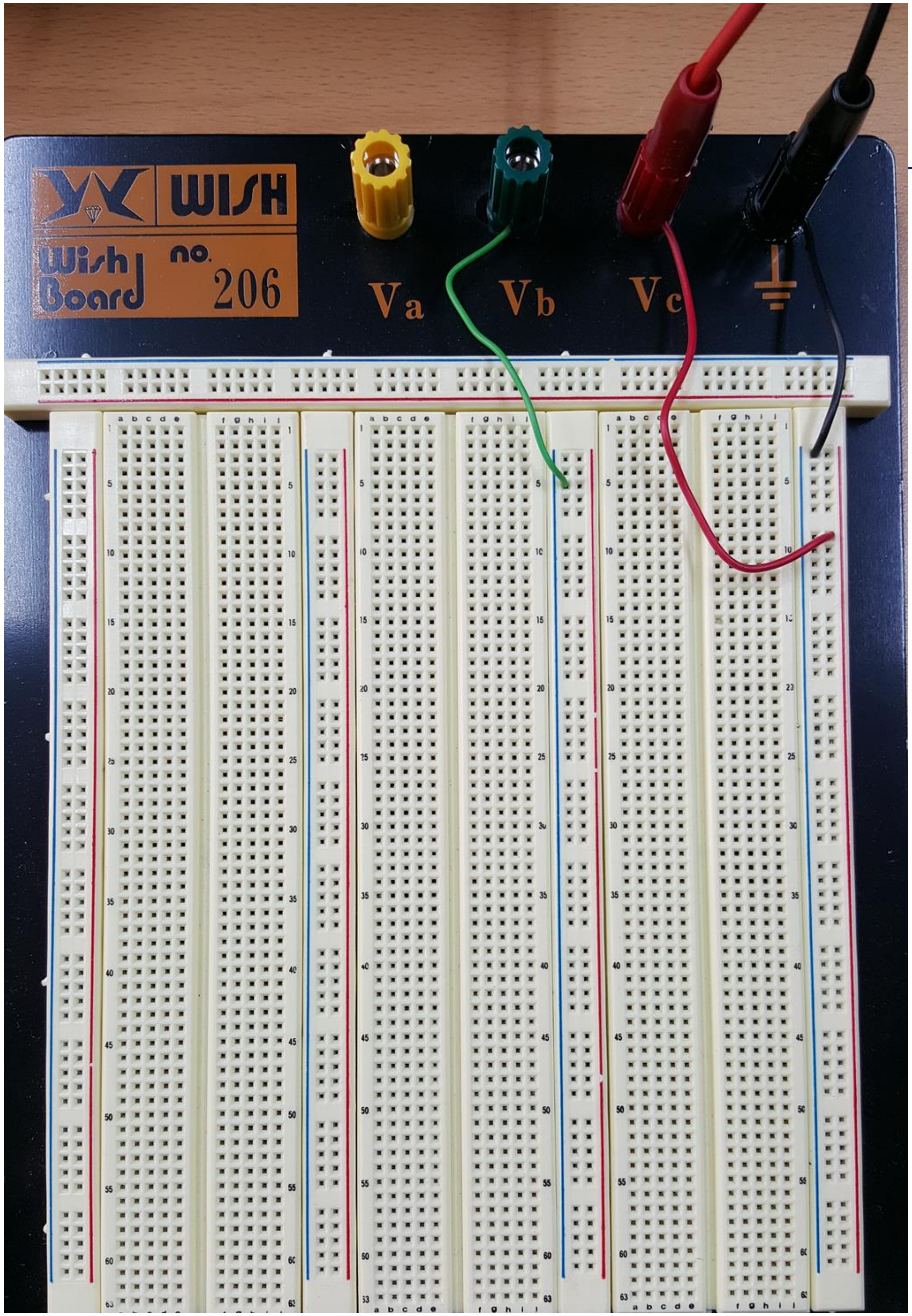
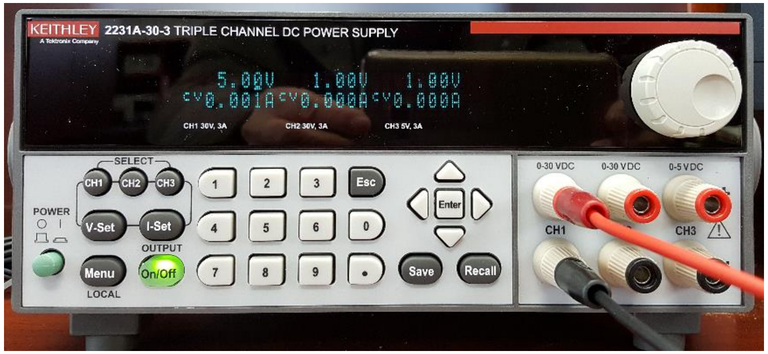
Optoelectronics Lab

