BJT Bias
Voltage Divider Bias (H.5)

20170422

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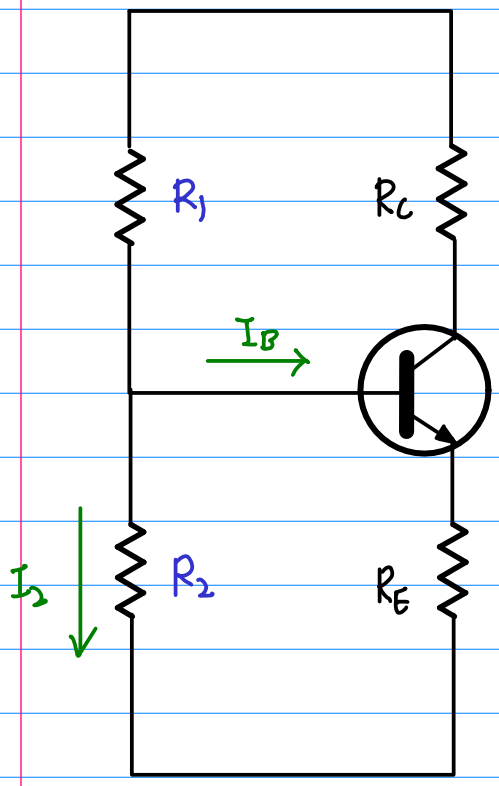
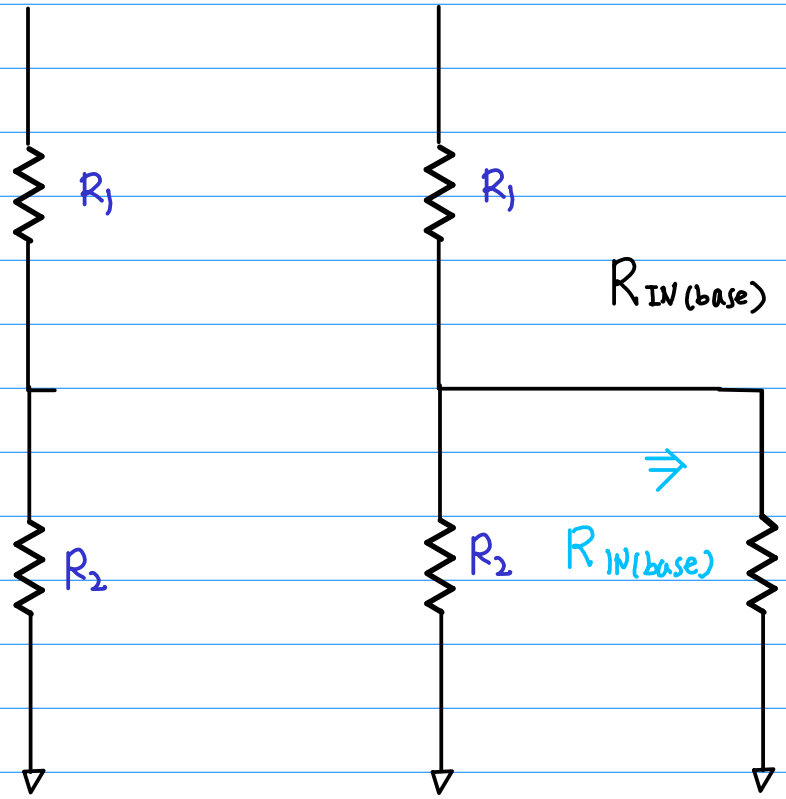
References

