BJT Bias
Feedback Bias (H.20)

20170602-2

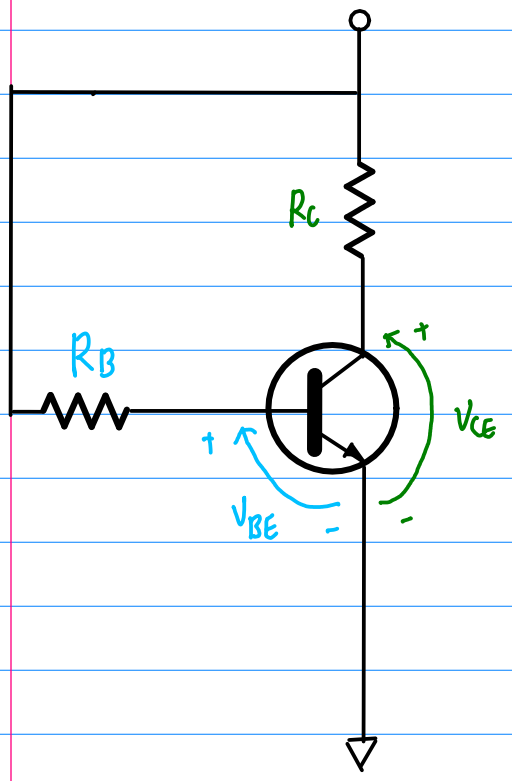
References

Based

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

[2] en.wikipedia.org

Base Bias



Q point values $I_C \cong I_E$

$$I_C = \beta_{DC}\left(\frac{V_{CC} - V_{BE}}{R_B}\right)$$

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

Fixed Bias :

fixed base current I_B

Temperature

I_B : fixed

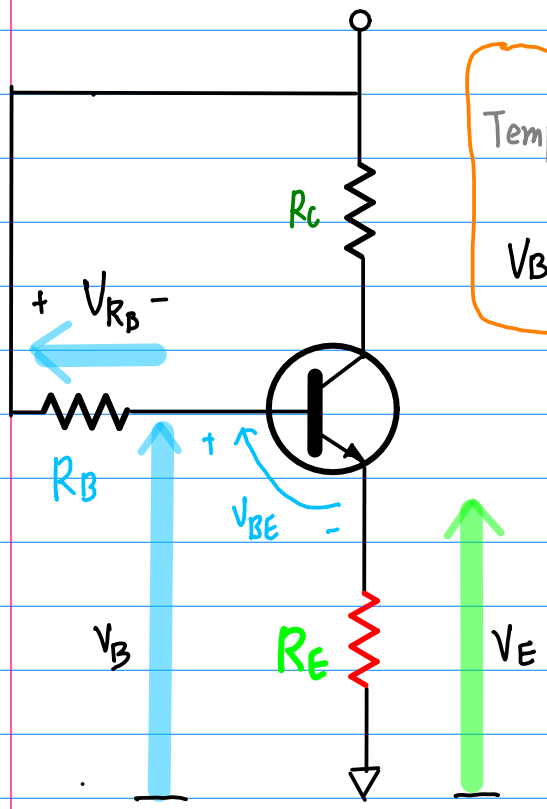
$I_C = \beta I_B$: change as β changes

Q moves all over the load line

Can not be used in the fixed Q circuits

⇒ Use R_E as a feedback

Emitter Feedback Bias



Temperature $\beta \uparrow \Rightarrow I_C \uparrow \Rightarrow V_E \uparrow \Rightarrow V_B \uparrow$