Series & Parallel Resistors

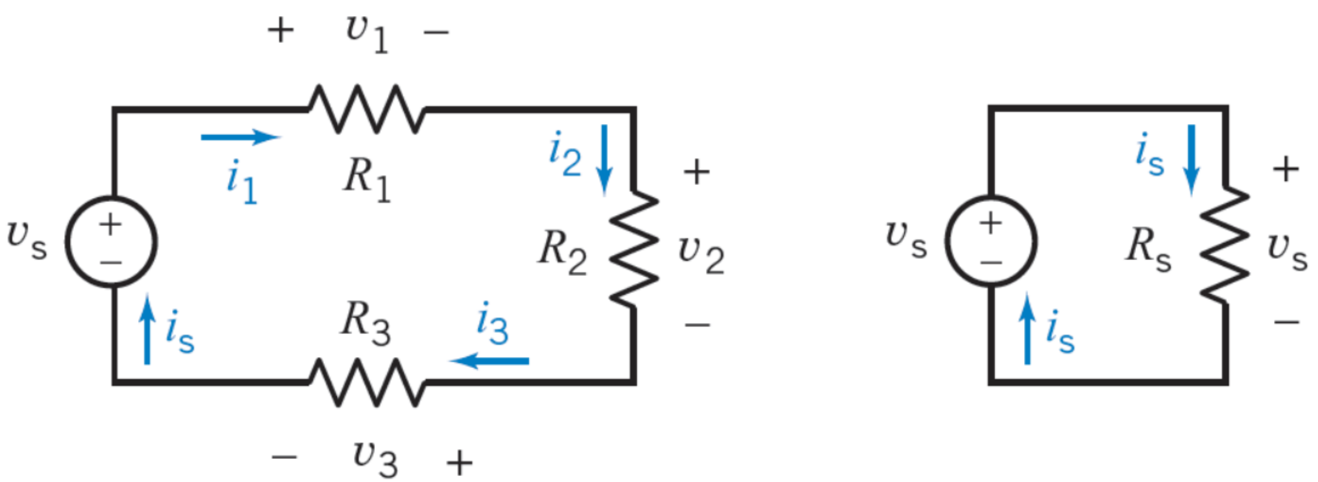
Thevenin's Theorem

Breadboard


WISH
Wish Board no. 206
Va
Vb
Vc


KEITHLEY
2231A-30-3 TRIPLE CHANNEL DC POWER SUPPLY
SELECT
CH1
CH2
CH3
V-Set
I-Set
OUTPUT
On/Off
Menu
LOCAL
POWER
Esc
Enter
Save
Recall
0-30 VDC
0-30 VDC
0-5 VDC
CH1
CH3

Series Resistors



$$v_1 + v_2 + v_3 - v_s = 0$$

$$R_1 i_1 + R_2 i_2 + R_2 i_3 - v_s = 0 \Rightarrow R_1 i_1 + R_2 i_1 + R_2 i_1 = v_s$$