Based

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

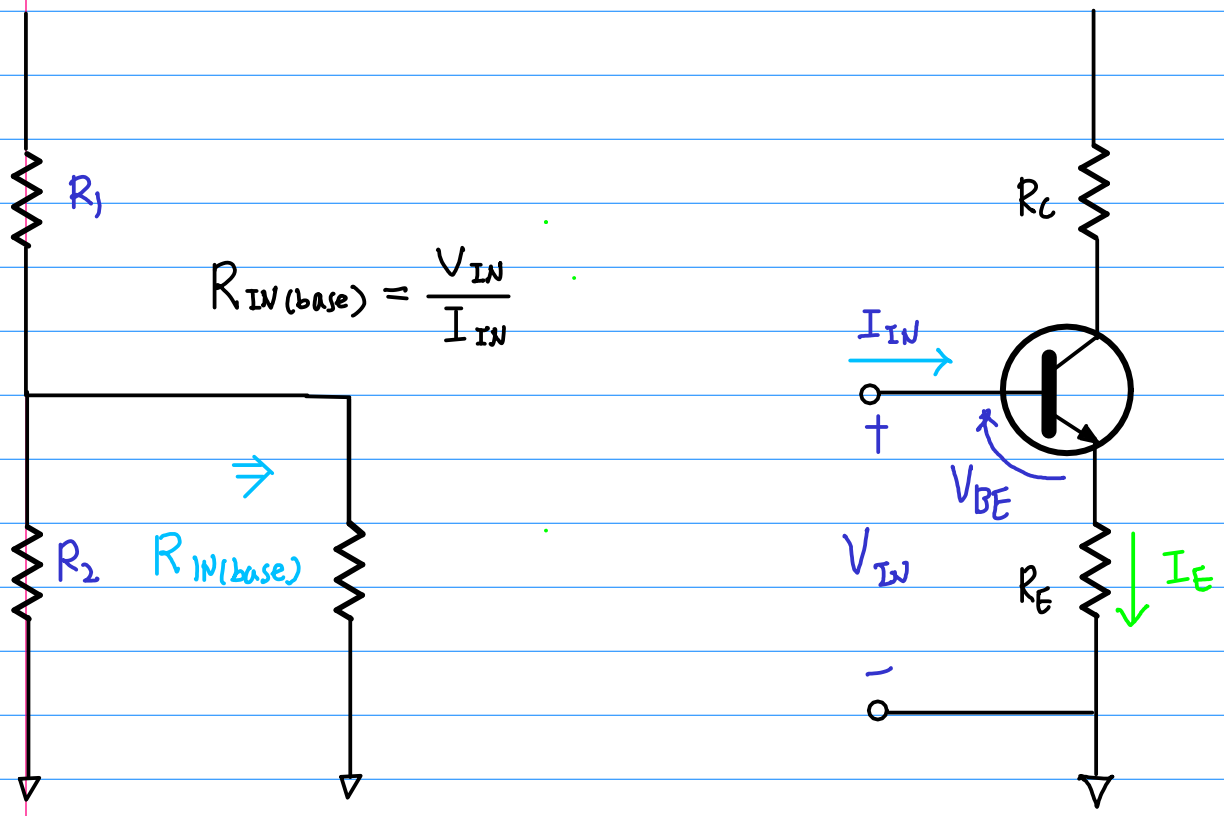
[2] en.wikipedia.org





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

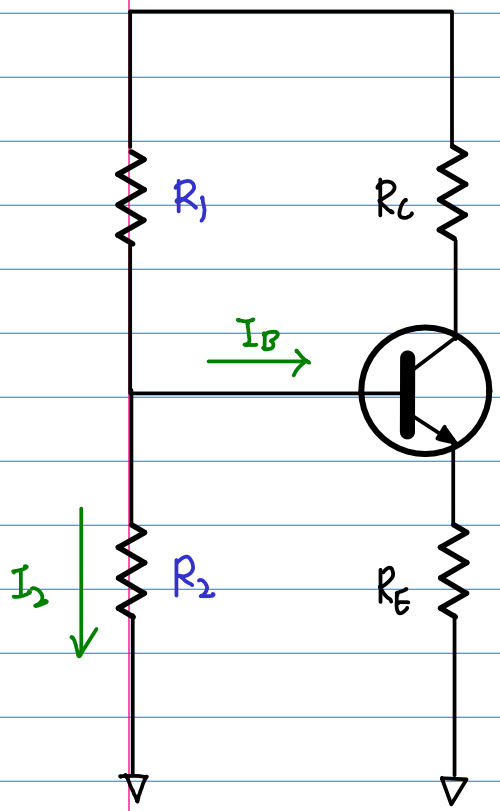
$\Rightarrow$

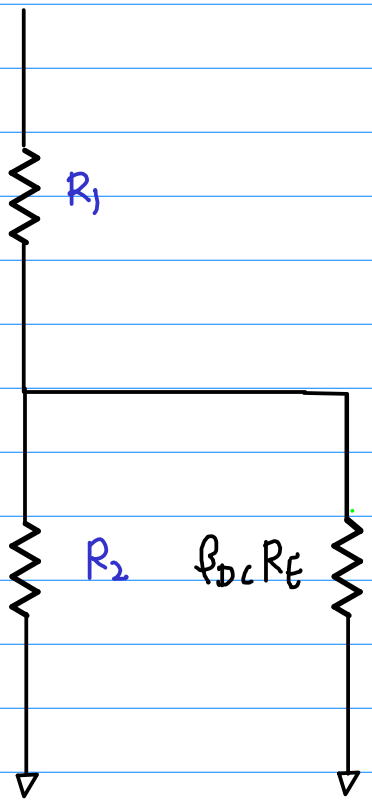


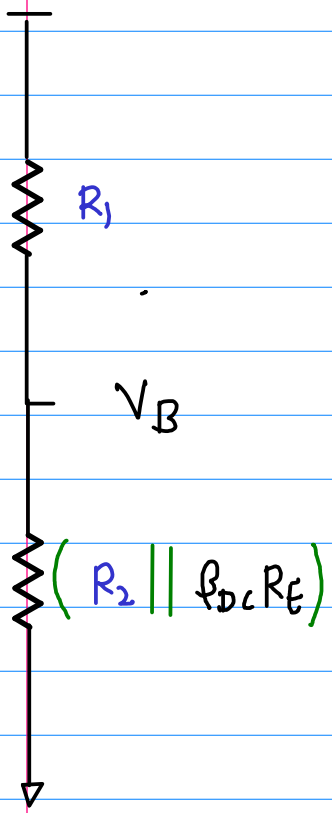
$$R_{IN(base)} = \frac{V_{IN}}{I_{IN}}$$