$V_B \uparrow \Rightarrow I_B \downarrow \Rightarrow I_C \downarrow$

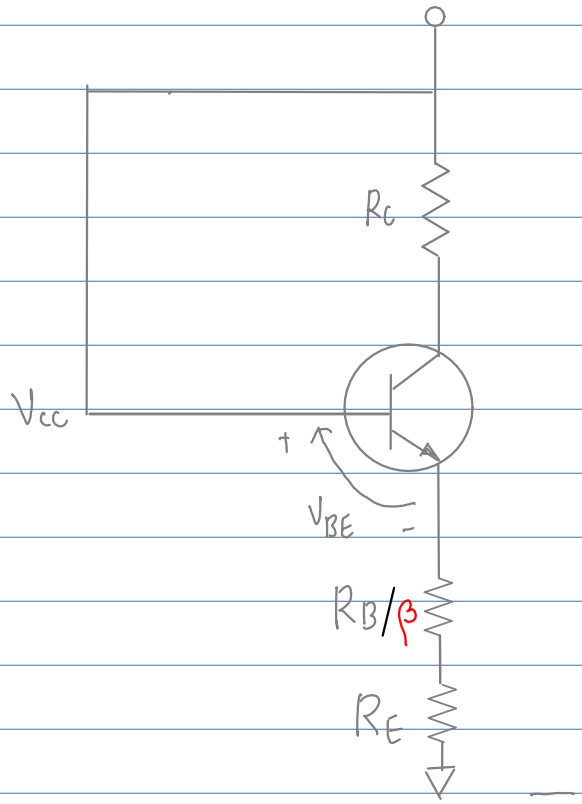
negative feedback

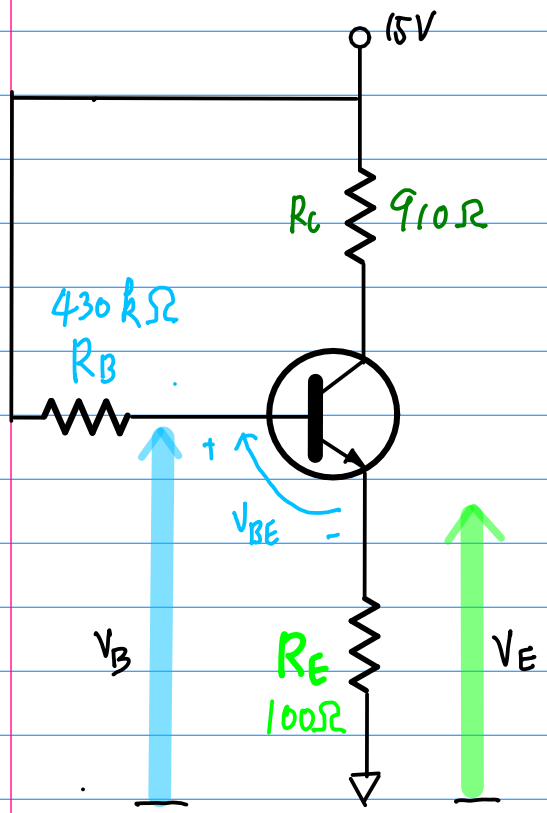
$$\begin{cases} V_E = I_C R_E \cong I_E \cdot R_E \\ V_B = V_E + V_{BE} \\ V_{R_B} = V_{CC} - V_B \end{cases}$$

Still Q moves a lot

$$I_E = \frac{V_{CC} - V_{BE}}{R_E + R_B/\beta_{dc}}$$

$$V_E = I_E R_E$$
$$V_B = V_E + V_{BE}$$
$$V_C = V_{CC} - I_C R_C$$





$$I_E = \frac{V_{CC} - V_{BE}}{R_E + R_B/\beta_{dc}}$$

$R_E \gg R_B/\beta_{dc}$

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

not practical

But cannot select large R_E in practice.

$$I_E = \frac{V_{CC} - V_{BE}}{R_E + R_B/\beta_{dc}} = \frac{15 - 0.7}{100 + 430000/\beta_{dc}}$$

