Numerical on BJT

Problem #1

- In a common base connection, $I_E = 1mA$, $I_C = 0.95mA$. Calculate the value of I_B

Solution

Using the relation,

$$\begin{aligned} I_E &= I_B + I_C \\ 1 &= I_B + 0.95 \\ I_B &= 1 - 0.95 = \mathbf{0.05\ mA} \end{aligned}$$

Problem #2

- In a common base connection, current amplification factor is 0.9. If the emitter current is 1mA, determine the value of base current.

Solution

$$\text{Here, } \alpha = 0.9, \quad I_E = 1 \text{ mA}$$

Now $$\alpha = \frac{I_C}{I_E}$$

or $$I_C = \alpha I_E = 0.9 \times 1 = 0.9 \text{ mA}$$

Also $$I_E = I_B + I_C$$

$\therefore$ $$\text{Base current, } I_B = I_E - I_C = 1 - 0.9 = \mathbf{0.1\ mA}$$

Problem #3

In a common base connection, I_C = 0.95 mA and I_B = 0.05 mA. Find the value of α.

Solution:

$$\text{We know } I_E = I_B + I_C = 0.05 + 0.95 = 1 \text{ mA}$$

$$\therefore \quad \text{Current amplification factor, } \alpha = \frac{I_C}{I_E} = \frac{0.95}{1} = \mathbf{0.95}$$

Problem #4

In a common base connection, the emitter current is 1mA. If the emitter circuit is open, the collector current is 50 µA. Find the total collector current. Given that $\alpha = 0.92$

Solution:

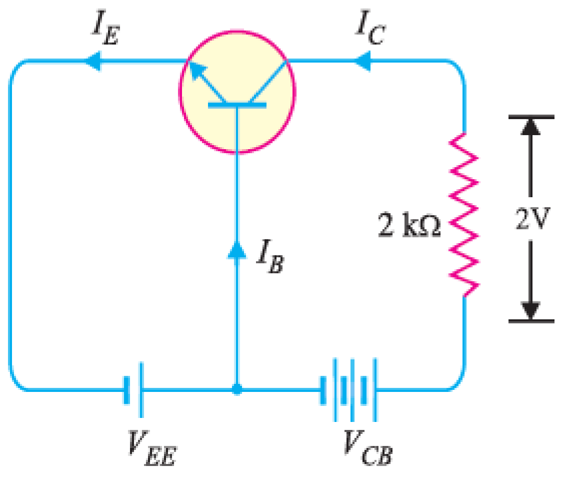
$$\text{Here, } I_E = 1 \text{ mA}, \alpha = 0.92, \quad I_{CBO} = 50 \ \mu\text{A}$$

$$\therefore \quad \text{Total collector current, } I_C = \alpha I_E + I_{CBO} = 0.92 \times 1 + 50 \times 10^{-3}$$

$$= 0.92 + 0.05 = \mathbf{0.97 \text{ mA}}$$

Problem #5

In a common base connection, α = 0.95. The voltage drop across 2 kΩ resistance, which is connected in the collector is 2V. Find the base current.



Solution:

The voltage drop across RC (= 2 kΩ) is 2V.