$$V_{IN} = V_{BE} + I_E R_E$$
$$\cong I_E R_E$$
$$\cong \beta_{DC} I_B R_E$$

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





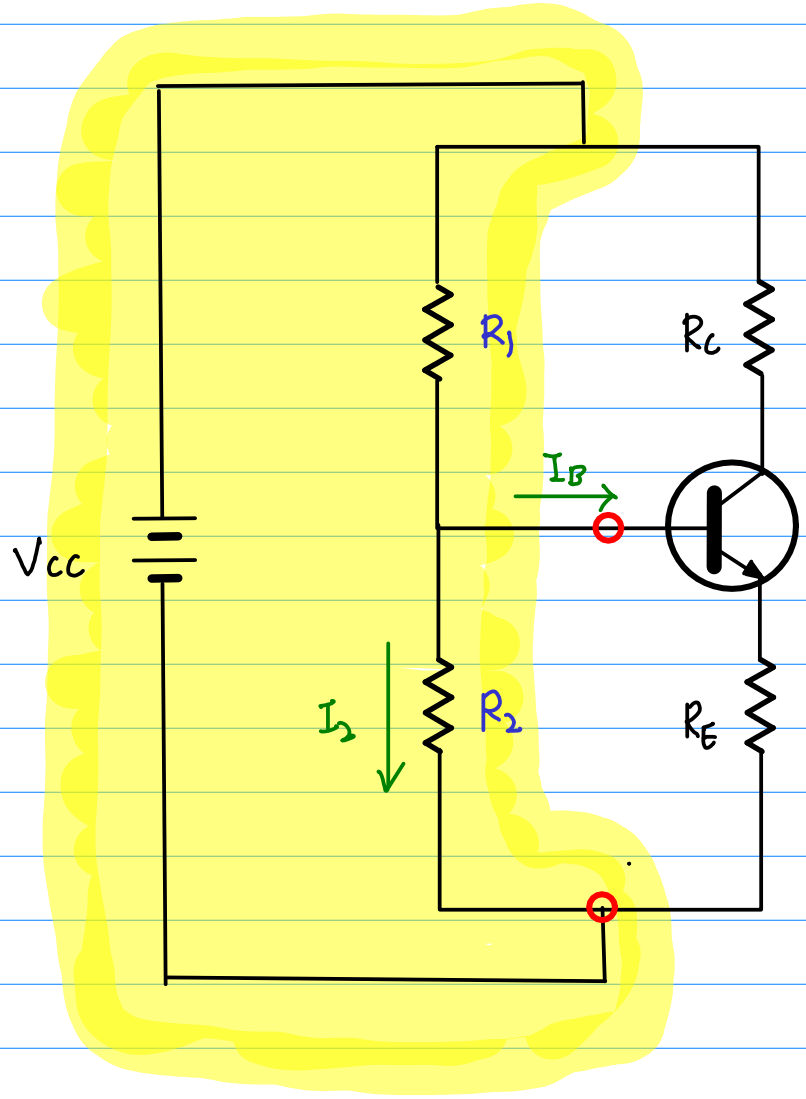


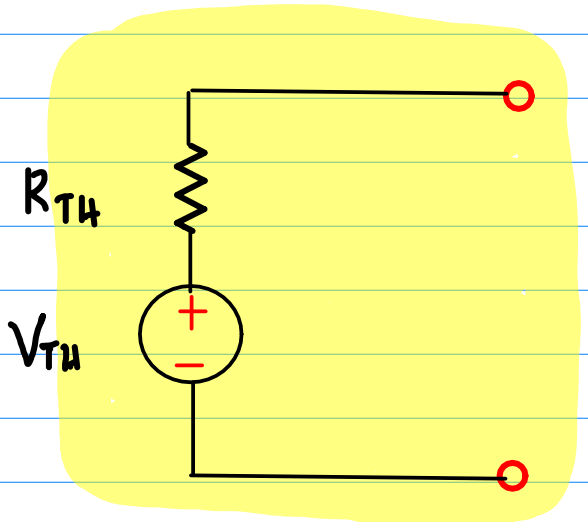
$$V_B = \frac{(R_2 \| \beta_{DC} R_E)}{R_1 + (R_2 \| \beta_{DC} R_E)} \cdot V_{CC}$$

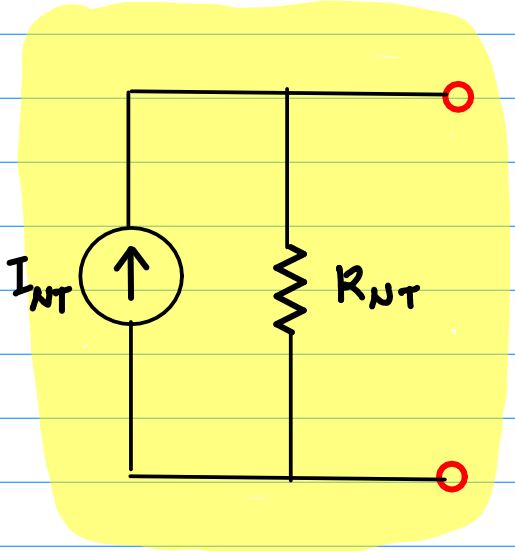
$$\approx \frac{R_2}{R_1 + R_2} \cdot V_{CC}$$

$R_2 \ll \beta_{DC} R_E \qquad (R_2 \| \beta_{DC} R_E) \approx R_2$

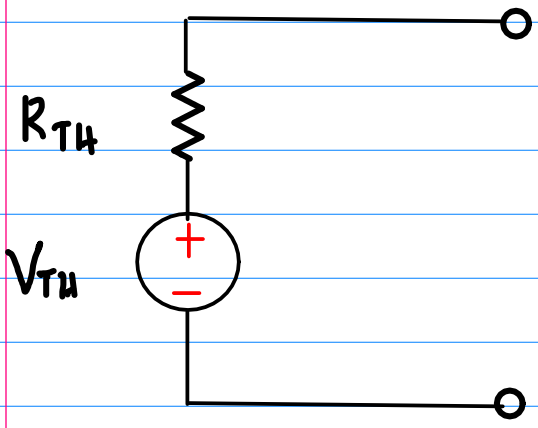
Thevenin's Equivalent Circuit

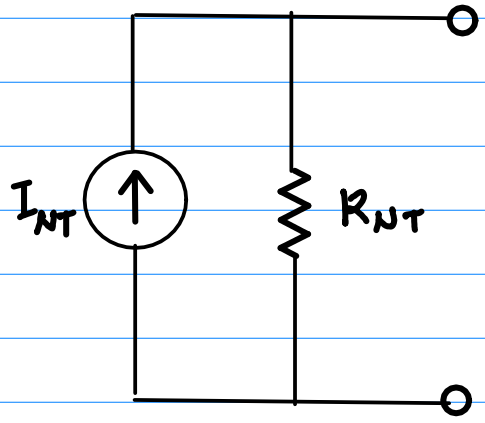






Getting Equivalent Resistance $R_{TH} = R_{NT}$



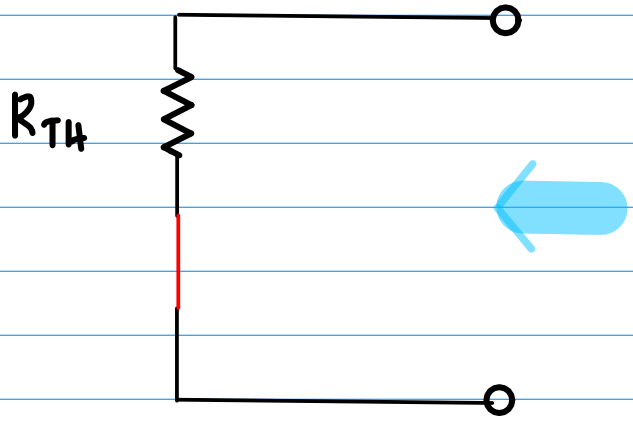


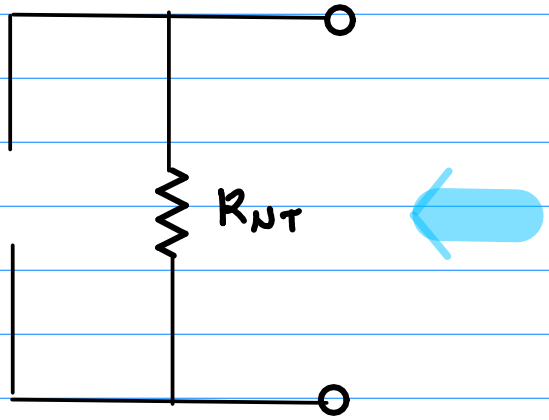
R_{TH} :