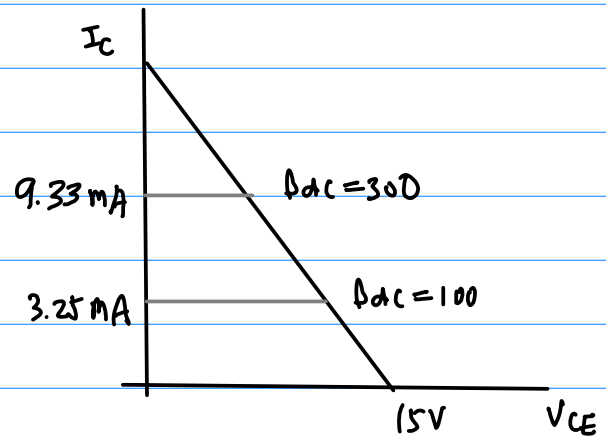
β_{dc}: 100 ~ 300

$I_C \cong I_E$

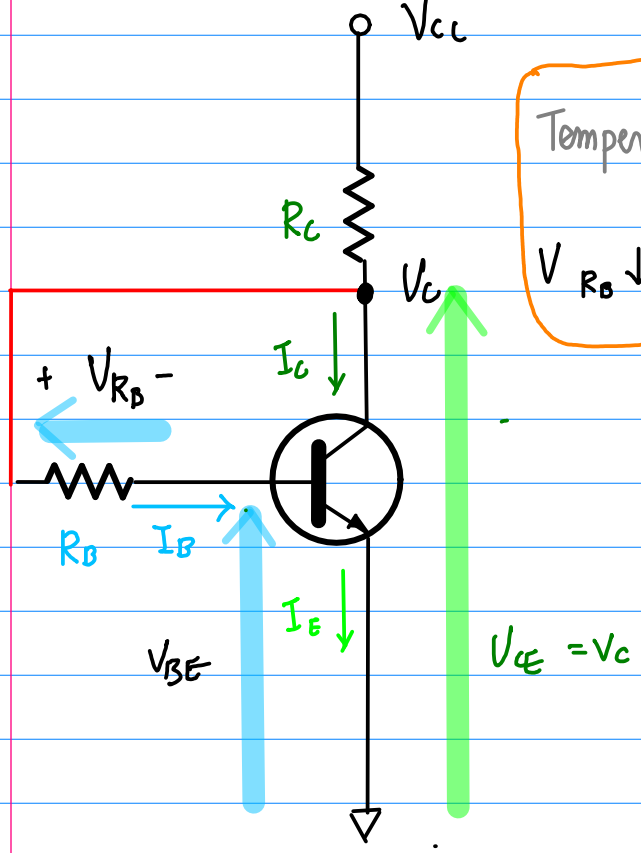
$\beta = 100$ $\quad I_C = \frac{14.3}{100 + 4300} = 3.25\,mA$

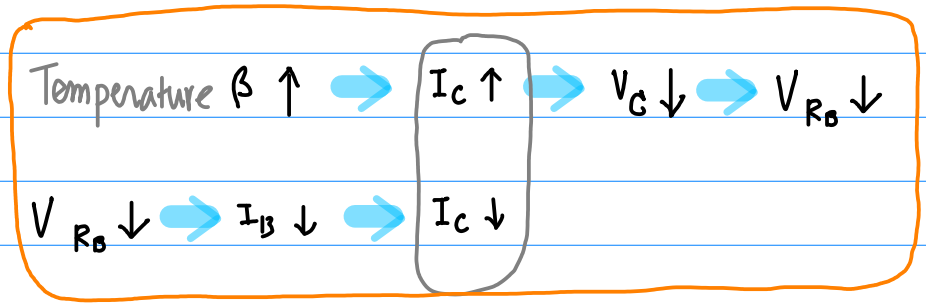
$\beta = 300$ $\quad I_C = \frac{14.3}{100 + 4300/3} = 9.32\,mA$

3:1 variation



Collector Feedback Bias (Self Bias)