$$\therefore \qquad I_C = 2\text{ V}/2\text{ k}\Omega = 1\text{ mA}$$

Now $\qquad \alpha = I_C/I_E$

$$\therefore \qquad I_E = \frac{I_C}{\alpha} = \frac{1}{0.95} = 1.05\text{ mA}$$

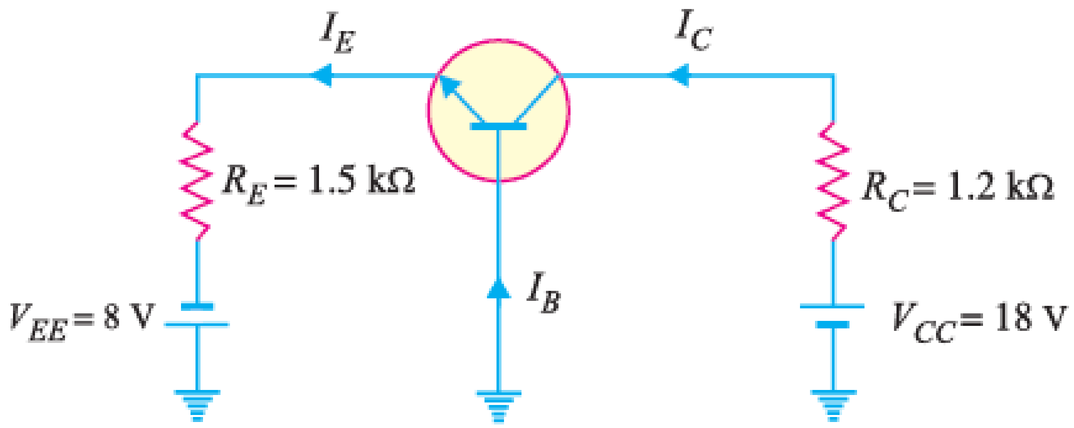
Using the relation, $I_E = I_B + I_C$

$$\therefore \qquad I_B = I_E - I_C = 1.05 - 1$$

$$= \mathbf{0.05\text{ mA}}$$

Problem #6

- For the common base circuit shown in Figure, determine I_C and V_{CB} . Assume the transistor to be of silicon.



Solution:

Since the transistor is of silicon, VBE = 0.7V.

Applying Kirchhoff's voltage law to the emitter-side loop,we get,

$$V_{EE} = I_E R_E + V_{BE}$$

$$\text{or} \quad I_E = \frac{V_{EE} - V_{BE}}{R_E}$$

$$= \frac{8V - 0.7V}{1.5\ \text{k}\Omega} = 4.87\ \text{mA}$$

$$\therefore \quad I_C \simeq I_E = \mathbf{4.87\ mA}$$

Applying Kirchhoff's voltage law to the collector-side loop, we have,

$$V_{CC} = I_C R_C + V_{CB}$$

$$\therefore \quad V_{CB} = V_{CC} - I_C R_C$$

$$= 18\ \text{V} - 4.87\ \text{mA} \times 1.2\ \text{k}\Omega = \mathbf{12.16\ V}$$

Problem #7

Find the value of β if (i) α = 0.9 (ii) α = 0.98 (iii) α = 0.99.

Solution:

(i) $\alpha = 0.9$

$$\beta = \frac{\alpha}{1-\alpha} = \frac{0.9}{1-0.9} = 9$$

(ii) $\alpha = 0.98$

$$\beta = \frac{\alpha}{1-\alpha} = \frac{0.98}{1-0.98} = 49$$

(iii) $\alpha = 0.99$

$$\beta = \frac{\alpha}{1-\alpha} = \frac{0.99}{1-0.99} = 99$$

Problem #8

Calculate I_E in a transistor for which $\beta = 50$ and $I_B = 20\ \mu A$.

Solution:

$$\text{Here } \beta = 50, \quad I_B = 20\mu A = 0.02 \text{ mA}$$

Now

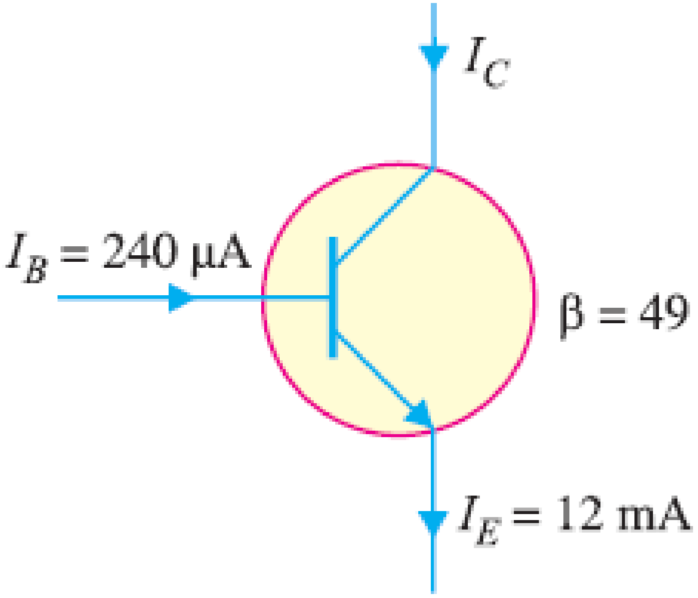
$$\beta = \frac{I_C}{I_B}$$

$$\therefore \quad I_C = \beta I_B = 50 \times 0.02 = 1 \text{ mA}$$

$$\text{Using the relation, } I_E = I_B + I_C = 0.02 + 1 = \mathbf{1.02 \text{ mA}}$$

Problem #9

Find the α rating of the transistor shown in Figure. Hence determine the value of I_C using both α and β rating of the transistor.



