

BJT Bias

Voltage Divider Bias (H.5)

20170422

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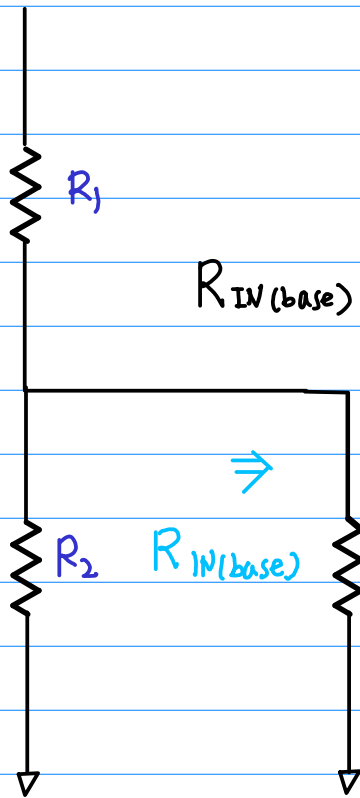
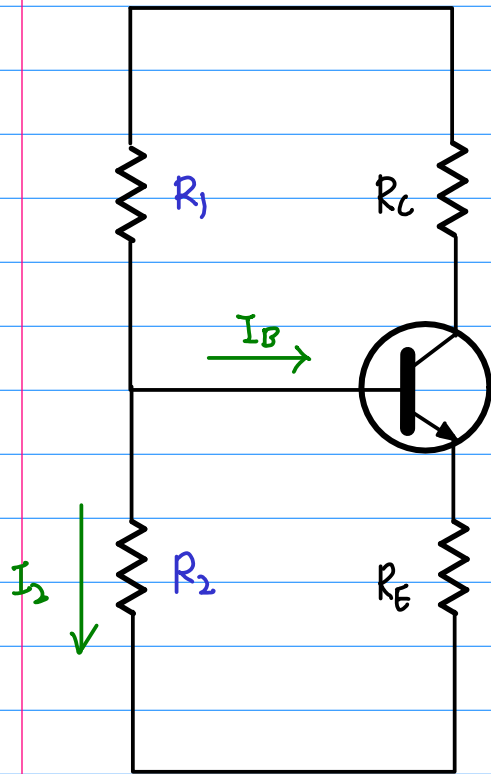
References

Based

[1] Floyd, Electronic Devices 7th ed

[2] Cook,

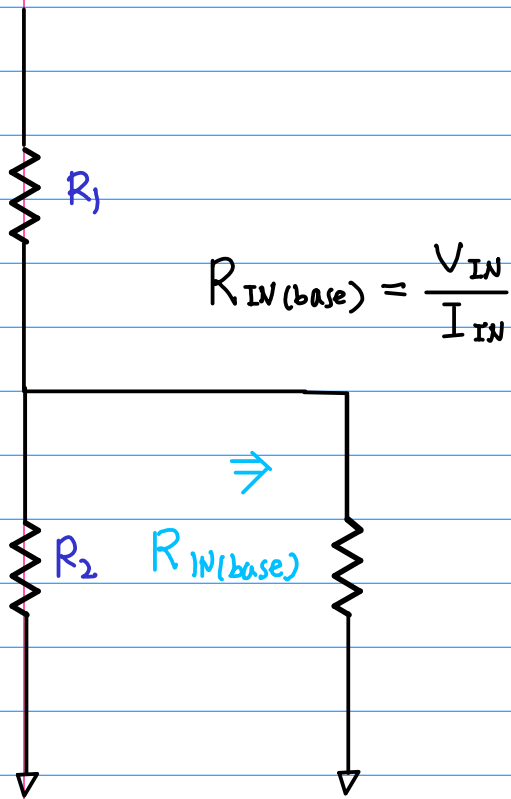
[2] en.wikipedia.org



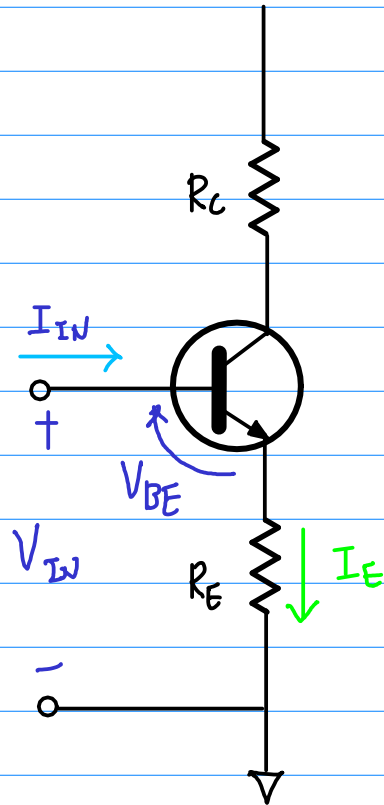
$$R_{IN(base)} = \frac{V_{IN}}{I_{IN}}$$