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

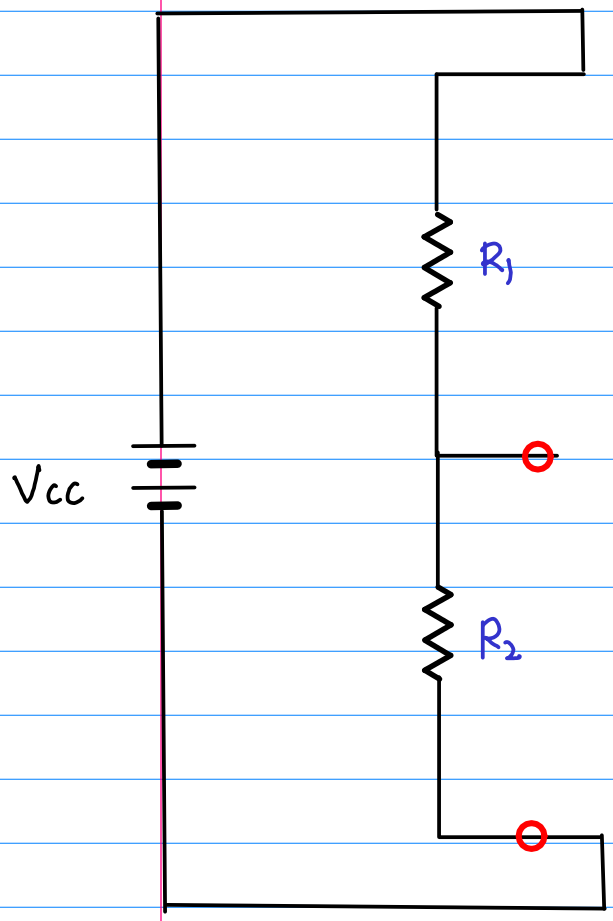
R_{NT} :

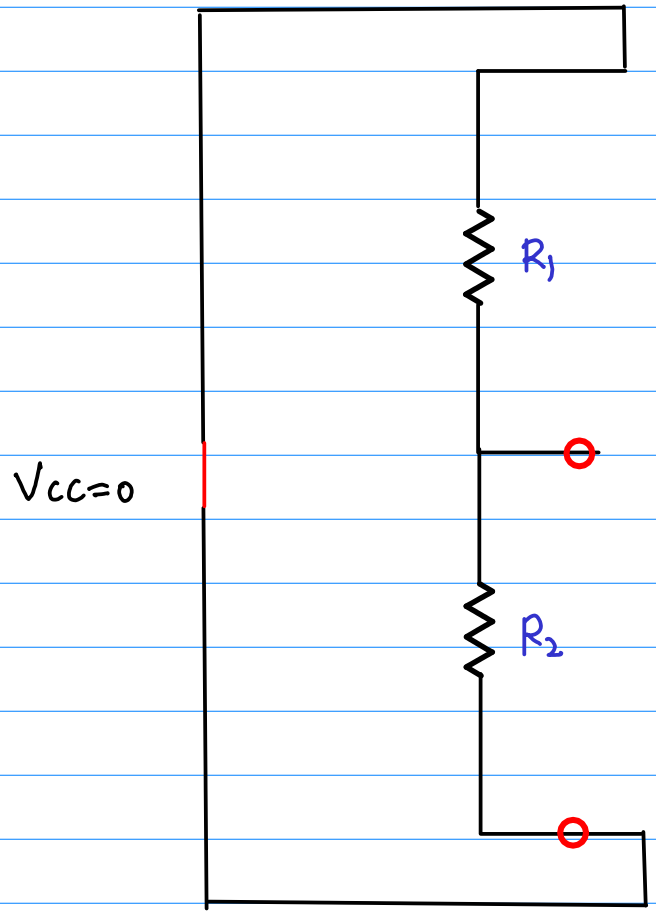
R when $I_{NT} = 0$ (open)