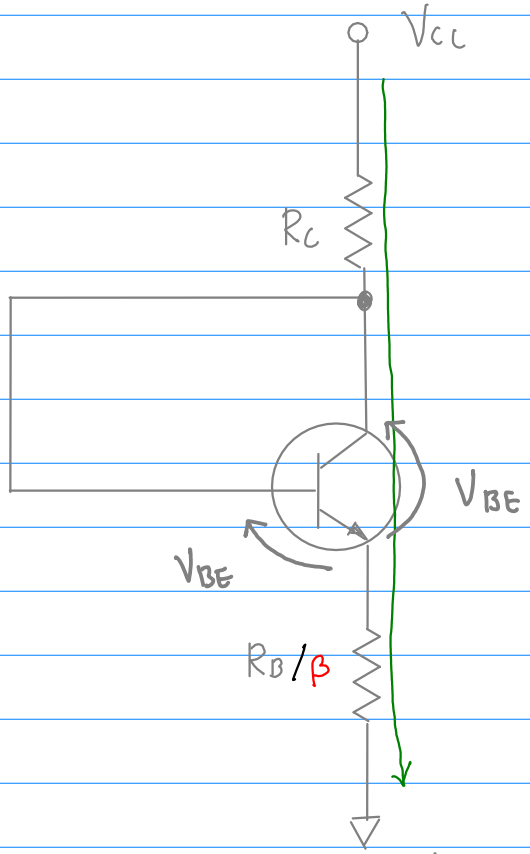


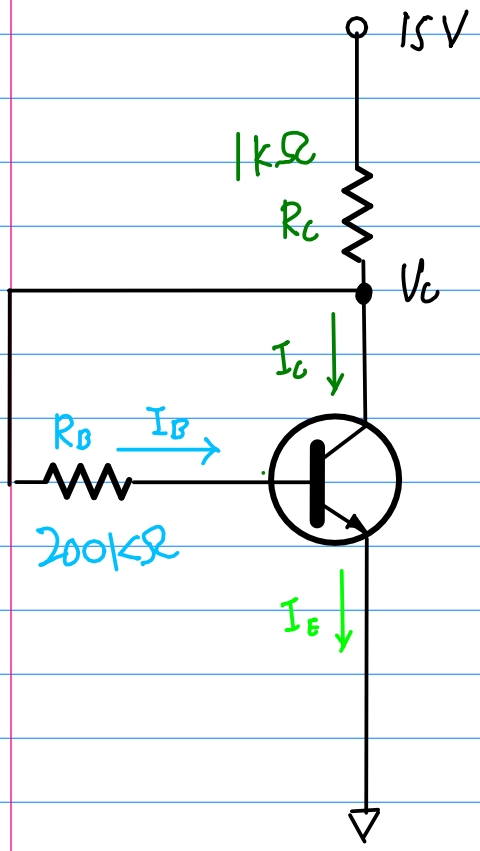
negative feedback

$$I_E = \frac{V_{CC} - V_{BE}}{R_C + R_B/\beta_{dc}}$$

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

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



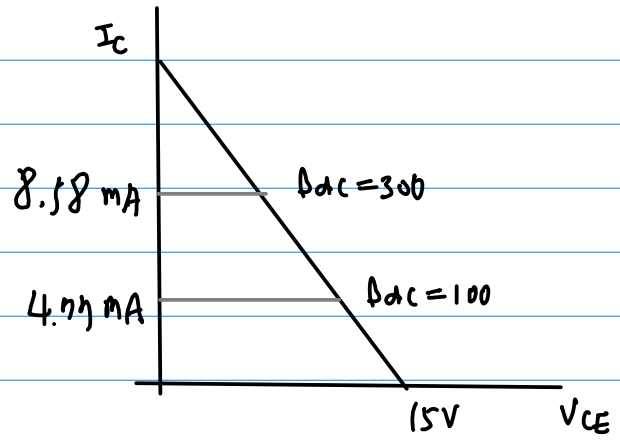


$$I_E = \frac{V_{CC} - V_{BE}}{R_C + R_B/\beta_{dc}} = \frac{15 - 0.7}{1000 + 200\,000/\beta_{dc}}$$

