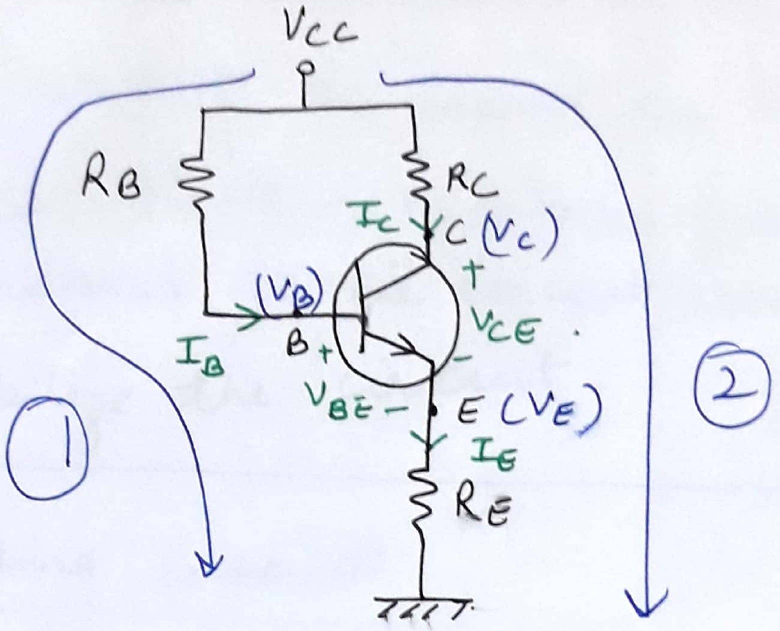
Emitter Bias (Self Bias)



* A resistance R_E has been added from emitter to the ground terminal in the fixed bias circuit. The remaining ckt is same as the fixed bias circuit.

* The Emitter resistance improves the bias stability as follows :-

→ If I_C increases. ⇒ I_E also increases

→ If I_E increases ⇒ Voltage $V_E = I_E R_E$ also increases.

⇒ If V_E increases ⇒ Voltage $V_B = V_{BE} + V_E$ ~~decreases~~ increases as V_{BE} is fixed.

⇒ if V_B increases ⇒ $I_B = \frac{V_{CC} - V_B}{R_B}$ decreases.

→ If I_B decreases ⇒ $I_C = \beta I_B$ also decreases.

Thus, we can say that the increase in I_C will be compensated by the decrease in the value of I_B. caused due to voltage V_E.
Hence, Emitter resistance provides negative feedback to the circuit and hence stabilize the circuit.

Finding Q.points

Applying KVL in loop 1.

$$V_{CC} - I_B R_B - V_{BE} - I_E R_E = 0.$$

put $I_E = (\beta+1) I_B$. ($\because I_E = I_B + I_C = I_B + \beta I_B = (\beta+1) I_B$)

$$\Rightarrow V_{CC} - I_B R_B - V_{BE} - (\beta+1) I_B R_E = 0.$$

$$\Rightarrow \boxed{I_B = \frac{V_{CC} - V_{BE}}{R_B + (\beta+1) R_E}} \quad \text{--- 1}$$

find
$$\boxed{\begin{aligned} I_C &= \beta I_B. \\ \text{and} \quad I_E &= (\beta+1) I_B. \end{aligned}} \quad \text{--- 2}.$$

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Applying KVL in loop ②.

$$V_{CC} - I_C R_C - V_{CE} - I_E R_E = 0.$$

$$\Rightarrow \boxed{V_{CE} = V_{CC} - I_C R_C - I_E R_E} \quad (3).$$

or $\because I_C \approx I_E$

$$\Rightarrow \boxed{V_{CE} \approx V_{CC} - I_C(R_C + R_E)} \quad (4).$$

Stability factor (S).

$$\boxed{S = \frac{1+\beta}{1-\beta\left(\frac{dI_B}{dI_C}\right)}}$$

To find $\frac{dI_B}{dI_C}$ for Emitter bias

we have,

$$V_{CC} - I_B R_B - V_{BE} - (I_B + I_C) R_E = 0$$

Differentiate the eq. w.r.t I_C.

$$\Rightarrow \quad 0 - \frac{dI_B}{dI_C} R_B - 0 - \left(\frac{dI_B}{dI_C} + 1\right) R_E = 0.$$

or $$\boxed{\frac{dI_B}{dI_C} = \frac{-R_E}{R_B + R_E}}.$$

$$\Rightarrow \quad S = \frac{1+\beta}{1-\beta\left(\frac{-R_E}{R_B+R_E}\right)}.$$

$$\boxed{S = \frac{1+\beta}{1+\frac{\beta R_E}{R_B+R_E}}}$$

if $R_B << R_E$.

$$\Rightarrow \quad R_B+R_E \simeq R_E$$

$$\Rightarrow \quad S \approx \frac{1+\beta}{1+\beta}$$

or $\boxed{S \approx 1}$

Hence the stability factor of Emitter Bias circuit is very low as compared to the fixed bias circuit $(1+\beta)$. Hence Emitter bias circuit provides high stability to the Transistor.