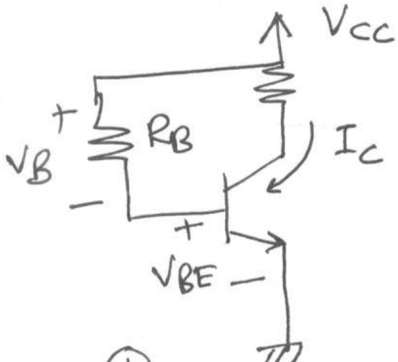
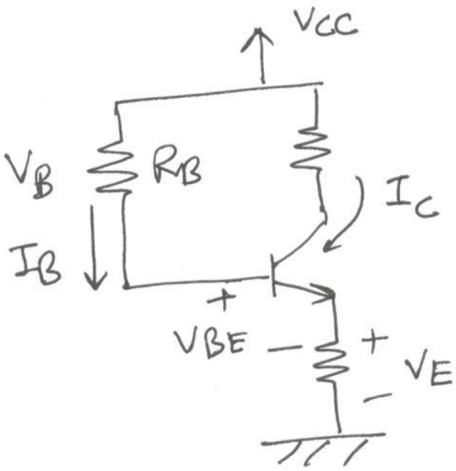
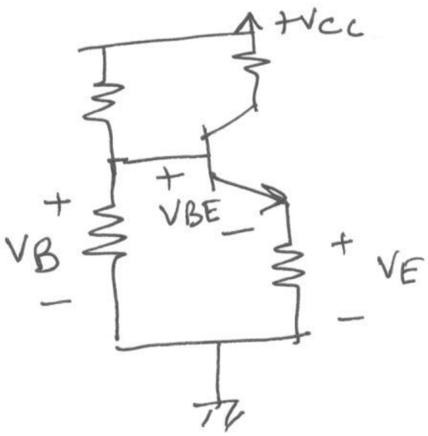
Explaination of stability w.r.t I_{CO}



1 Fixed Bias.



2 Emitter Bias

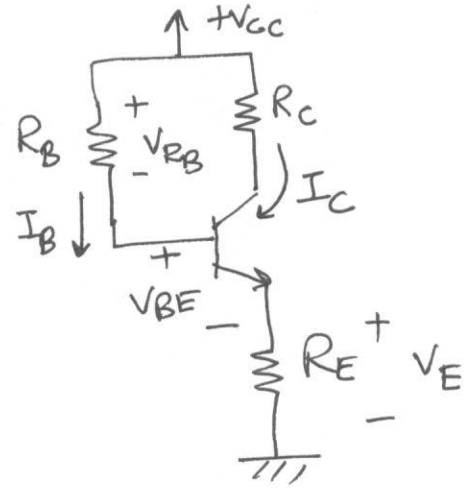


1 $$I_B = \frac{V_{CC} - V_{BE}}{R_B}$$

$$I_C = \beta I_B + (\beta + 1) I_{CO}$$

Due to increase in I_{CO}, I_C increases, there is nothing in the eqn for I_B that would attempt to offset this undesirable increase in ct level. (assuming V_{BE} is const) I_B remains const. I_C will continue to rise with temp,

Emitter Bias



$$I_B = \frac{V_{CC} - V_{BE} - V_E}{R_B}$$

as $V_E \uparrow$, $I_B \downarrow$

Increase in I_C due to ($\uparrow$ in I_{CO}) will cause voltage $V_E = I_E R_E \cong I_C R_E$ to increase.

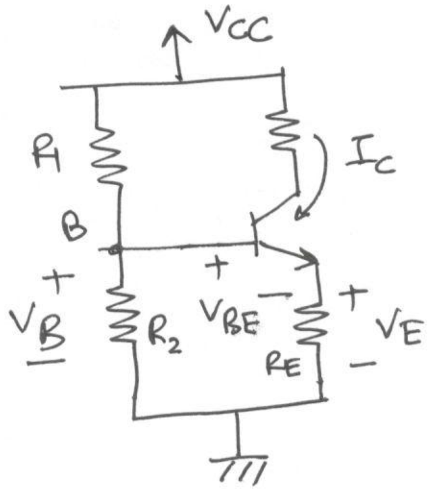
This will cause I_B to drop as

$$I_B \downarrow = \frac{V_{CC} - V_{BE} - V_E \uparrow}{R_B}.$$

A drop in I_B will have the effect of reducing the level of I_C through transistor action and thereby offset the tendency of I_C to increase due to an increase in temp.

Thus there is a reaction to an increase in I_C that will tend to oppose the change in bias conditions.

③



Voltage − divider bias.

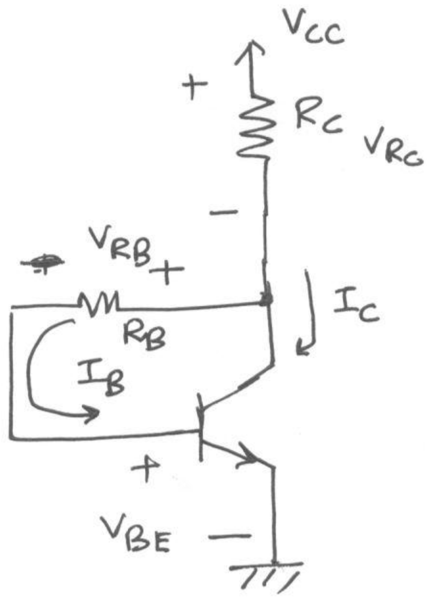
If $\beta R_E \gg 10 R_2$ is satisfied, the voltage V_B will remain fairly constant for changing level of I_C.