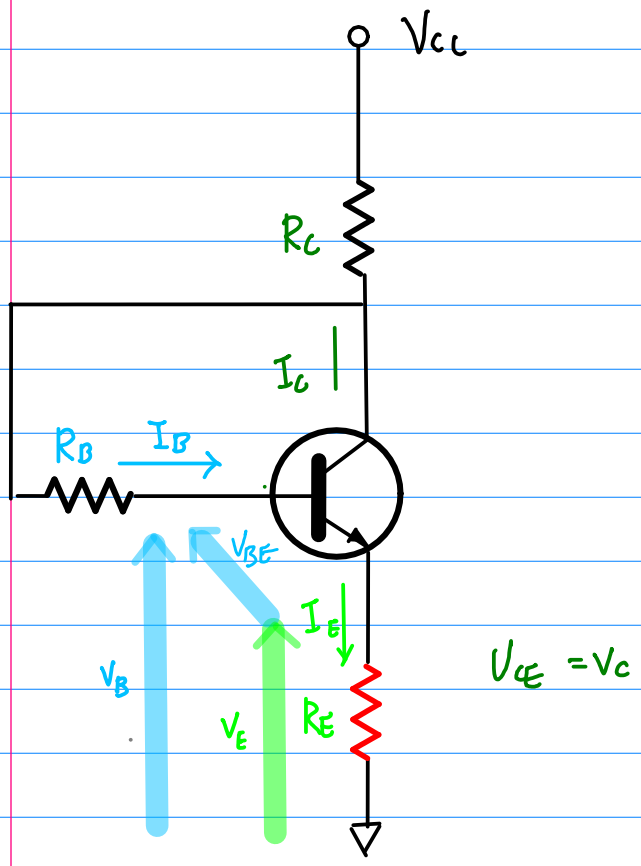
$\beta = 100$ $\quad I_E = \dfrac{14.3}{1000 + 200\,00} = 4.77\ mA$

$\beta = 300$ $\quad I_E = \dfrac{14.3}{1000 + 200\,00/3} = 8.58\ mA$

2:1



Collector - Emitter Feedback



Emitter Feedback
⊕ Collector Feedback

Still not enough feedback to stabilize.