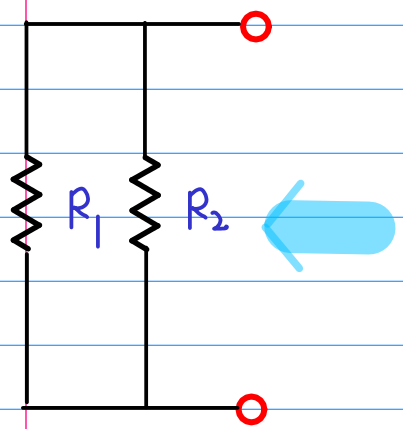


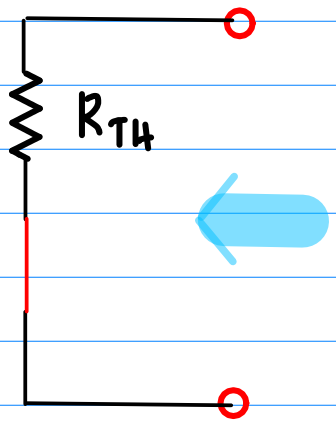


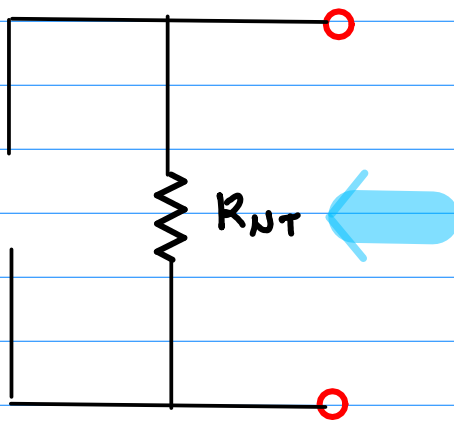
$$R_{TH} = R_{NT}$$







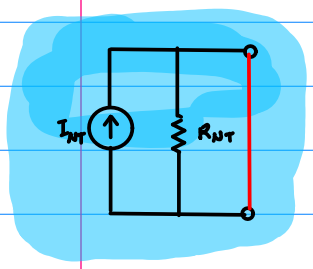




$R_1 \parallel R_2 = R_{TH} = R_{NT}$

Load Resistance R_L

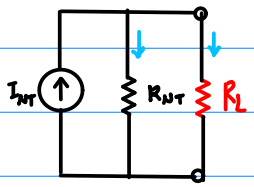
$R_L = 0$



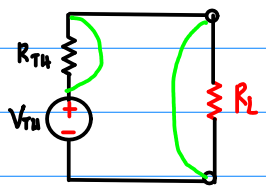
max current
I_{NT} · short

$0 < R_L < \infty$

divides I_{NT}

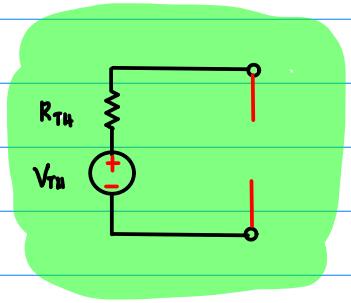


divides V_{TH}



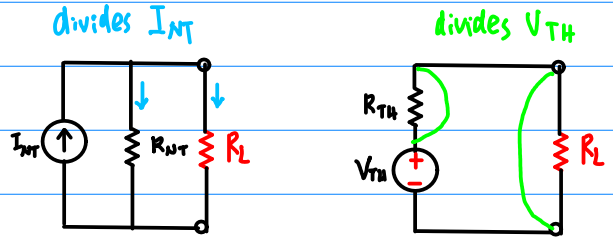
$$-\frac{1}{R_{TH}} = -\frac{1}{R_{NT}}$$

max voltage
V_{TH} open

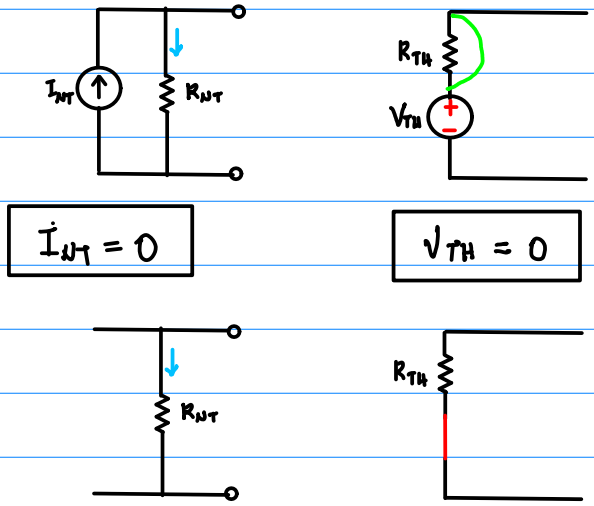


$R_L = \infty$

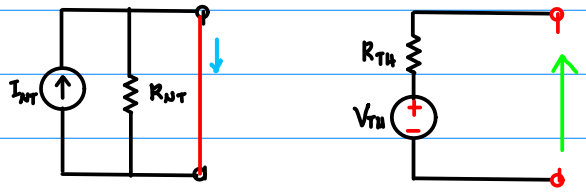
R_{TH}, R_{NT}, V_{TH}, I_{NT}



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



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



Closed circuit current

no divided current

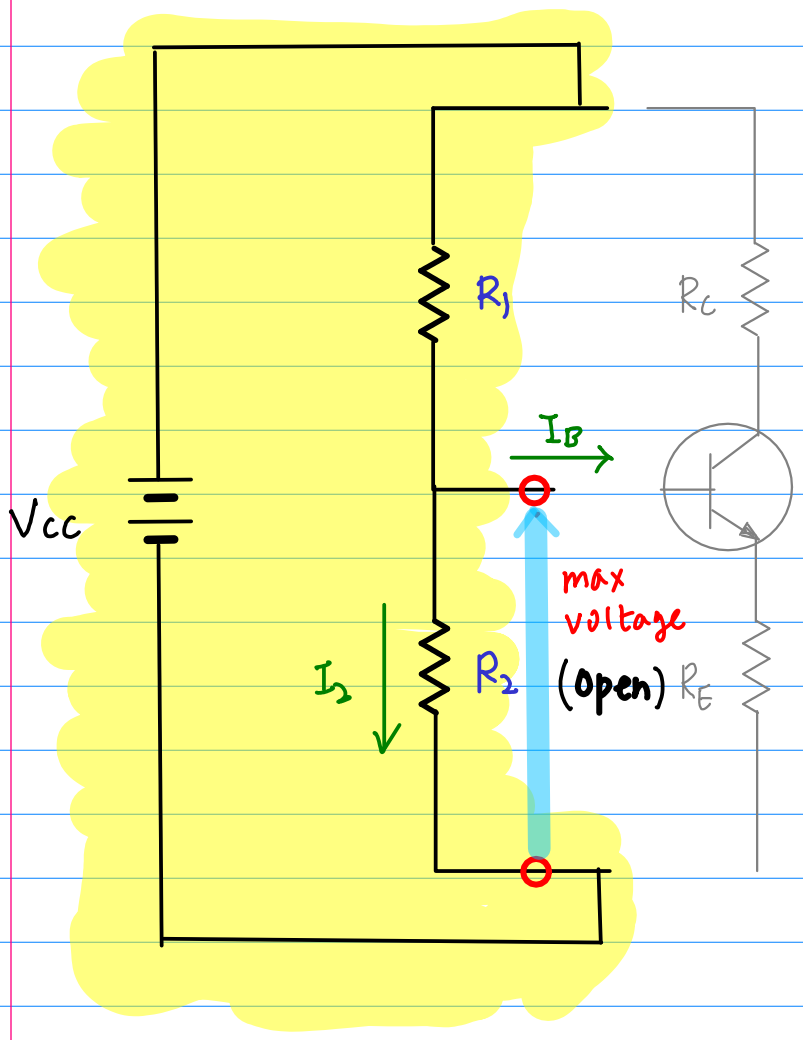
max current

Open circuit voltage

no divided voltage

max voltage.

