# BJT Bias
# Emitter Bias (H.7)

20170425

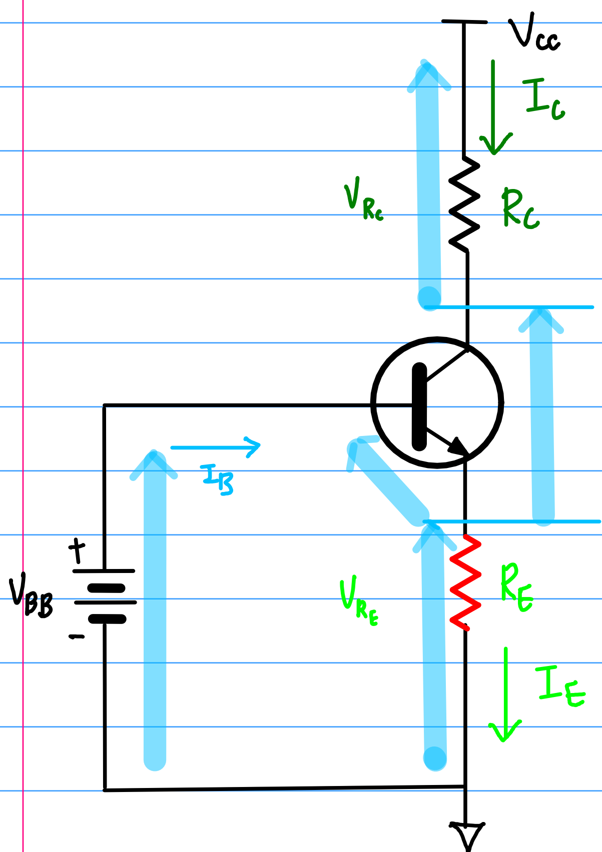
# References

Based

[1] Floyd, Electronic Devices 7th ed
[2] Cook,

[2] en.wikipedia.org

# Emitter Bias




$$V_{BB} = V_{BE} + V_{R_E}$$

$$V_{R_E} = V_{BB} - V_{BE} = V_{BB} - 0.7$$

$$I_E = \frac{V_{R_E}}{R_E} = \frac{V_{BB} - V_{BE}}{R_E}$$

$$I_C \cong I_E = \frac{V_{BB} - V_{BE}}{R_E}$$

$$V_{R_C} = I_C R_C$$

$$V_{CE} = V_{CC} - V_{R_E} - V_{R_C}$$

$$= V_{CC} - (R_C + R_E) I_E$$

$$= V_{CC} - (R_C + R_E)\frac{V_{BB} - V_{BE}}{R_E}$$

# minor effect on current gain

$$I_E = I_C + I_B$$

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

$$= \left(\frac{\beta + 1}{\beta}\right) I_C$$

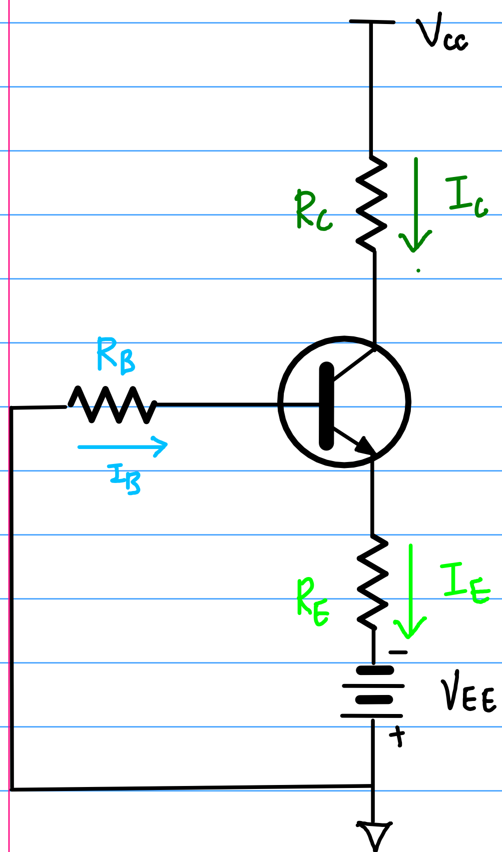
$$I_C = \left(\frac{\beta}{\beta + 1}\right) I_E$$