$$i_1 = \frac{v_s}{R_1 + R_2 + R_3}$$

$$i_s = \frac{v_s}{R_1 + R_2 + R_3}$$

$$i_s = \frac{v_s}{R_s}$$

$$R_s = R_1 + R_2 + R_3$$

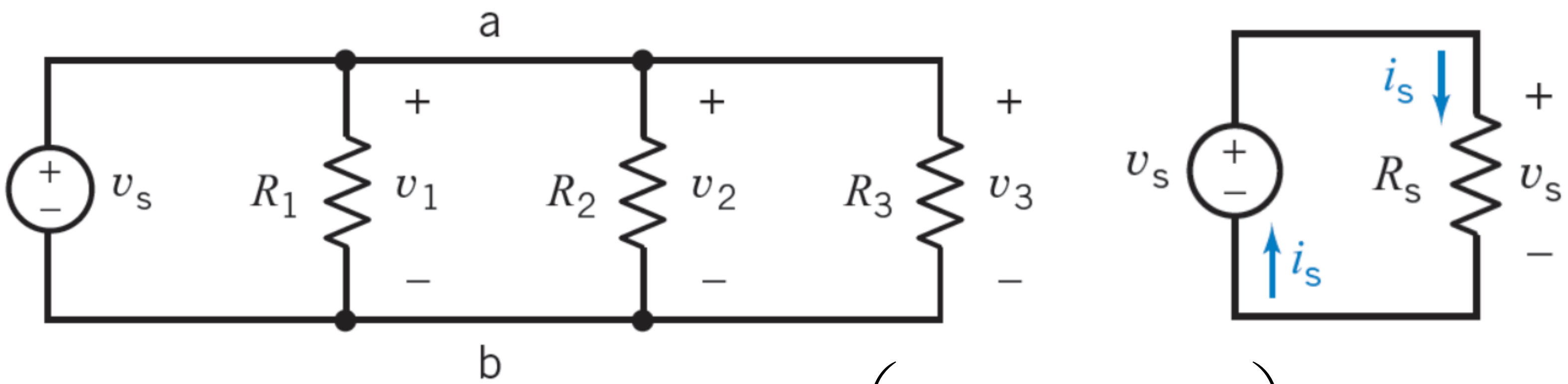
Voltage Division

$$v_1 = R_1 i_S = \frac{R_1}{R_1 + R_2 + R_3} v_S$$

$$v_2 = R_2 i_S = \frac{R_2}{R_1 + R_2 + R_3} v_S$$

$$v_3 = R_3 i_S = \frac{R_3}{R_1 + R_2 + R_3} v_S$$

Parallel Resistors



$$i_S = i_1 + i_2 + i_3 = \frac{v_S}{R_1} + \frac{v_S}{R_2} + \frac{v_S}{R_3} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right) v_S$$

$$i_S = \left(\frac{1}{R_S} \right) v_S$$

$$\frac{1}{R_S} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \Rightarrow R_S = \frac{1}{\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right)}$$

Current Division

$$i_1 = \frac{v_S}{R_1} = \frac{1}{R_1} R_S i_S = \frac{\frac{1}{R_1}}{\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)} i_S$$

$$i_2 = \frac{v_S}{R_2} = \frac{1}{R_2} R_S i_S = \frac{\frac{1}{R_2}}{\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)} i_S$$

$$i_3 = \frac{v_S}{R_3} = \frac{1}{R_3} R_S i_S = \frac{\frac{1}{R_3}}{\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)} i_S$$

$$\frac{1}{R_S} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow R_S = \frac{1}{\left(\frac{1}{R_1} + \frac{1}{R_2}\right)} = \frac{R_1 R_2}{R_1 + R_2}$$

