658V$$

Problem

- Find currents and voltages