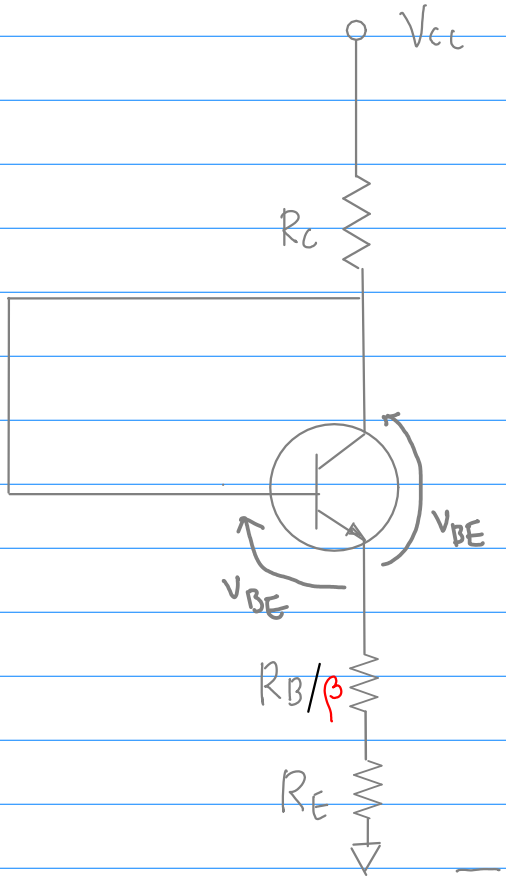
$V_{CE} = V_C$

$$I_E = \frac{V_{cc} - V_{BE}}{R_c + R_E + R_B/\beta}$$

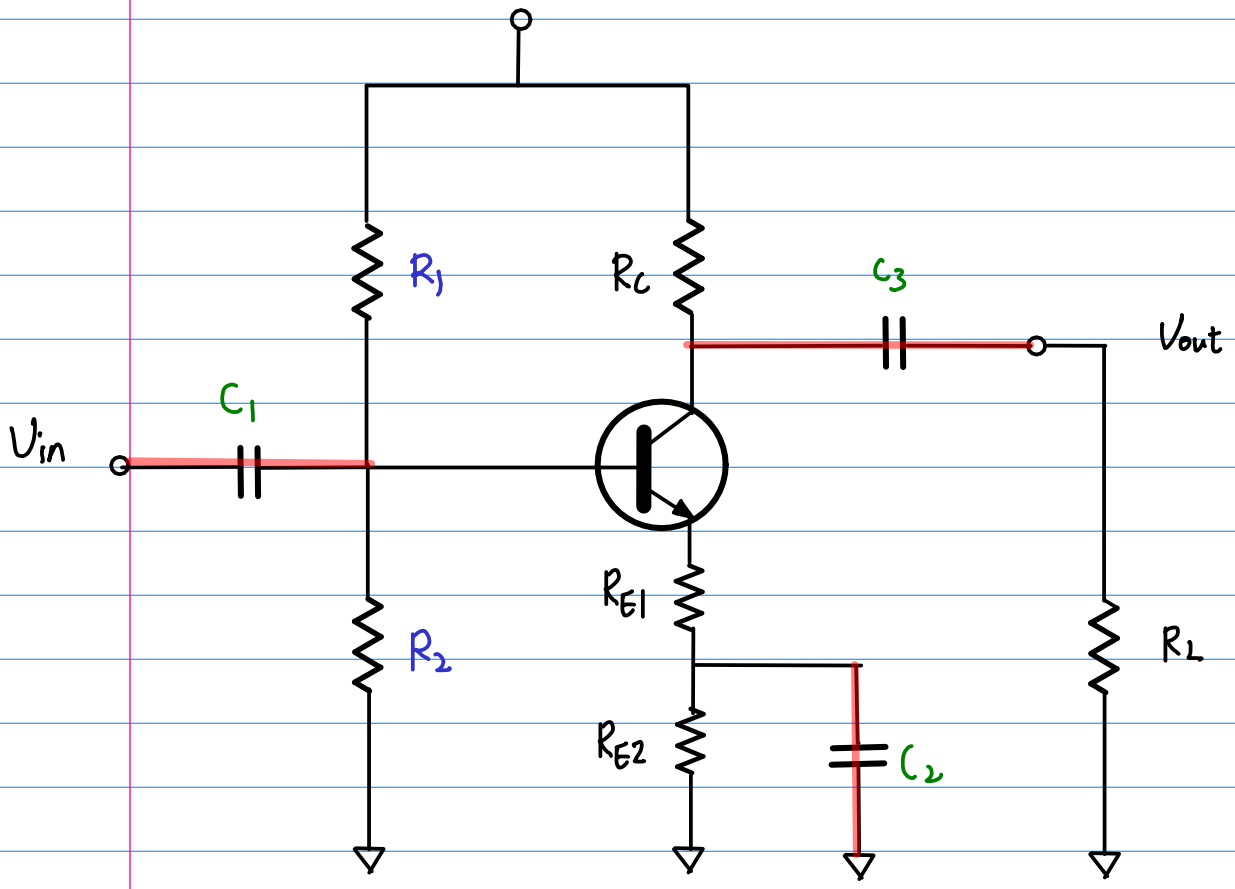
$V_E = I_E R_E$

$V_B = V_E + V_{BE}$

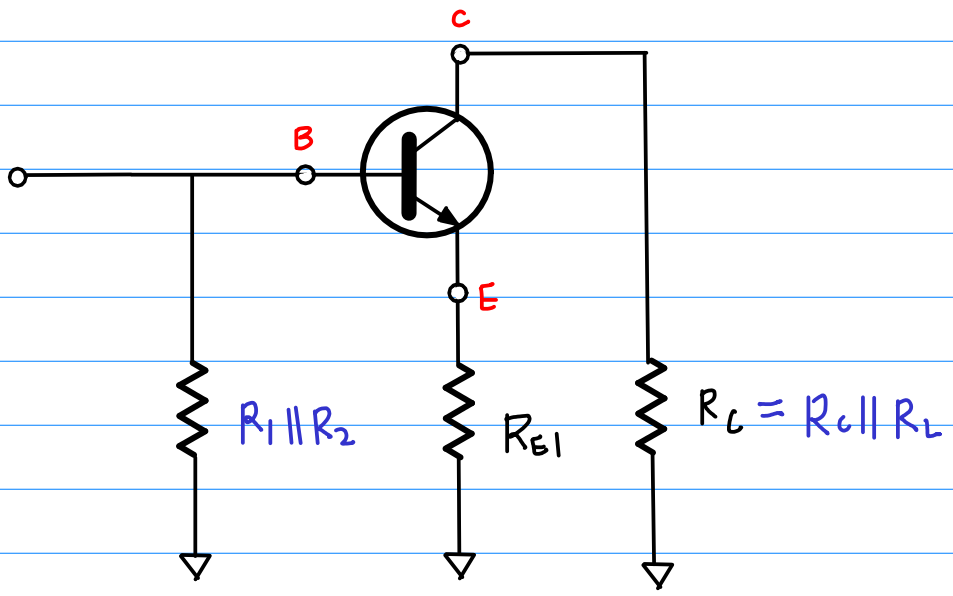