Thevenin's Theorem

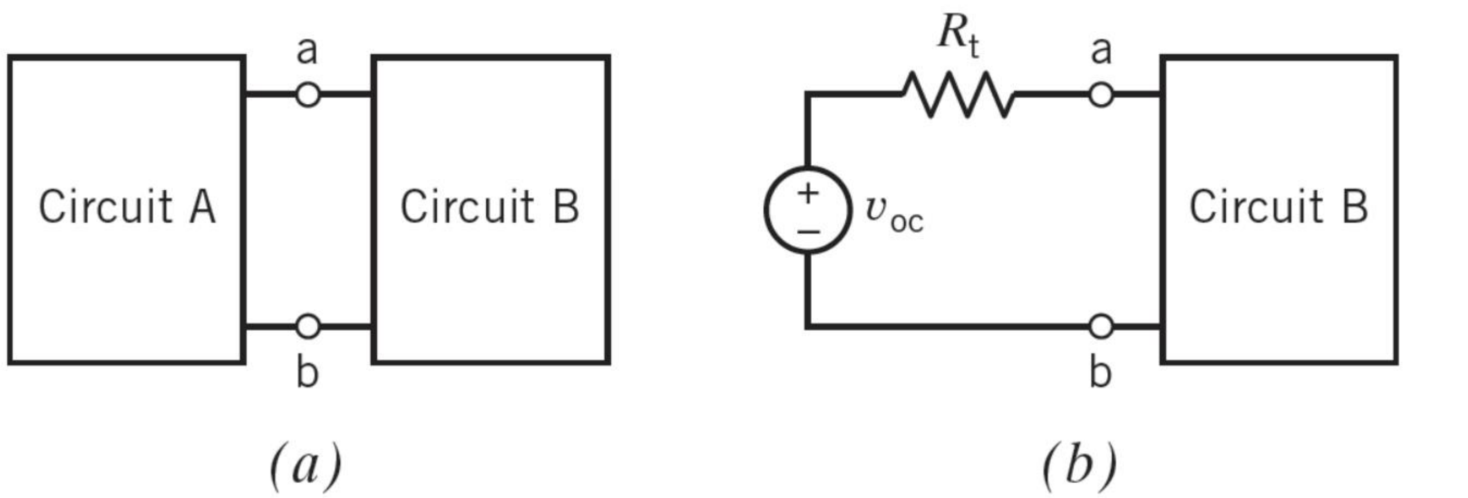


FIGURE 5.4-2 (*a*) A circuit partitioned into two parts: circuit A and circuit B. (*b*) Replacing circuit A by its Thévenin equivalent circuit.

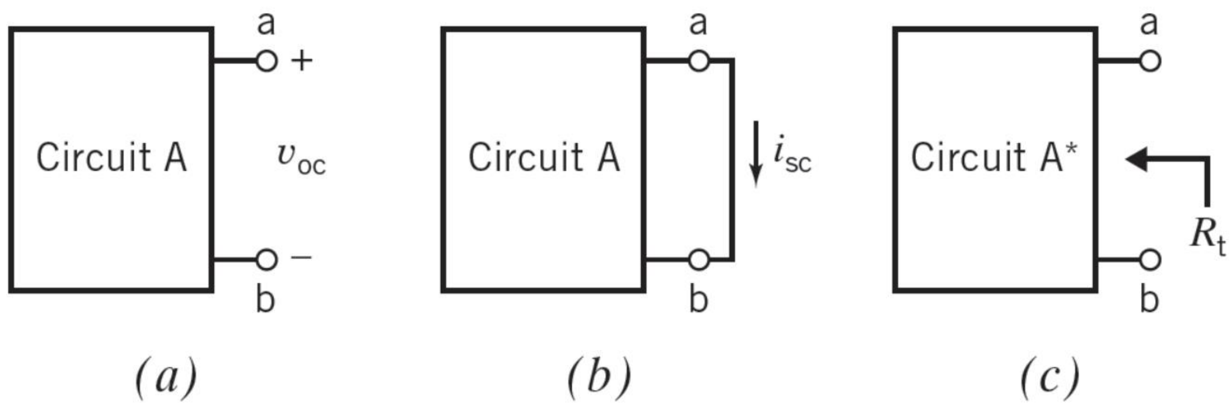
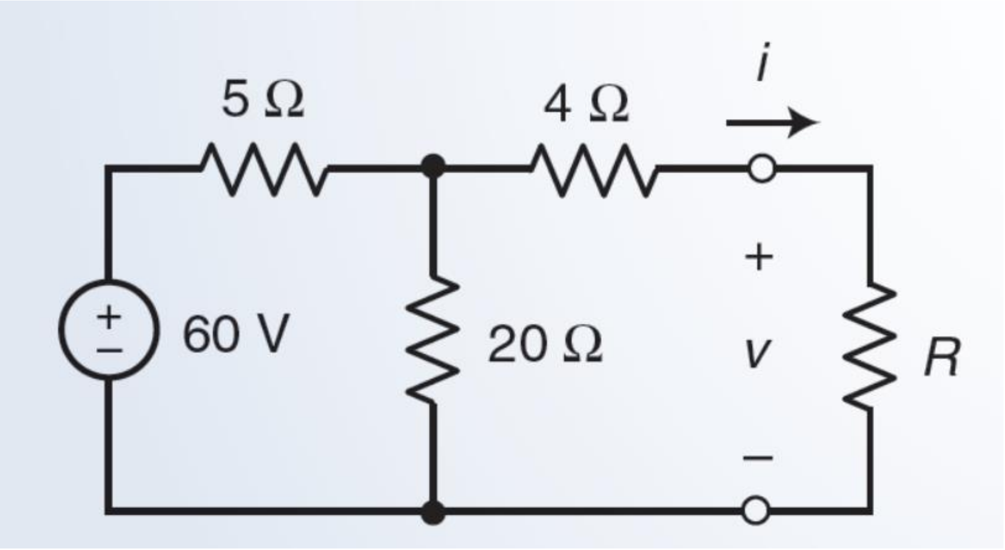