Getting V_{TH}

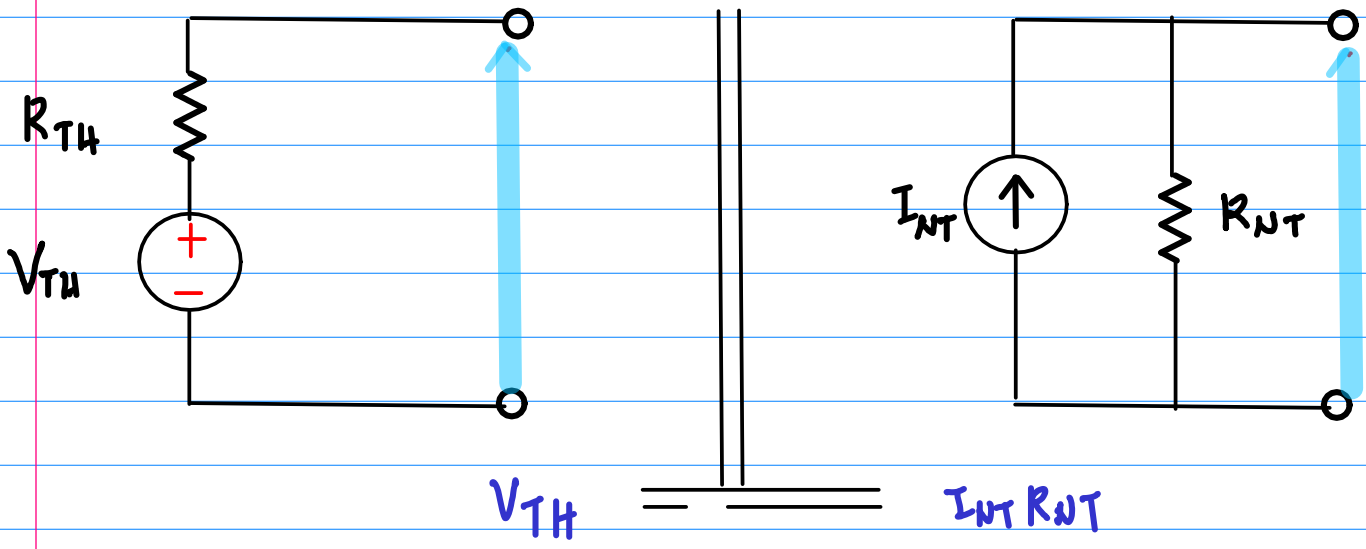


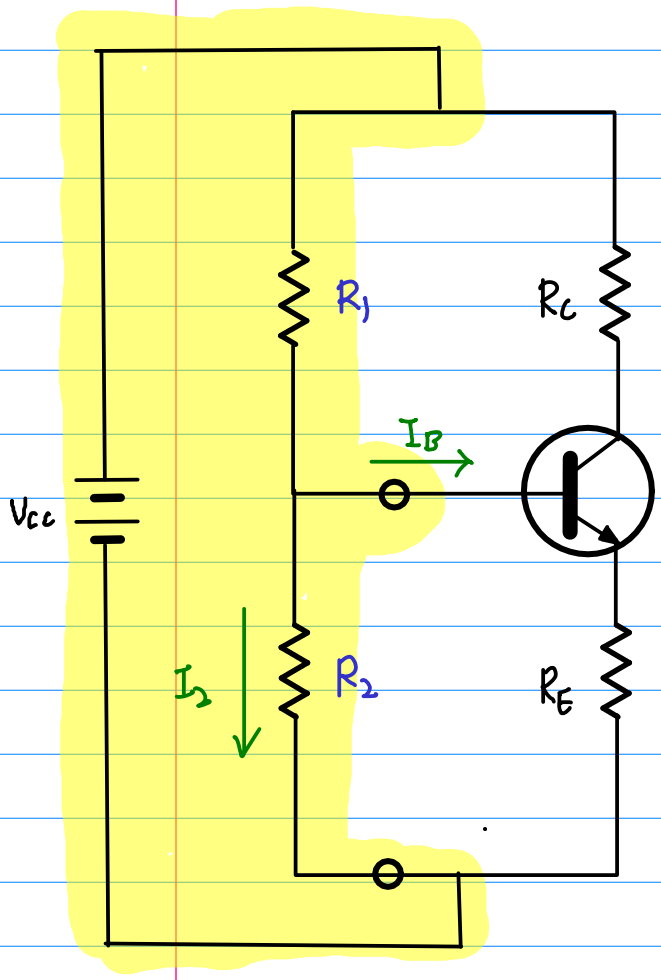
$$V_{TH} = V_{CC} \frac{R_2}{R_1 + R_2}$$

