Optoelectronics Lab

KCL, KVL

Kirchhoff's Current Law

- The algebraic sum of the currents entering any node is zero.

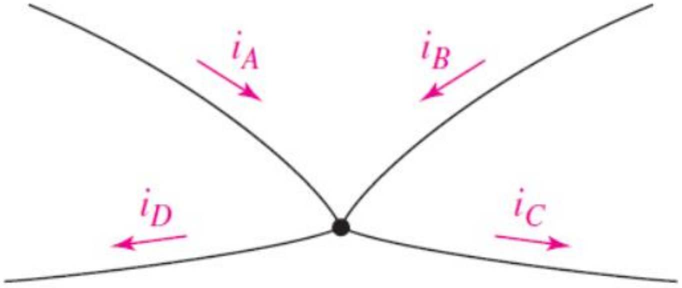


FIGURE 3.2 Example node to illustrate the application of Kirchhoff's current law.

$$i_A + i_B + (-i_C) + (-i_D) = 0$$

$$(-i_A) + (-i_B) + i_C + i_D = 0$$

$$i_A + i_B = i_C + i_D$$

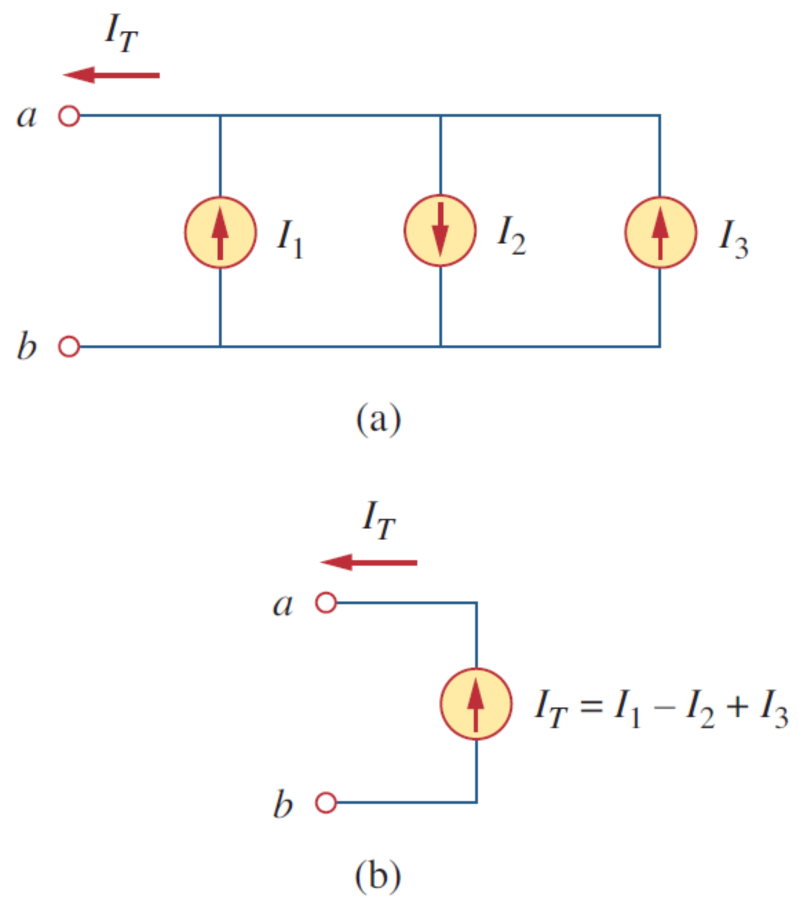
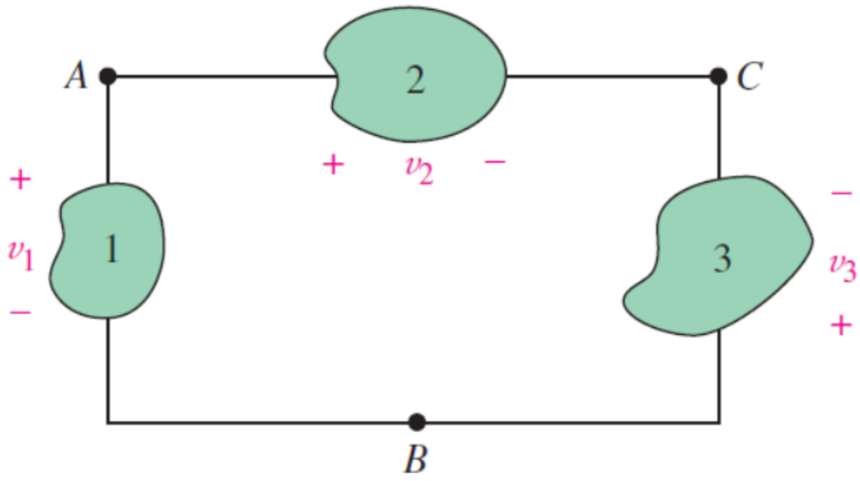


Figure 2.18
Current sources in parallel: (a) original circuit, (b) equivalent circuit.