$\left(\frac{\beta_{dc}}{\beta_{dc} + 1}\right)$ correction factor

how $I_C$ differs from $I_E$

$\beta_{dc} = 100$ $\frac{100}{101} = 0.99$

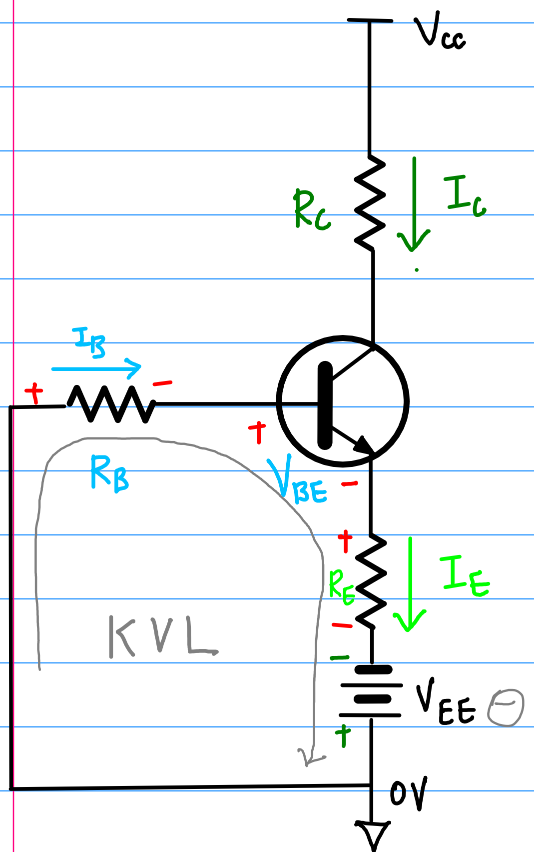
# Two-Supply Emitter Bias (TSEB)

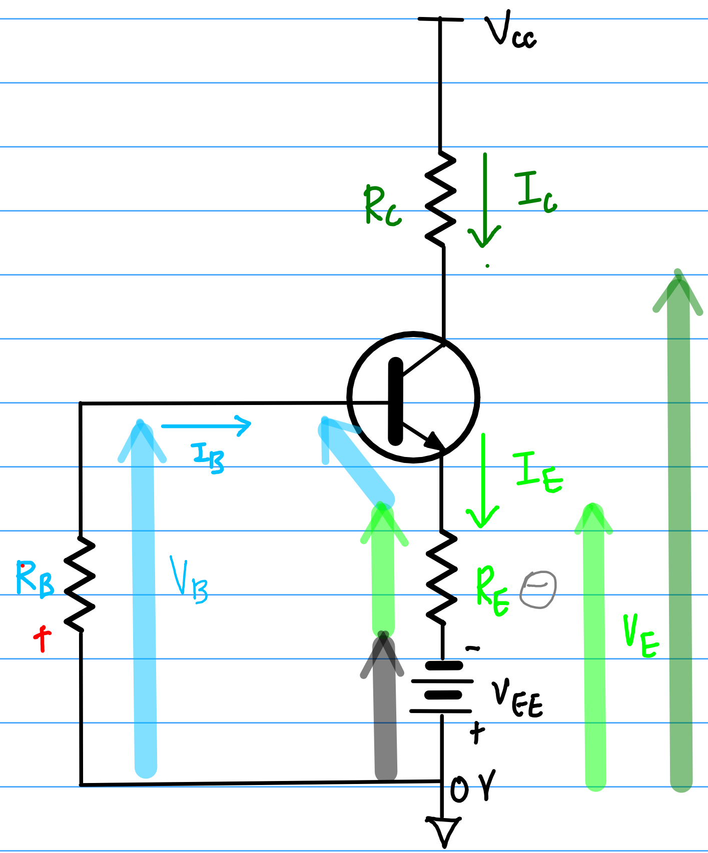



$I_C \cong I_E$

$$I_C = \frac{V_{BB} - V_{BE}}{R_E + R_B/\beta_{DC}}$$

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




$$V_{R_B} + V_{BE} + V_{R_E} + V_{EE} = 0$$

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

$$I_B R_B + V_{BE} + I_E R_E + V_{EE} = 0$$

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

$$I_B R_B + V_{BE} + I_E R_E = -V_{EE}$$

$$V_C = V_{CC} - I_C R_C$$

$$\boxed{I_E \cong I_C = \beta_{DC} I_B} \quad \boxed{I_B \cong \frac{I_E}{\beta_{DC}}}$$