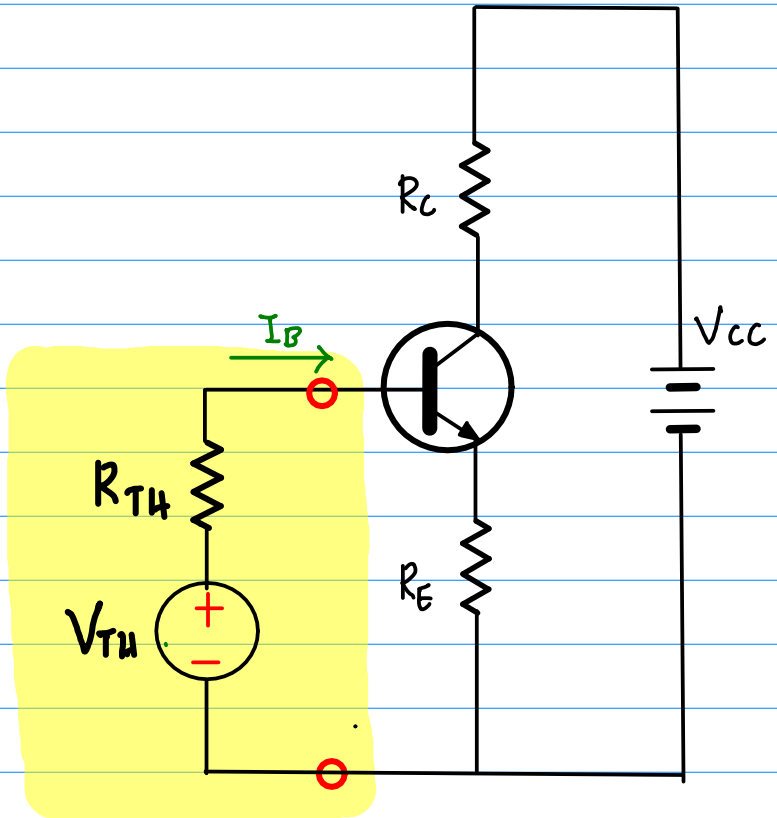
Voltage Divider

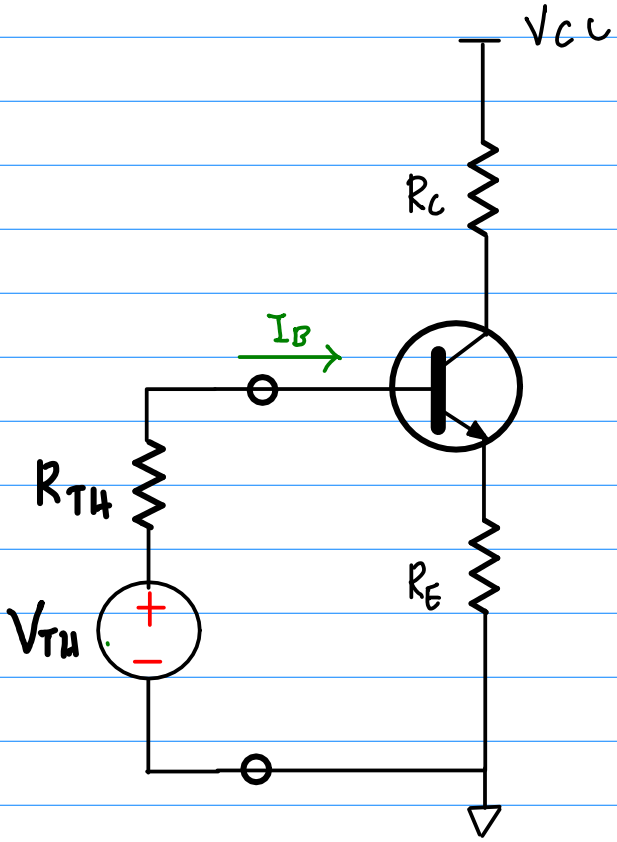
Open Circuit
Max Voltage

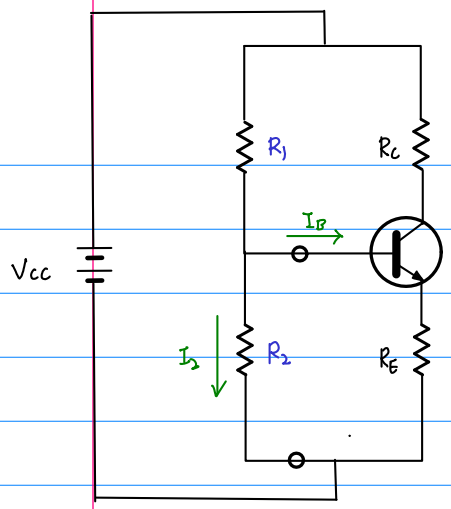
$$V_{TH} = V_{CC} \frac{R_2}{R_1 + R_2}$$