\Rightarrow

$R_{IN(base)}$

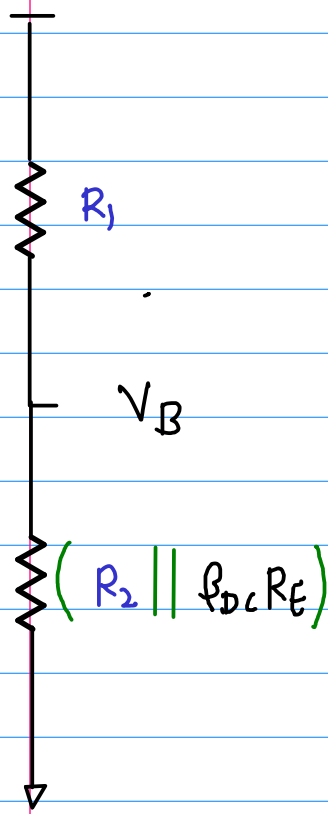
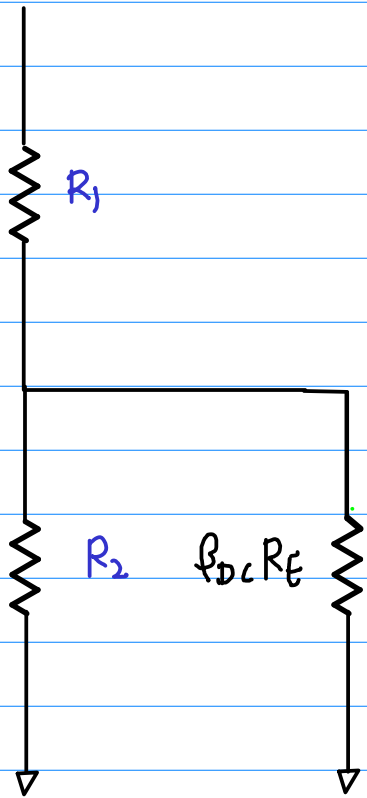
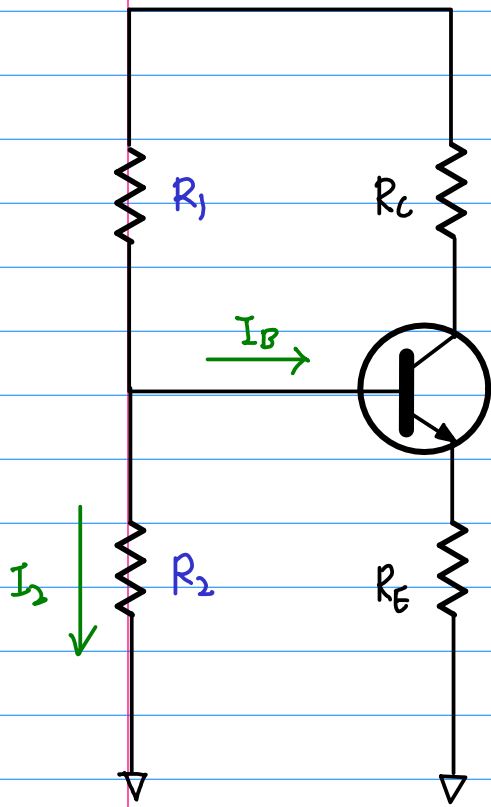


$$R_{IN(base)} = \frac{V_{IN}}{I_{IN}}$$



$$\begin{aligned} V_{IN} &= V_{BE} + I_E R_E \\ &\approx I_E R_E \\ &\approx \beta_{DC} I_B R_E \end{aligned}$$

$$R_{IN(base)} = \frac{V_{IN}}{I_{IN}} = \frac{\beta_{DC} I_B R_E}{I_B} = \beta_{DC} R_E$$

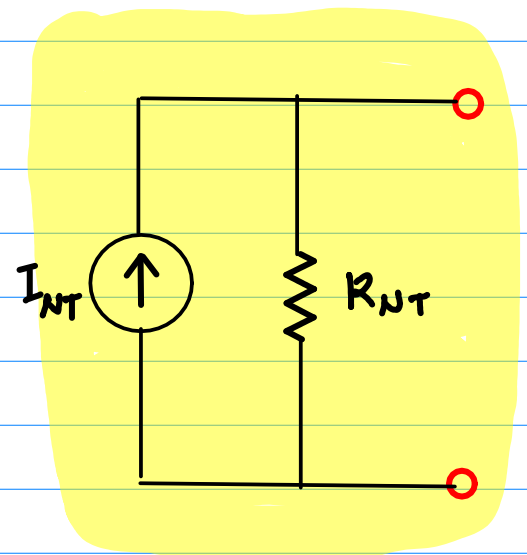
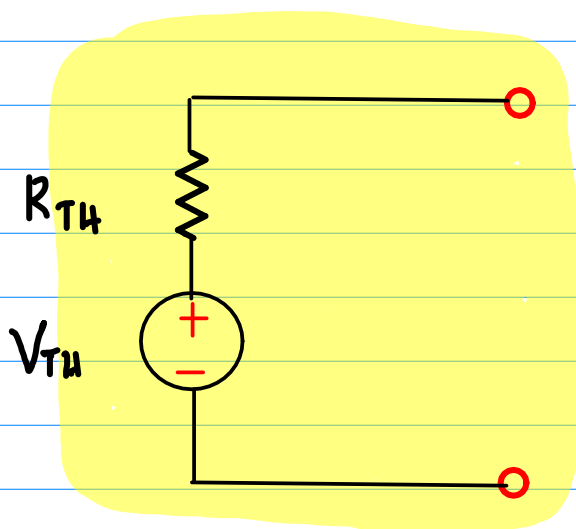
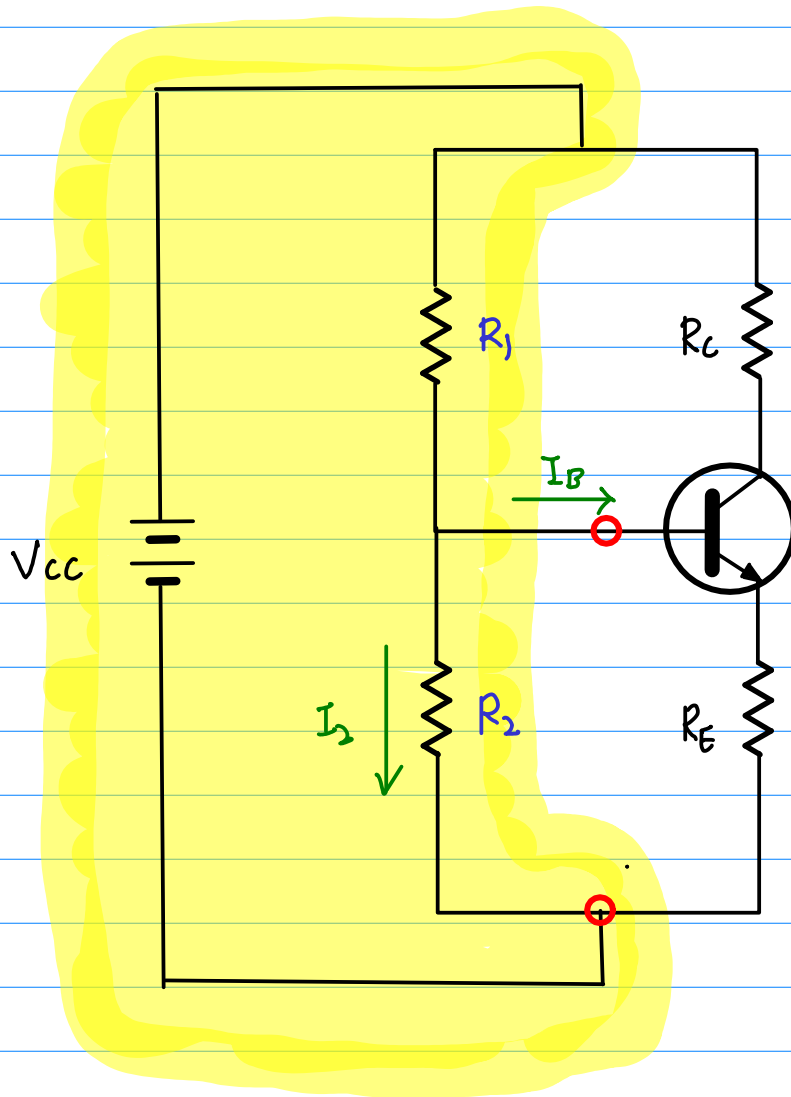