$$\frac{I_E}{\beta_{DC}} R_B + V_{BE} + I_E R_E = -V_{EE}$$

$$I_E \left( \frac{R_B}{\beta_{DC}} + R_E \right) + V_{BE} = -V_{EE}$$

⊕

$$I_E = \frac{-V_{EE} - V_{BE}}{R_E + R_B/\beta_{DC}} \cong I_C$$

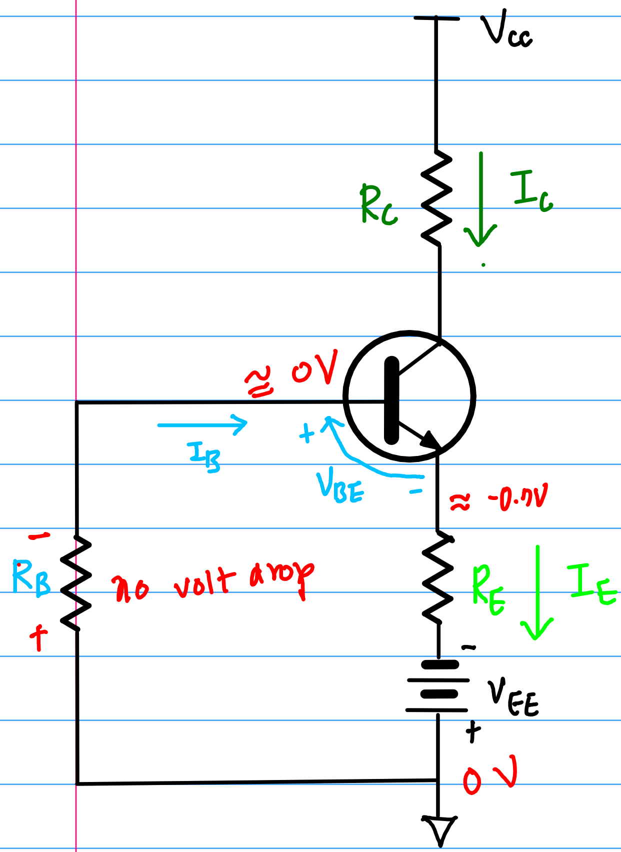
# Q-point Stability

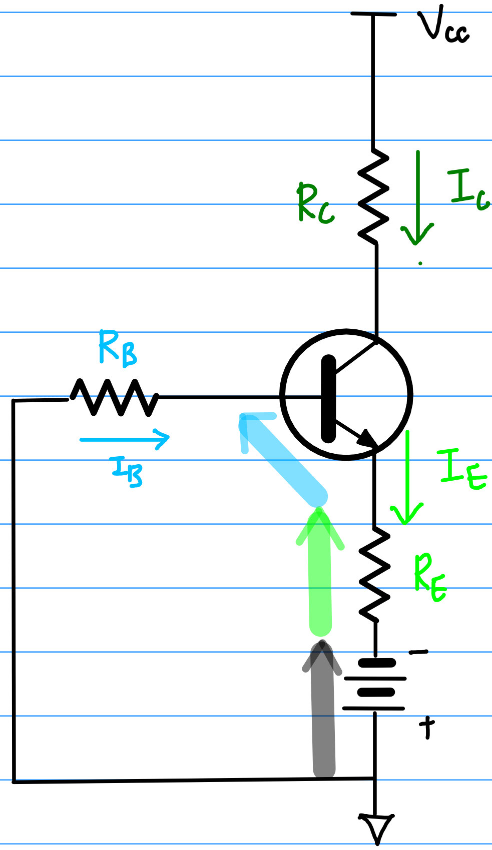
$$I_E = \frac{-V_{EE} - V_{BE}}{R_E + R_B/\beta_{DC}} \cong I_C$$

$R_E \gg R_B/\beta_{DC}$ $\qquad$ $I_E = \dfrac{-V_{EE} - V_{BE}}{R_E} \cong I_C$

$-V_{EE} \gg V_{BE}$ $\qquad$ $I_E = \dfrac{-V_{EE}}{R_E} \cong I_C$

$I_E$ independent of $V_{BE}$ and $\beta_{DC}$ → stable Q point




$V_B \approxeq 0\,V$

$V_{RE} = -V_{EE} - V_{BE}$

$I_E = \frac{V_{RE}}{R_E}$

$V_C = V_{CC} - I_C R_C$

$V_{CE} = V_C + V_{BE}$