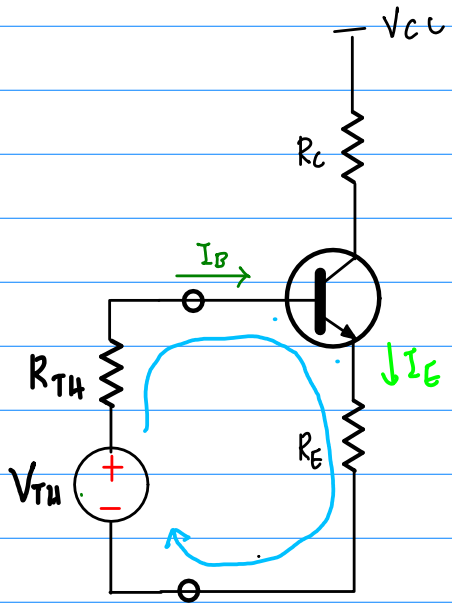



R_1
R_C
I_B
V_{CC}
I_2
R_2
R_E


R_C
I_B
V_{CC}
R_{TH}
V_{TH}
R_E


V_{CC}
R_C
I_B
R_{TH}
V_{TH}
R_E





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

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

$$V_{TH} \simeq I_B R_{TH} + V_{BE} + I_E R_E$$

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

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

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

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

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

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

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

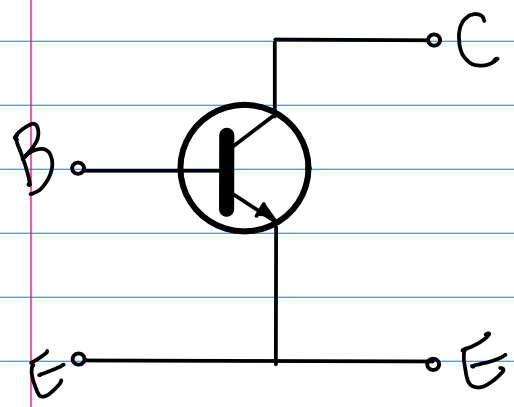
$$\frac{1}{200+1} = \frac{1}{200}$$

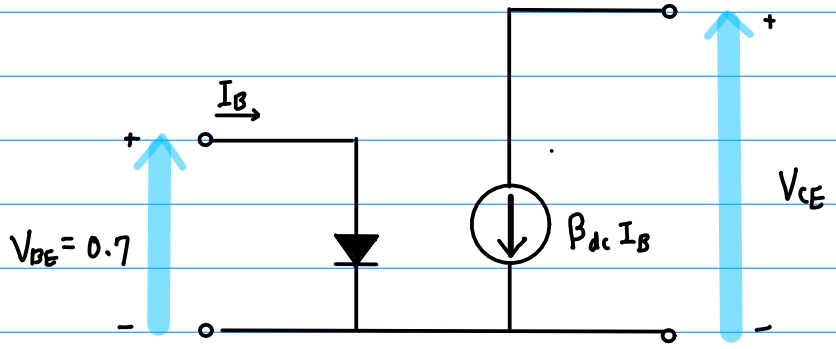
$$I_E = (\beta+1) I_B = 201 \cdot I_B$$

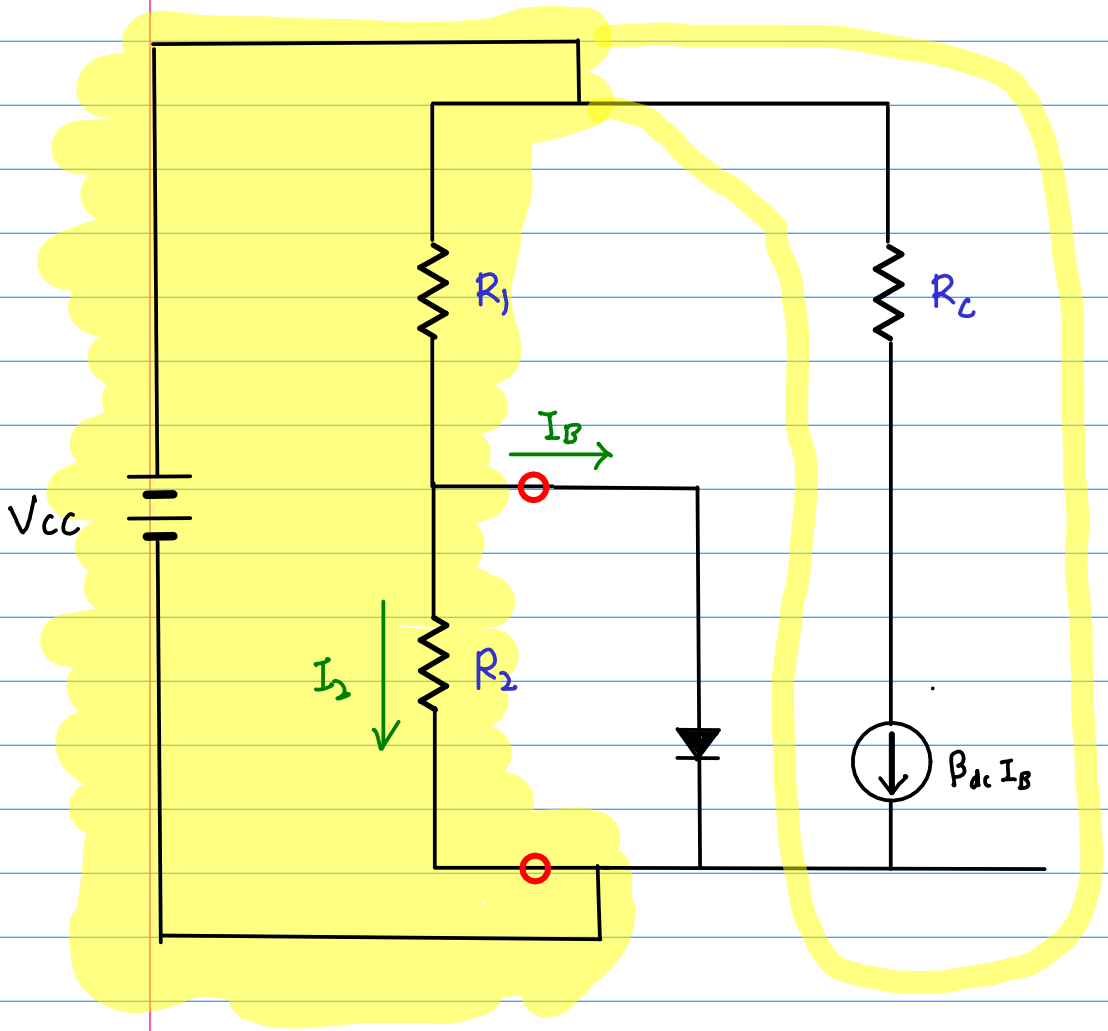
$$I_C = \beta I_B = 200 \cdot I_B$$

$$I_E \cong I_C$$

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







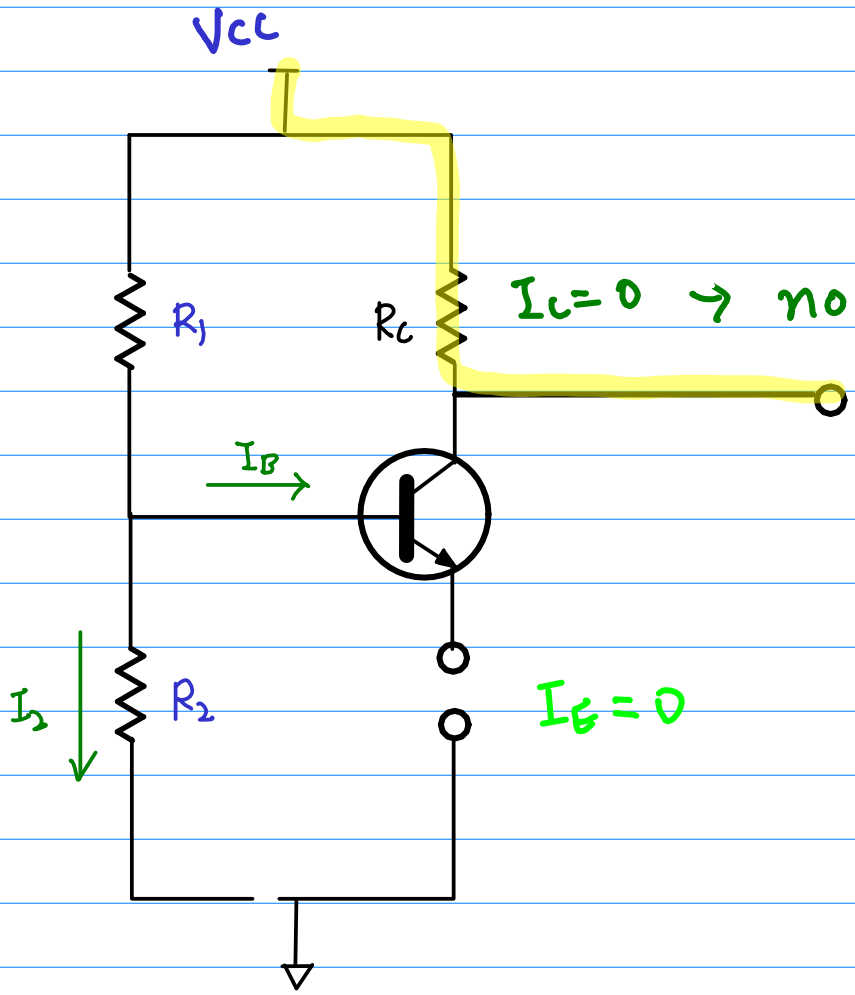
does not affect

R_{TH}

(current source → open)

nor V_{TH}

Open Emitter Resistor



$I_C = 0$ → no voltage drop

open circuit voltage → Vcc (High)