$$V_B = \frac{(R_2 \parallel \beta_{DC} R_E)}{R_1 + (R_2 \parallel \beta_{DC} R_E)} \cdot V_{CC}$$

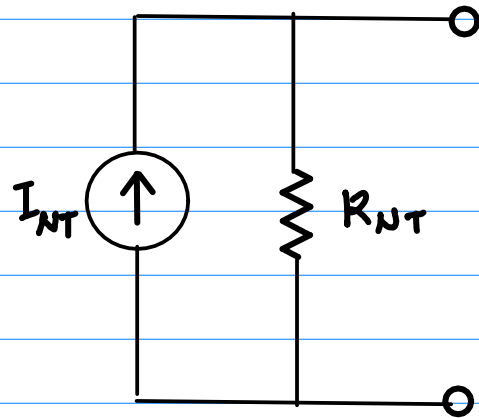
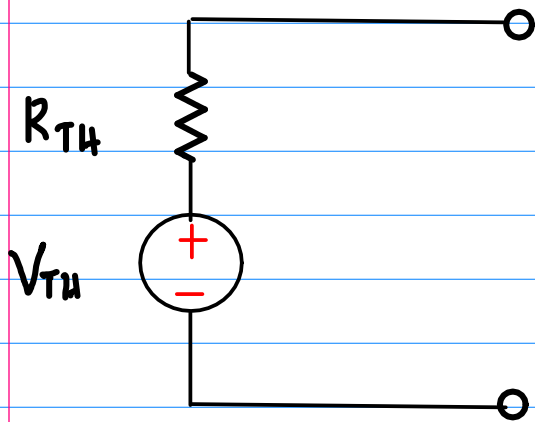
$$\approx \frac{R_2}{R_1 + R_2} \cdot V_{CC}$$

$$R_2 \ll \beta_{DC} R_E \quad (R_2 \parallel \beta_{DC} R_E) \approx R_2$$

Thevenin's Equivalent Circuit



Getting Equivalent Resistance $R_{TH} = R_{NT}$

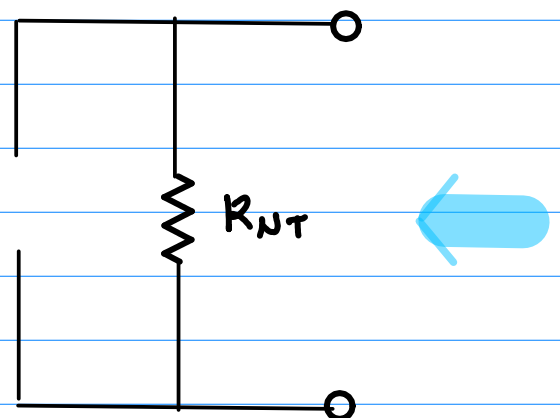
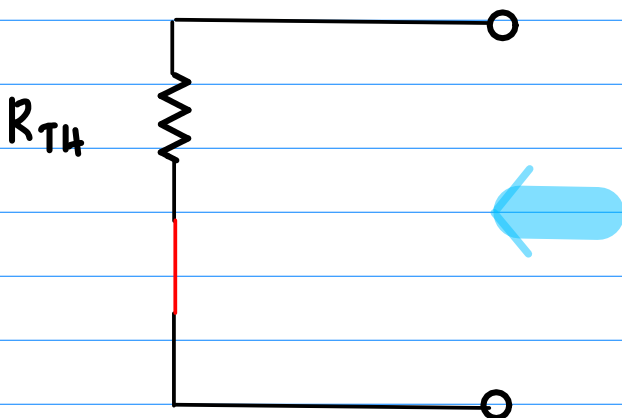


R_{TH} :

