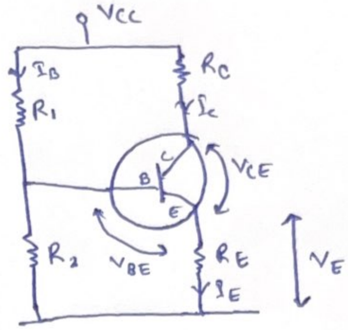
Voltage Divider Bias Method / Self Bias:

This is the most commonly used method for stabilizing & biasing ~~of~~ a transistor.

The resistors R_1 and R_2 will divide the supply voltage and across R_2 will forward bias the Emitter-Base junction.



Approximate Analysis:->

1. In this method two resistance R_1 & R_2 are connected across the supply voltage V_{cc}
2. R_1 & R_2 provide biasing.
3. R_E provide stabilization to the circuit.
4. Voltage drops across R_2 i.e ~~EB~~ E-B junction in FB.

> Collector Current (I_c):-

$I_B \to I_1$

{ I_1 is the current flowing throu' R_1 since I_B is very small current through R_2 is approximately I_1.

$$I_1 = \frac{V_{cc}}{R_1 + R_2}$$

voltage across R_2 : $V_2 = R_2 I_1$

$$V_2 = R_2 \cdot \frac{V_{cc}}{R_1 + R_2}$$

Applying KVL to the input part:

$$V_2 = V_{BE} + V_E$$

$$V_2 = V_{BE} + R_E I_E$$

$$\Rightarrow I_E = \frac{V_2 - V_{BE}}{R_E}$$

Since: $I_E \simeq I_C$ $\quad (\because I_E = \underset{\approx 0}{I_B} + I_C)$

$$\boxed{I_C = \frac{V_2 - V_{BE}}{R_E}}$$

$\Rightarrow$ I_C is independent of β.

+ $V_{BE} << V_2$ i.e I_C is independent of V_{BE}

So in this circuit I_C is independent of transistor parameter and hence a good stabilization is ensured.

Hence potential divider circuit has become universal method for dividing voltage and used for stabilizing and biasing.

- Collector-emitter voltage:- (V_{CE})

Applying KVL to output.

$$V_{CC} = I_C R_C + V_{CE} + I_E R_E$$

as $I_C \simeq I_E$

So,

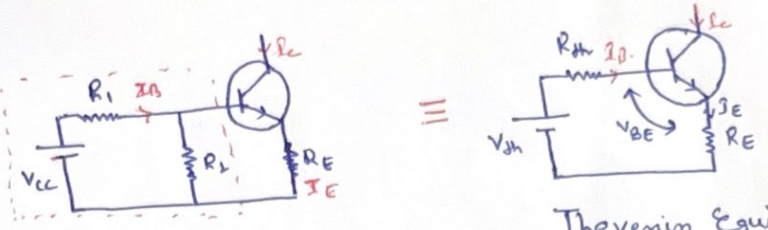
$$V_{CC} = I_C(R_C + R_E) + V_{CE}$$

$$\boxed{V_{CE} = V_{CC} - I_C(R_C + R_E)}$$

Since, I_C and V_{CE} are both independent of β, Q-point doesnot change with change in transistor parameters.

Exact Analysis / Stability factor for potential Divider Bias :-

Drawing the input part and replacing it by the thevenin Equivalent circuit



Thevenin Equivalent circuit.

as $R_1 \parallel R_2$

$$R_{th} = \frac{R_1 R_2}{R_1 + R_2}$$

$$V_{th} = I_1 R_2$$

$$V_{th} = \frac{V_{CC} R_2}{R_1 + R_2}$$

Applying KVL in the input loop.

$$V_{th} = R_{th} I_B + V_{BE} + I_E R_E \rightarrow (1)$$

$$I_E = I_C + I_B$$

$$I_E = I_B + \beta I_B$$

$$I_E = (1+\beta) I_B \rightarrow (2)$$

Substituting (2) in (1)

$$\Rightarrow V_{th} = R_{th} I_B + V_{BE} + (1+\beta) I_B \cdot R_E$$

$$\boxed{I_B = \frac{V_{th} - V_{BE}}{R_{th} + R_E(1+\beta)}}$$

Hence, I_B is depending on β as Temp. ↑es β ↑es and hence I_B ↓es, which reduces I_C maintaing the stabilization and Avoid thermal runaway.

Assignment:- To Submit (3-oct.2023)

i) For a Collector to Base bias circuit, derive the expression for stability factor.

ii) Calculate the stability factor in case of Voltage Divider Bias.