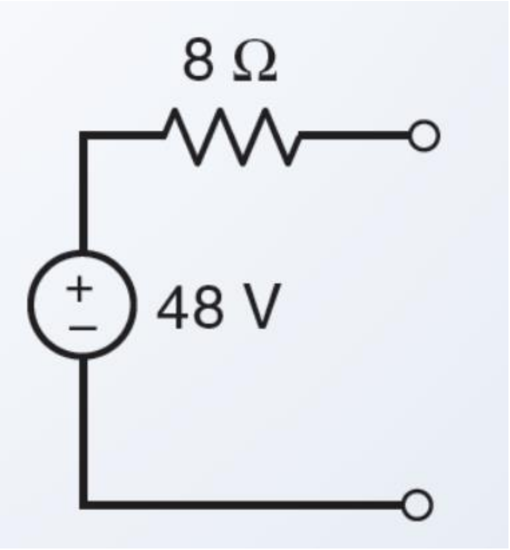
FIGURE 5.4-3 The Thévenin equivalent circuit involves three parameters: (*a*) the open-circuit voltage, v_{oc}, (*b*) the short-circuit current, i_{sc}, and (*c*) the Thévenin resistance, R_t.

The open-circuit voltage, v_{oc}, the short-circuit current, i_{sc}, and the Thévenin resistance, R_t, are related by the equation