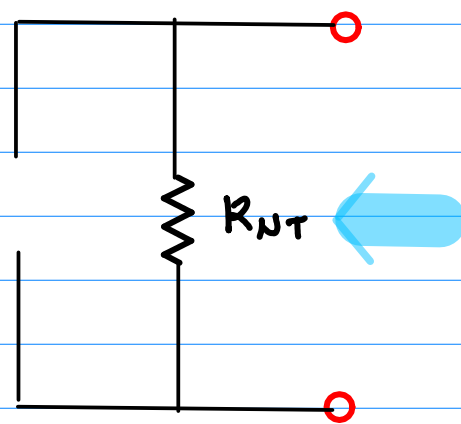
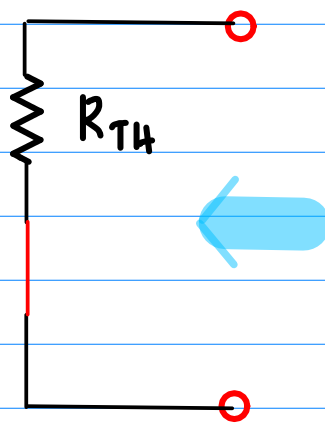
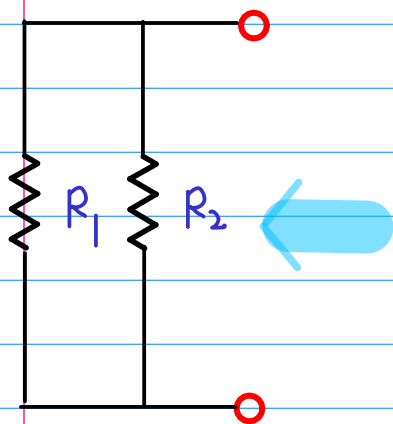
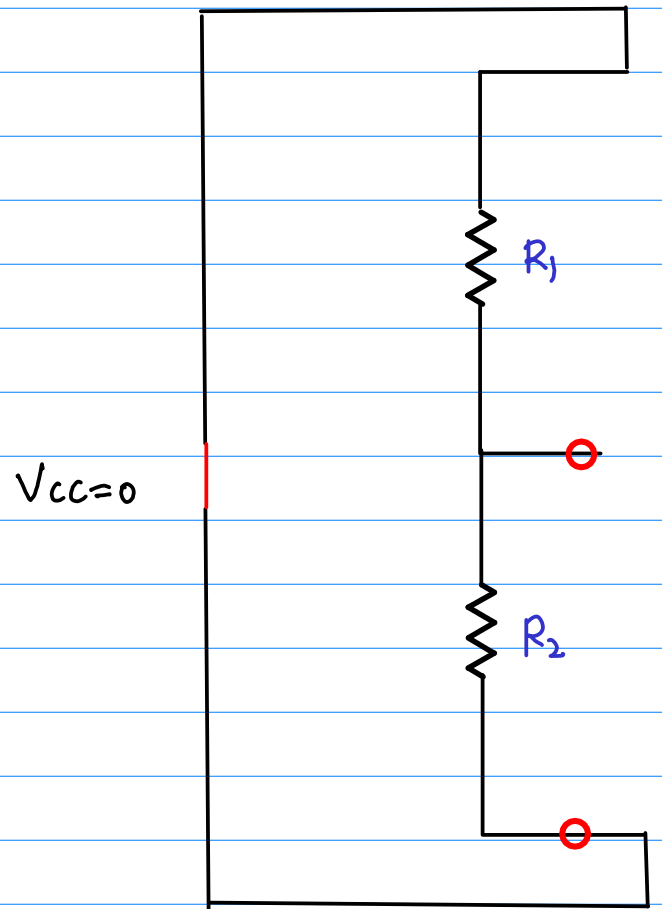
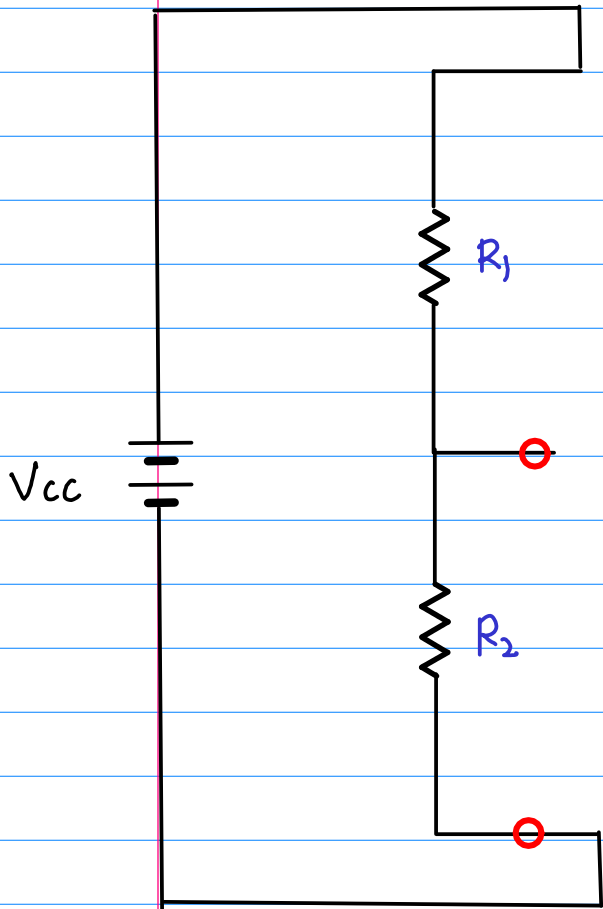
R when $V_{TH} = 0$ (short)

R_{NT} :

R when $I_{NT} = 0$ (open)