$V_{BE} = V_B - V_E$,

If I_C should increase, V_E will increase, for a constant V_B.

V_{BE} will ↓,

As V_{BE} ↓, I_B ↓ which will try to offset the increased level of I_C.

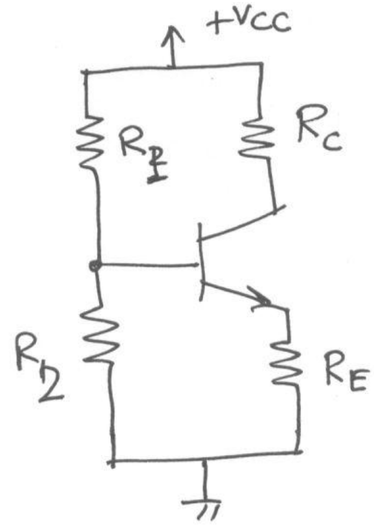


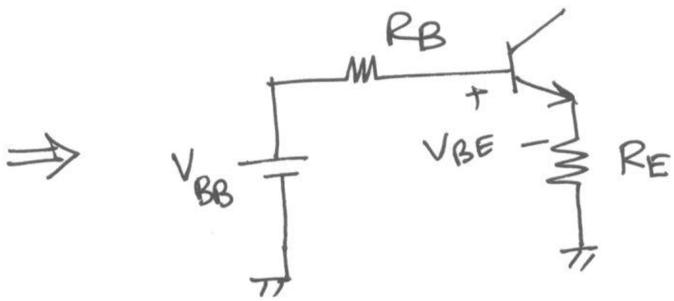
Collector Feedback Config

$$I_B \downarrow = \frac{V_{CC} - V_{BE} - V_{R_C} \uparrow}{R_B}$$

An increase in I_C due to increase in temp, causes V_{RC} to increase $\uparrow$.
and as a result $I_B \downarrow$ as seen in the eqn.

Derivation of $S(\beta)$





$$R_B = R_1 \parallel R_2$$

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

$$I_C = \beta I_B + (\beta+1) I_{CBO}$$

$$V_{BB} = I_B R_B + V_{BE} + I_E R_E \quad \text{(a)}$$: using KVL in Base Emitter loop

$$V_{CC} = I_C R_C + V_{CE} + I_E R_E$$: using KVL in Collector Emitter loop

$$I_C = \alpha I_E + I_{CBO}$$

$$I_E = I_B + I_C$$

or $$I_B = \frac{1-\alpha}{\alpha} I_C - \frac{I_{CBO}}{\alpha} = (1-\alpha) I_E - I_{CBO}$$

$$= \frac{I_E}{(\beta+1)} - I_{CBO} \quad \text{(b)}$$

$$I_B = \frac{I_E}{(\beta+1)} - I_{CBO}$$

$$\boxed{I_C = \frac{\beta}{(\beta+1)} I_E + I_{CBO}} \quad \text{— (c)}$$

Combining (a) & (b)

$$V_{BB} = V_{BE} - I_{CBO} R_B + I_E \left(R_E + \frac{R_B}{\beta+1}\right)$$

Now use eqn (c) to obtain

$$\boxed{I_{CQ} = \frac{\beta (V_{BB} - V_{BE}) + (\beta+1) I_{CBO} (R_E + R_B)}{(\beta+1) R_E + R_B}}$$

<u>To calculate S_β</u>

Since $V_{BB} - V_{BE} \gg I_{CBO}(R_E + R_B)$ in Active region, the I_{CBO} term is neglected.

Thus $I_{CQ} \simeq \beta \dfrac{(V_{BB} - V_{BE})}{R_B + (\beta+1) R_E}$

Let β_1 and β_2 are two values on β with I_{CQ_1} and I_{CQ_2} are corresponding currents.

Next we form the ratio

$$\frac{I_{CQ_2}}{I_{CQ_1}} = \frac{\beta_2}{\beta_1}\left[\frac{R_B + (\beta_1+1)R_E}{R_B + (\beta_2+1)R_E}\right]$$

$$\frac{I_{CQ_2} - I_{CQ_1}}{I_{CQ_1}} = \frac{\Delta I_{CQ}}{I_{CQ_1}} = \frac{\Delta\beta\,(R_B + R_E)}{\beta_1\left[R_B + (\beta_2+1)R_E\right]}$$

$$\Delta I_{CQ} = I_{CQ_2} - I_{CQ_1} \qquad \Delta\beta = \beta_2 - \beta_1$$

Thus $$S_\beta = \frac{\Delta I_{CQ}}{\Delta\beta} = \frac{I_{CQ_1}}{\beta_1}\left[\frac{R_B + R_E}{R_B + (\beta_2+1)R_E}\right]$$

For Emitter - Bias Configuration

$$S(\beta) = \frac{\Delta I_C}{\Delta\beta} = \frac{I_{C_1}\,(1 + R_B/R_E)}{\beta_1\,(\beta_2 + R_B/R_E)}$$