$$v_{oc} = R_t i_{sc} \tag{5.4-2}$$

Example

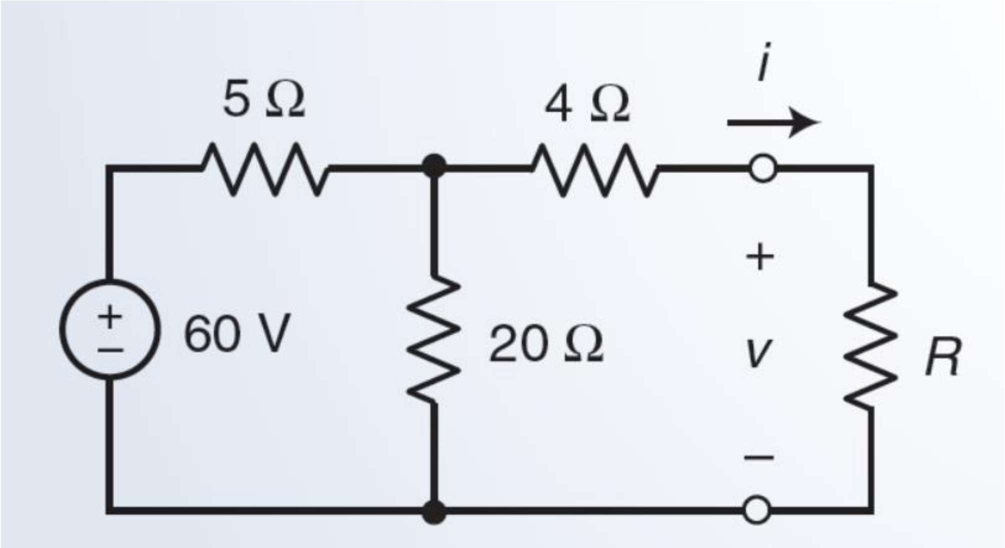


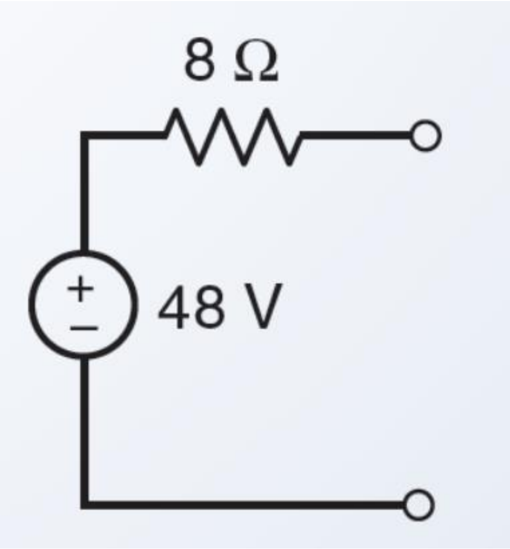


$$\frac{5\times 20}{5+20}+4=8\Omega$$

$$60\times\frac{20}{5+20}=48V$$

Example

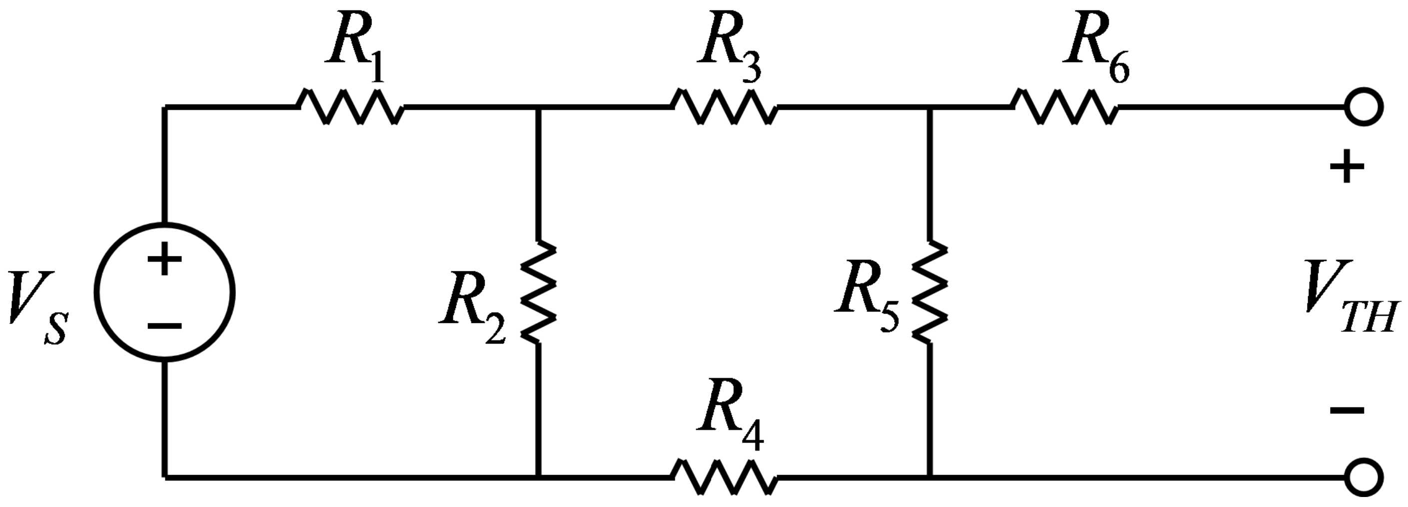


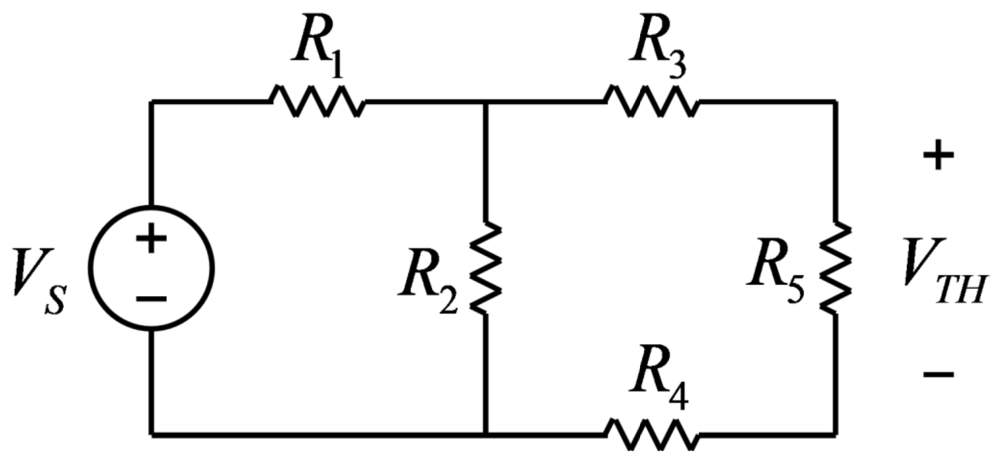