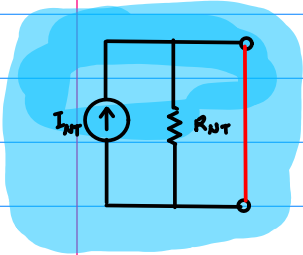
$$R_{TH} = R_{NT}$$



$$R_1 \parallel R_2 \quad \equiv \quad R_{TH} \quad \equiv \quad R_{NT}$$

Load Resistance R_L

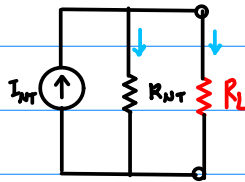
$R_L = 0$



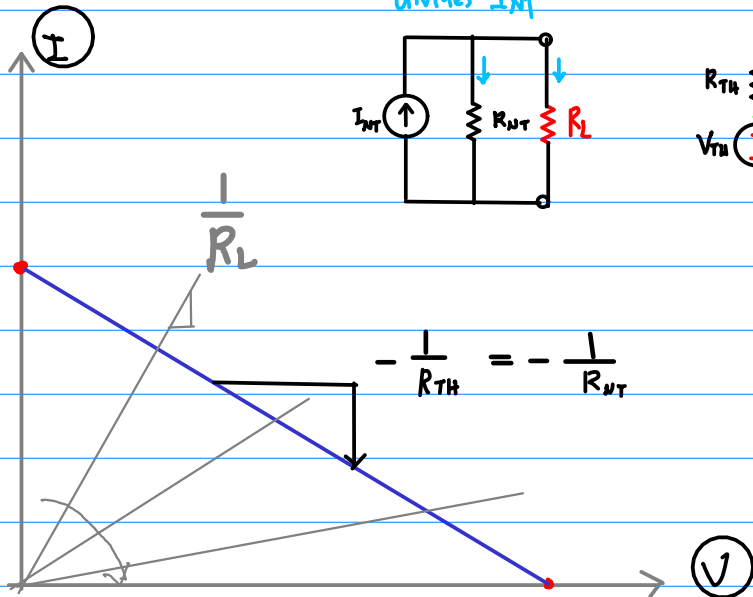
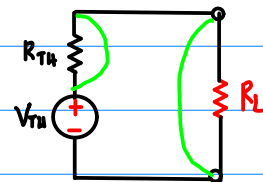
max current
 I_{NT} Short

$0 < R_L < \infty$

divides I_{NT}

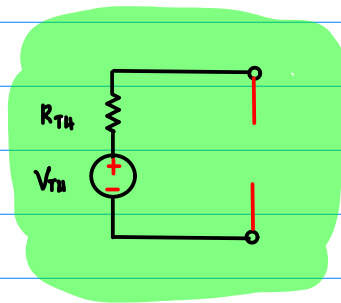


divides V_{TH}



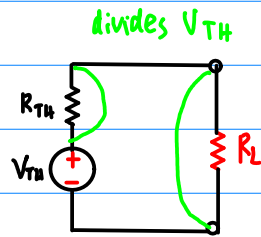
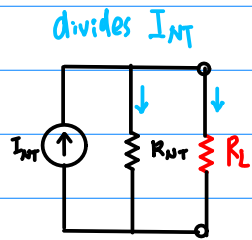
max voltage

V_{TH} Open

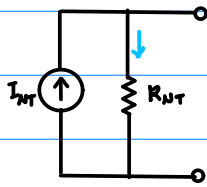


$R_L = \infty$

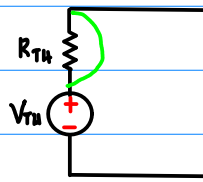
R_{TH} , R_{NT} , V_{TH} , I_{NT}



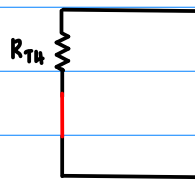
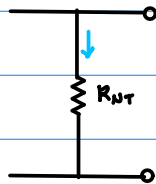
* How to get R_{NT} or R_{TH} ?



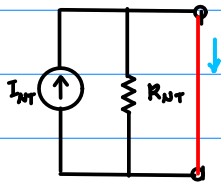
$$I_{NT} = 0$$



$$V_{TH} = 0$$



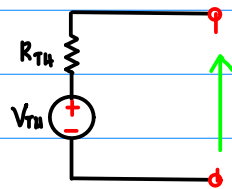
* How to get V_{TH} , I_{NT} ?



