TRANSISTOR BISINGN

Find the transistor current in the circuit shown in **fig. 5**, if I_{CO}= 20nA, β =100.

Solution:

For the base circuit, 5 = 200 x IB + 0.7

Therefore, $I_B = \frac{5-0.7}{200k} = 0.0215mA$

Since $I_{CO} << I_B$, therefore, $I_C = \beta I_B = 2.15$ mA

From the collector circuit, $V_{CE} = 10 - 3 \times 2.15 = 3.55$ V

Since, $V_{CE} = V_{CB} + V_{BE}$

Thus, $V_{CB} = 3.55 - 0.7 = 2.55$ V

Therefore, collector junction is reverse biased and transistor is operating in its active region.

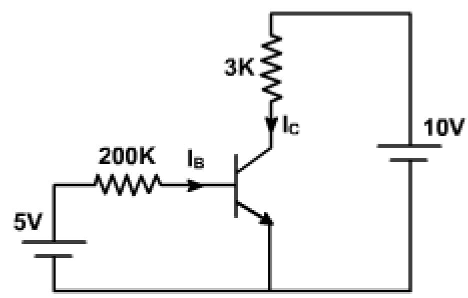

Fig. 5

Example - 2

If a resistor of 2K is connected in series with emitter in the circuit as shown in **fig. 6**, find the currents. Given I_{CO}= 20 nA, β =100.

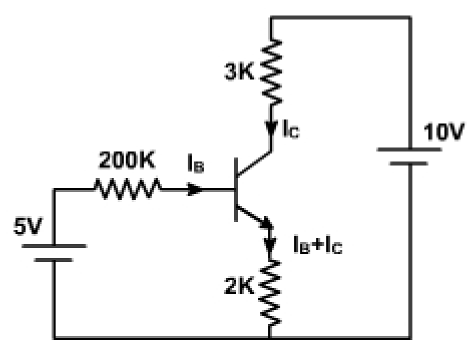

Fig. 6

Solution:

$I_E = I_B + I_C = I_B + 100\, I_B = 101\, I_B$

For the base circuit, $5 = 200 \times I_B + 0.7 + 2k \times 101\, I_B$

Therefore, $I_B = \frac{5-0.7}{402k} = 0.0107mA$

Since $I_{CO} << I_B$, therefore, $I_C = \beta I_B = 1.07$ mA

From the collector circuit, $V_{CB} = 10 - 3 \times 1.07 - 0.7 - 2 \times 101 \times 0.0107 = 3.93$ V

Therefore collector junction is reverse biased and transistor is operating in its active region.

Example - 3

Repeat the **example-1** if R_B is replaced by 50k.

Solution:

The circuit is shown in **fig. 7**.

Since the base resistance is reduced, the base current must have increased and there is a possibility that the transistor has entered into saturation region.

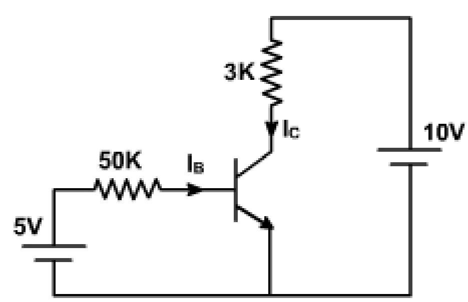

Fig. 7

Assuming transistor is operating in its saturation region,

$V_{BE\,(sat)} = 0.8$ V and $V_{CE\,(sat)} = 0.2$V

Therefore, $I_B = \frac{5-0.8}{50k} = 0.0840mA$

and $I_C = \frac{10-0.2}{3k} = 3.267\,mA$

The minimum base current required for operating the transistor in saturation region is

$$I_{B(min)} = \frac{I_C}{\beta} = 0.03267mA$$

Since $I_B > I_{B(min)}$, therefore, transistor is operating in its saturation region.

Example - 4

Repeat the **example-2** if R_B is replaced by 50k.

Solution:

The circuit is shown in **fig. 8**.

Since the base resistance is reduced, the base current must have increased and there is a possibility that the transistor has entered into saturation region.

Assuming transistor is operating in its saturation region,

$$5 = 50I_B + 0.8 + 2 \times (I_B + I_C)$$
$$10 = 3I_C + 0.2 + 2 \times (I_B + I_C)$$

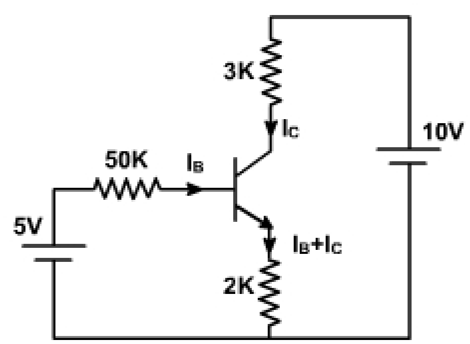

Fig. 8

Solving these equations, we get,

$I_C = 1.96mA$ and $I_B = 0.0035mA$

The minimum base current required for operating the transistor in saturation region is

$$I_{B(min)} = \frac{I_C}{\beta} = 0.0196mA$$

Since I B < I B(min) , therefore, transistor is operating in its **active** region and not in saturation. The base and the collector currents can be recalculated assuming the transistor to be in active region.

For the base circuit, $5 = 50 \times I_B + 0.7 + 2k \times 101\ I_B$

Therefore, $I_B = \frac{5 - 0.7}{252k} = 0.0171mA$

$I_C = 1.71mA$

From the collector circuit, $V_{CB} = 10 - 3 \times 1.71 - 0.7 - 2 \times 101 \times 0.0171 = 0.716$ V