Solution:

$$\alpha = \frac{\beta}{1+\beta} = \frac{49}{1+49} = \mathbf{0.98}$$

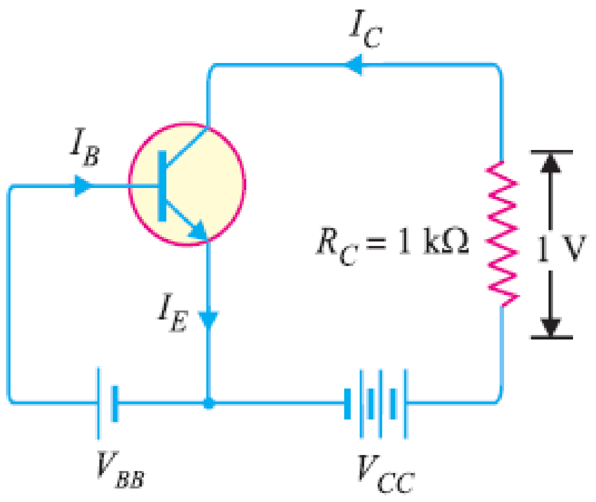
The value of I_C can be found by using either α or β rating as under :

$$I_C = \alpha I_E = 0.98\ (12\ \text{mA}) = \mathbf{11.76\ mA}$$

Also $$I_C = \beta I_B = 49\ (240\ \mu\text{A}) = \mathbf{11.76\ mA}$$

Problem #10

For a transistor, β = 45 and voltage drop across 1kΩ which is connected in the collector circuit is 1 volt. Find the base current for common emitter connection.



Solution:

The voltage drop across RC (= 1 kΩ) is 1 volt.

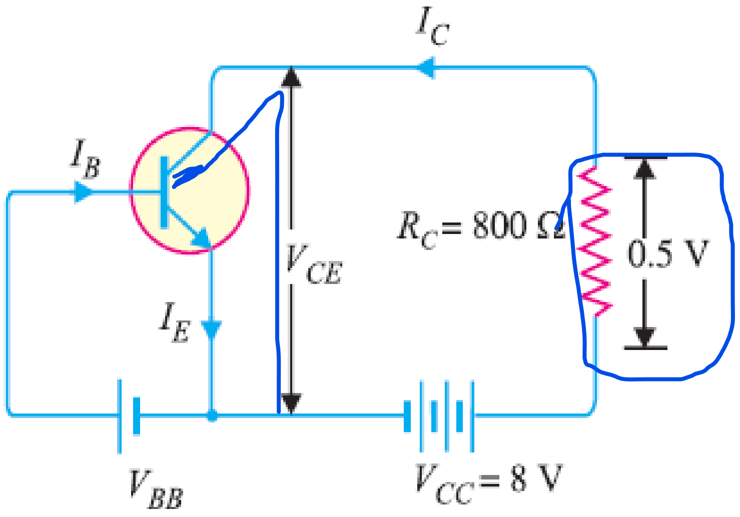
$$\therefore \quad I_C = \frac{1\,V}{1\,k\Omega} = 1 \text{ mA}$$

$$\text{Now} \quad \beta = \frac{I_C}{I_B}$$

$$\therefore \quad I_B = \frac{I_C}{\beta} = \frac{1}{45} = \mathbf{0.022\ mA}$$

Problem #11

A transistor is connected in common emitter (CE) configuration in which collector supply is 8 V and the voltage drop across resistance R_C connected in the collector circuit is 0.5 V. The value of R_C = 800 Ω. If α = 0.96, determine : (i) collector-emitter voltage (ii) base current.



(i)

Collector-emitter voltage,

$$V_{CE} = V_{CC} - 0.5 = 8 - 0.5 = \mathbf{7.5\ V}$$

(ii)

The voltage drop across $R_C (= 800\ \Omega)$ is 0.5 V.

$$I_C = \frac{0.5\ \text{V}}{800\ \Omega} = \frac{5}{8}\ \text{mA} = 0.625\ \text{mA}$$

Now $$\beta = \frac{\alpha}{1-\alpha} = \frac{0.96}{1-0.96} = 24$$

$\therefore$ Base current, $$I_B = \frac{I_C}{\beta} = \frac{0.625}{24} = \mathbf{0.026\ mA}$$

Problem #12

In a transistor, I_B = 68 μA, I_E = 30 mA and β = 440. Determine the α rating of the transistor. Then determine the value of I_C using both the α rating and β rating of the transistor.

Solution:

$$\alpha = \frac{\beta}{\beta + 1} = \frac{440}{440 + 1} = 0.9977$$

$$I_C = \alpha I_E = (0.9977)\,(30\text{ mA}) = 29.93\text{ mA}$$
$$I_C = \beta I_B = (440)\,(68\ \mu\text{A}) = 29.93\text{ mA}$$