closed circuit
current

no divided current

max current

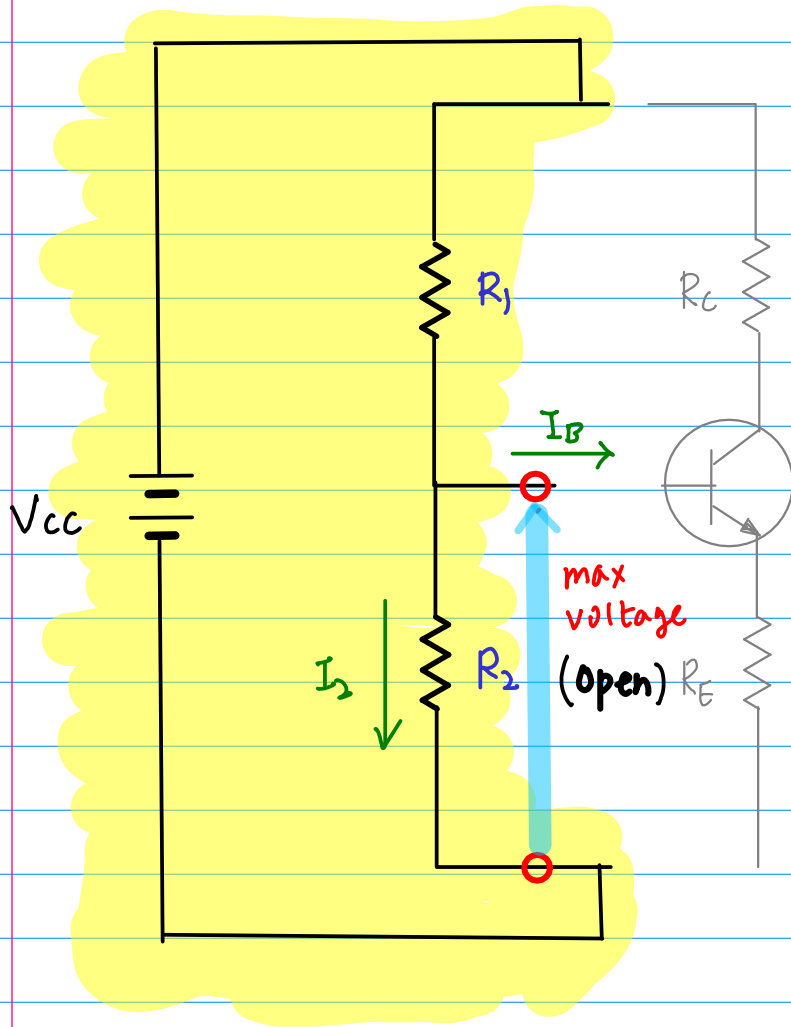


open circuit
voltage

no divided voltage

max voltage

Getting V_{TH}

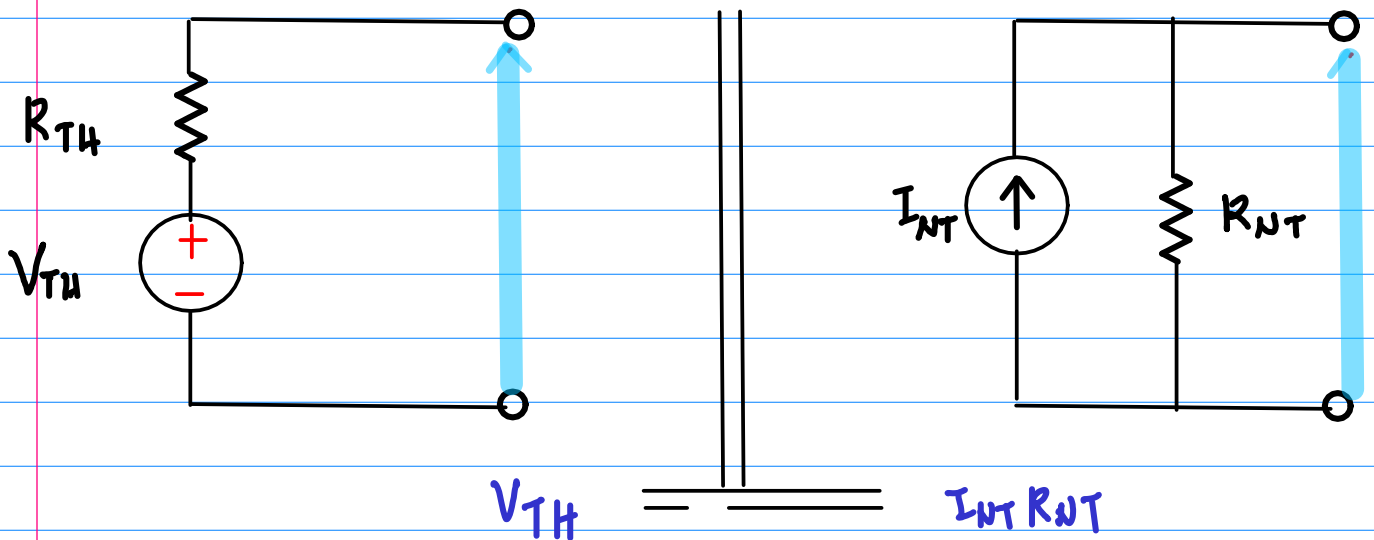


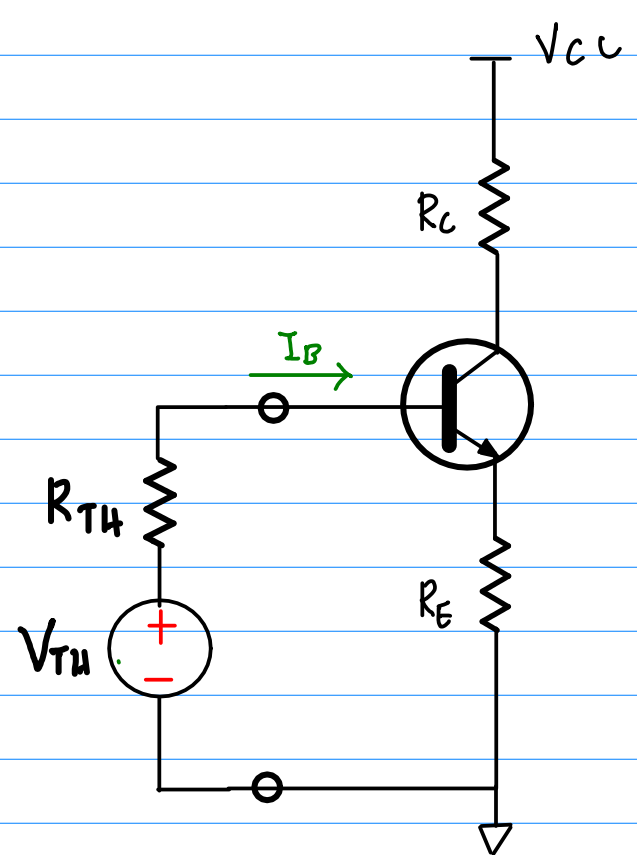
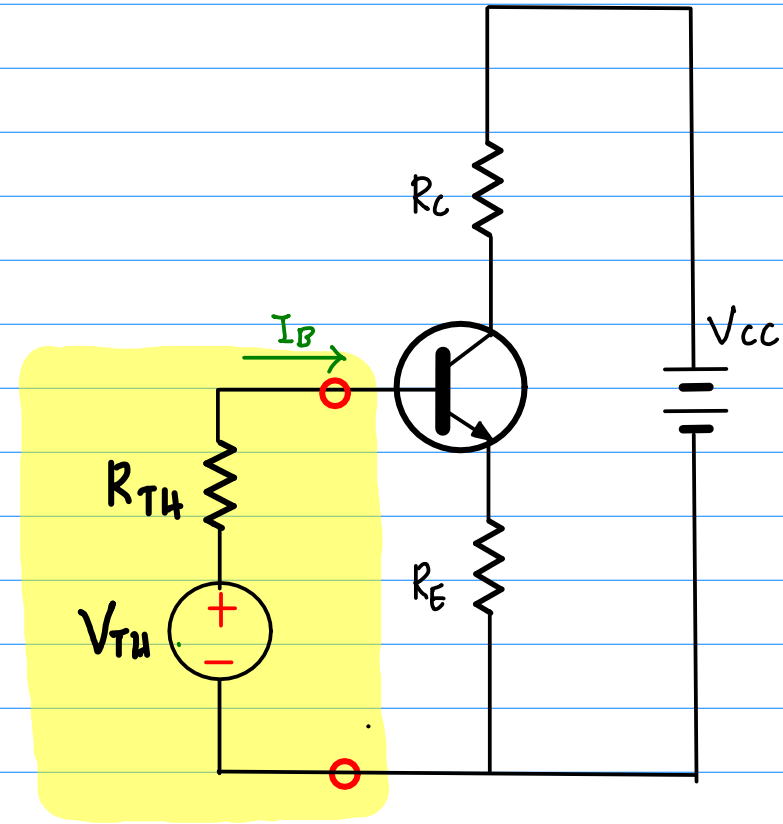
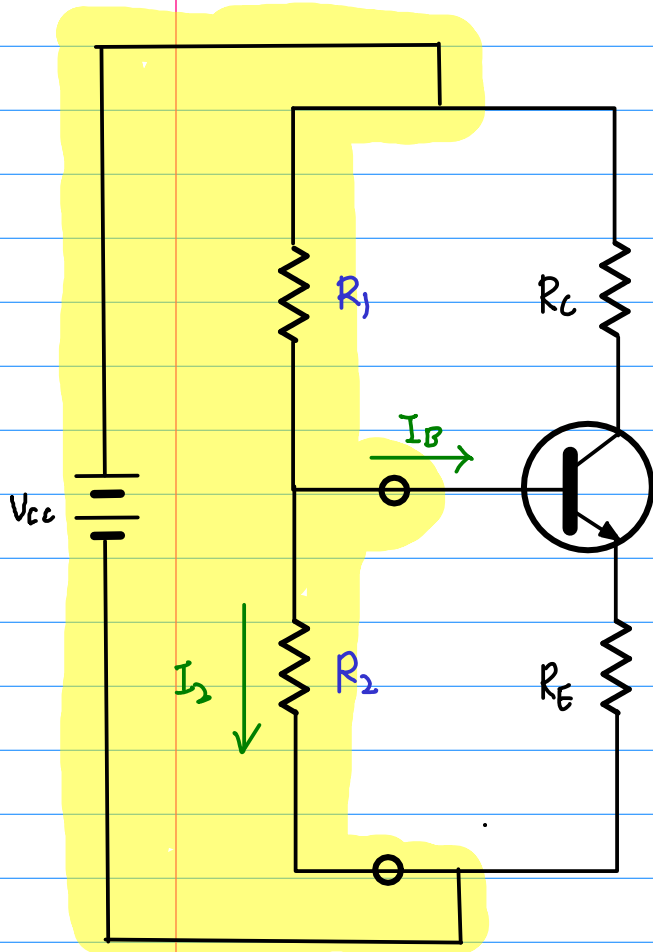
$$V_{TH} = V_{CC} \frac{R_2}{R_1 + R_2}$$

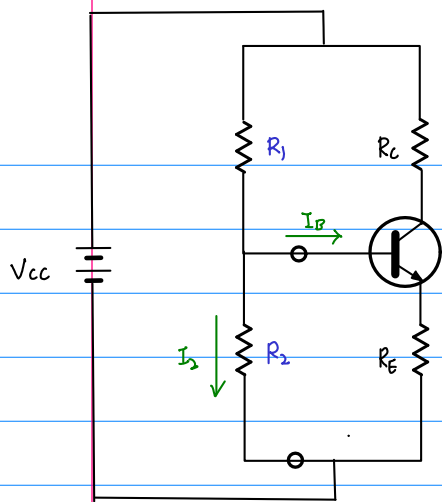
Voltage Divider

Open Circuit
Max Voltage

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