$V_C = V_{cc} - I_c R_c$



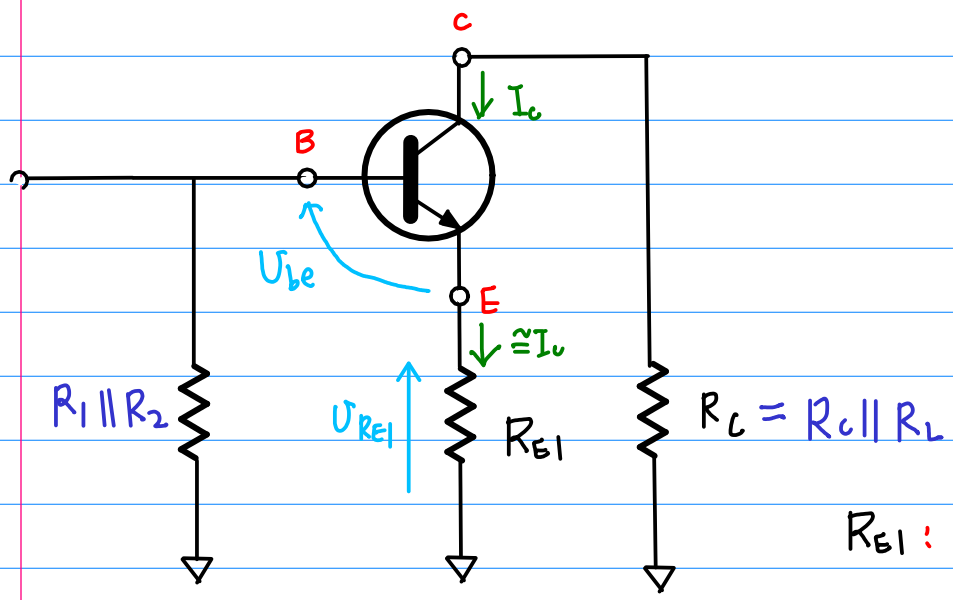
AC Emitter Feedback



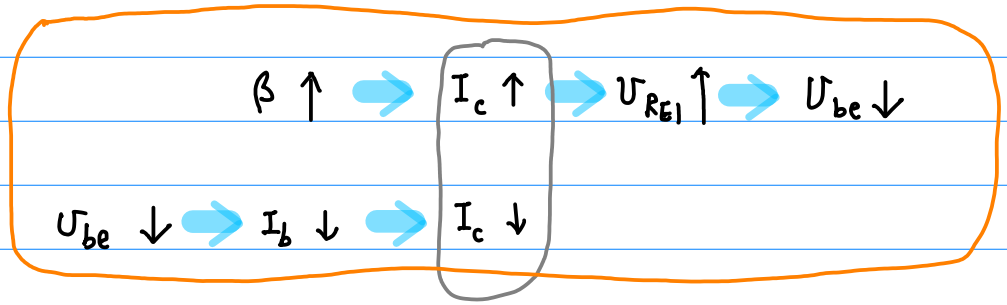
AC equivalent circuit



R_{E1} : feedback resistor



R_{E1} : feedback resistor



negative feedback