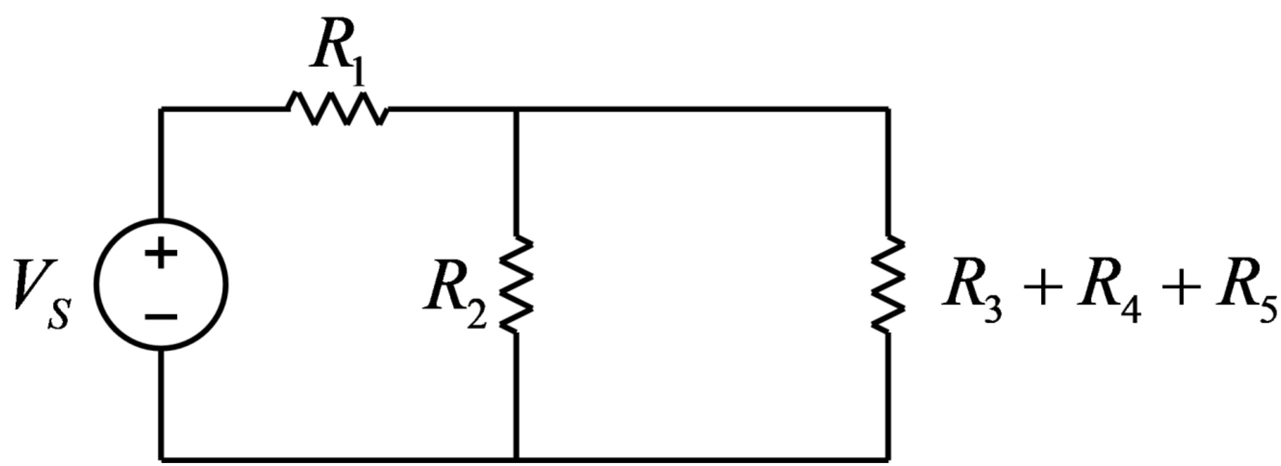
$$R = 0 \Rightarrow 5 + \frac{4 \times 20}{4 + 20} = 5 + \frac{10}{3} = \frac{25}{3}\Omega$$

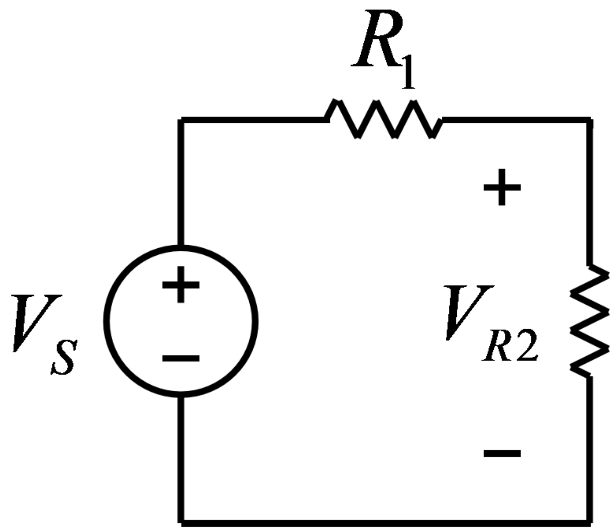
$$i = \frac{60}{\left(\frac{25}{3}\right)} \times \frac{20}{4 + 20} = 6A \Rightarrow \frac{48}{6} = 8\Omega$$