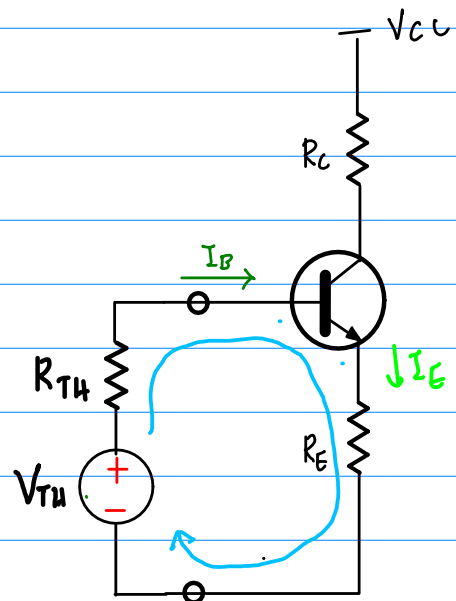






$$R_{TH} = R_1 \parallel R_2$$

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



$$V_{TH} = I_B R_{TH} + V_{BE} + I_E R_E$$

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

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

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

$$I_E = (\beta + 1) \frac{V_{TH} - V_{BE}}{R_{TH} + (\beta + 1) R_E}$$

$$= \frac{(\beta + 1)}{(\beta + 1)} \frac{V_{TH} - V_{BE}}{\left(\frac{R_{TH}}{(\beta + 1)} + R_E \right)}$$

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

$$\approx \frac{V_{TH} - V_{BE}}{R_E + \frac{R_{TH}}{\beta}}$$

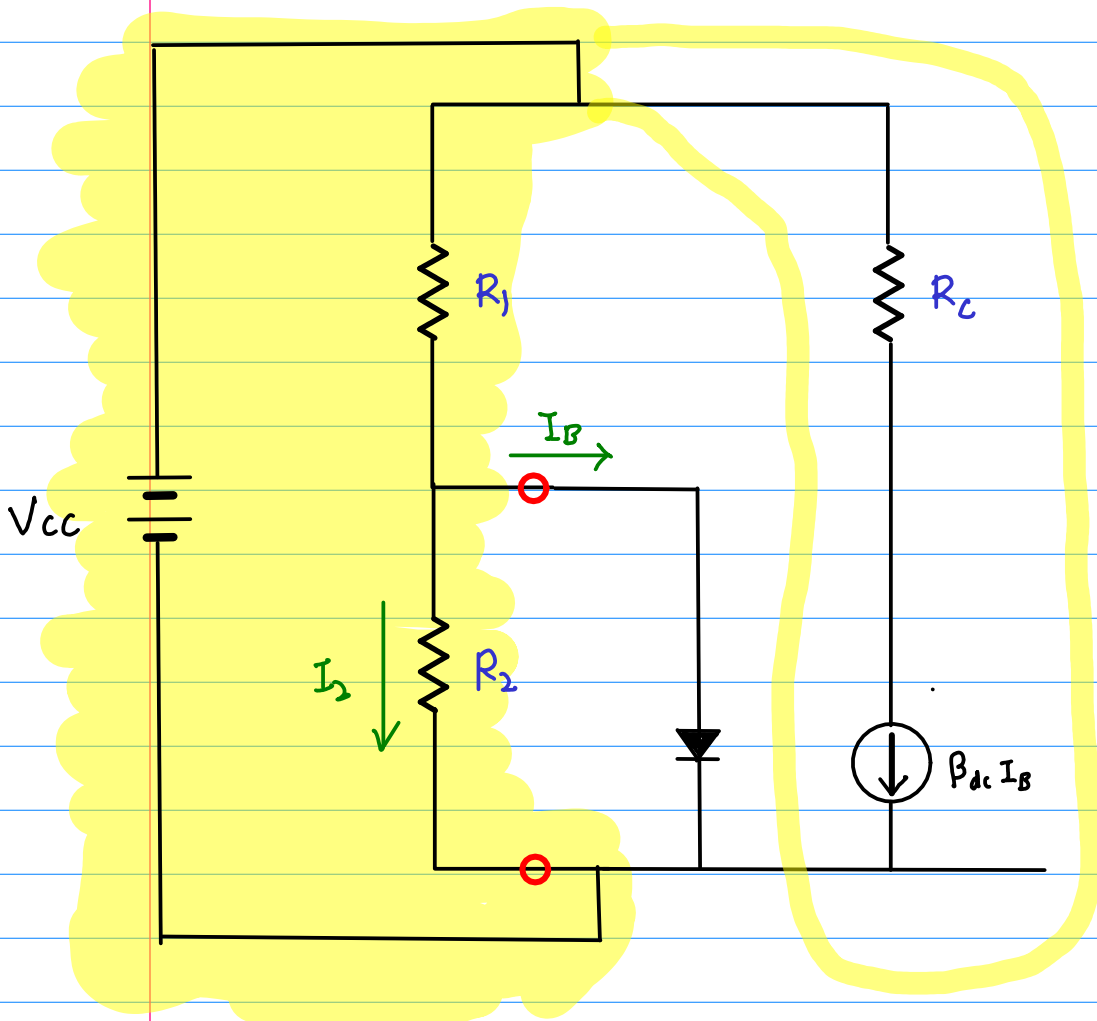
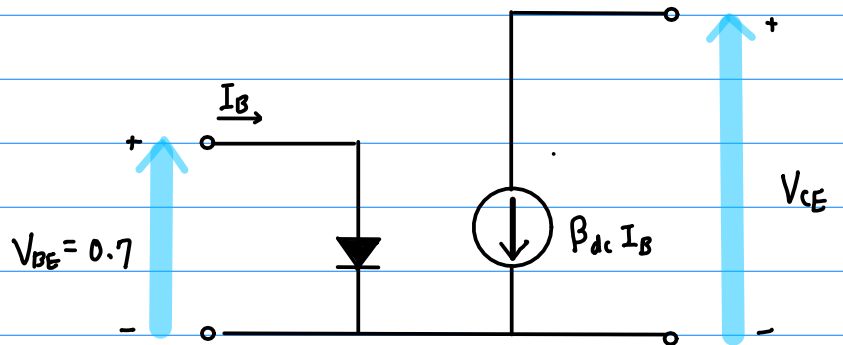
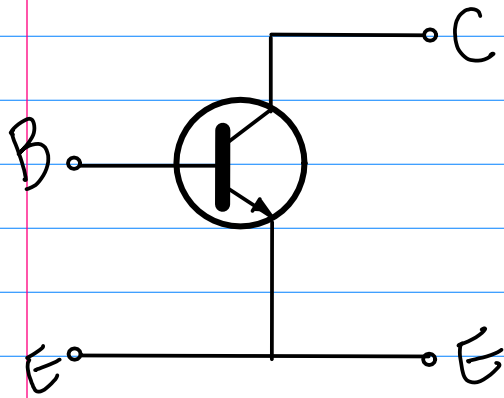
$$\frac{1}{200+1} = \frac{1}{200}$$

$$I_E = (\beta + 1) I_B = 201 \cdot I_B$$

$$I_C = \beta I_B = 200 \cdot I_B$$

$$I_E \cong I_C$$

$$\frac{1}{201} \cong \frac{1}{200}$$



does not affect

R_{TH}
(current source)
→ open

nor V_{TH}

Open Emitter Resistor