Lab Circuit 2




R_1
R_3
+
V_S
R_2
R_5
V_{TH}
R_4
–


R_1
V_S
R_2
$R_3 + R_4 + R_5$

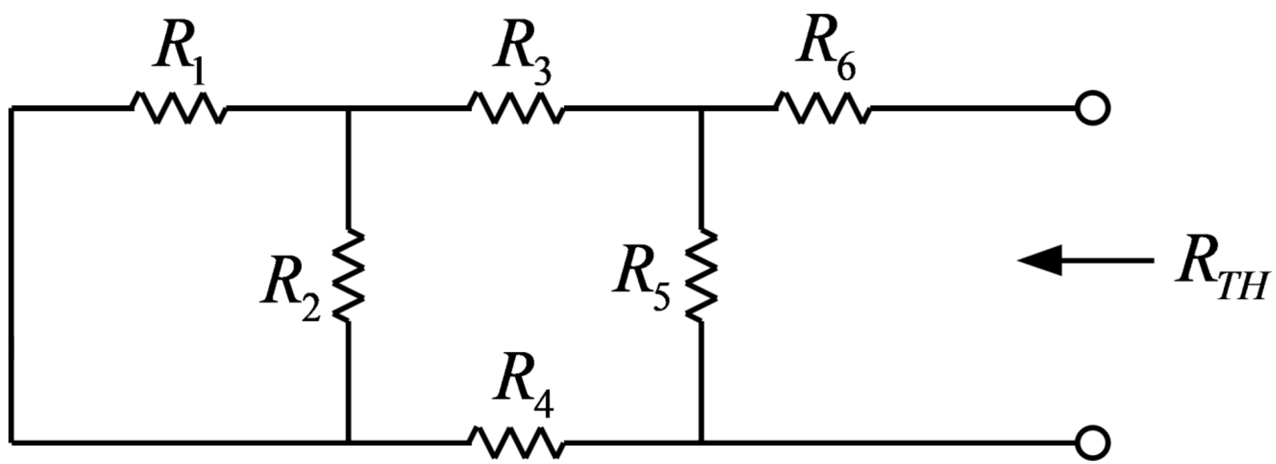


$$R_2 \parallel \left(R_3 + R_4 + R_5\right)$$

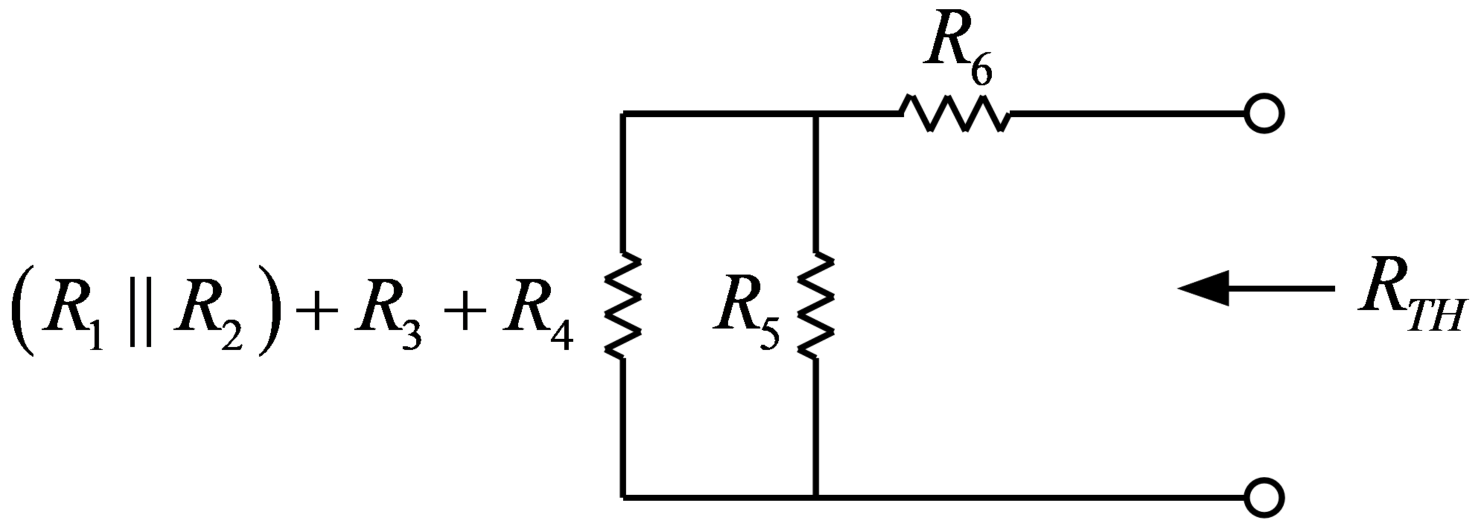
$$= \frac{R_2\left(R_3 + R_4 + R_5\right)}{R_2 + \left(R_3 + R_4 + R_5\right)}$$

$$V_{R2} = V_S \frac{R_2 \parallel \left(R_3 + R_4 + R_5\right)}{R_1 + R_2 \parallel \left(R_3 + R_4 + R_5\right)}$$

$$V_{TH} = V_{R2} \frac{R_5}{R_3 + R_4 + R_5}$$



R_1
R_3
R_6
R_2
R_5
R_{TH}
R_4



$$R_{TH} = \left(\left(\left(R_1 \| R_2 \right) + R_3 + R_4 \right) \| R_5 \right) + R_6$$