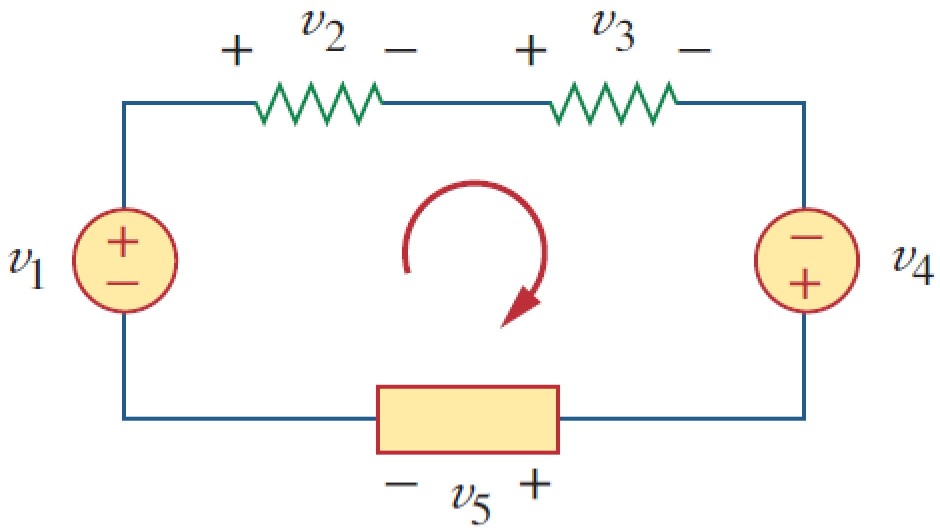
Kirchhoff's Voltage Law

- The algebraic sum of the voltages around any closed path is zero.



$$v_1 = v_2 - v_3$$

$$v_1 + v_2 + v_3 + \cdots + v_N = 0$$



$$-v_1 + v_2 + v_3 - v_4 + v_5 = 0$$

$$v_2 + v_3 + v_5 = v_1 + v_4$$

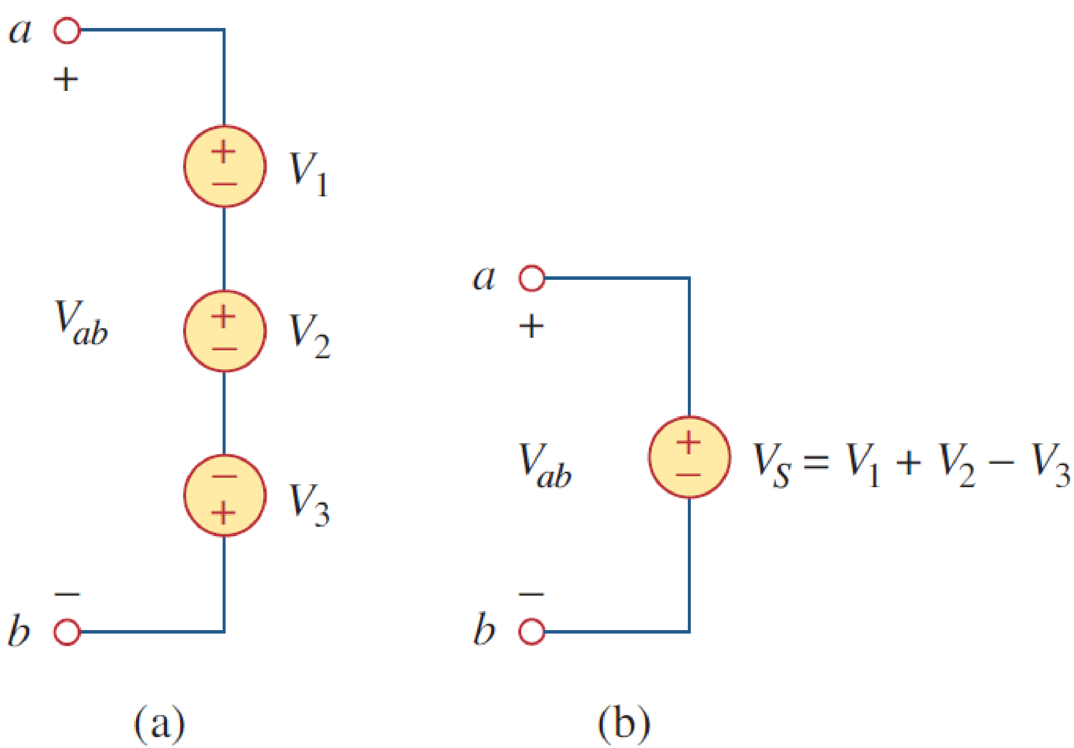
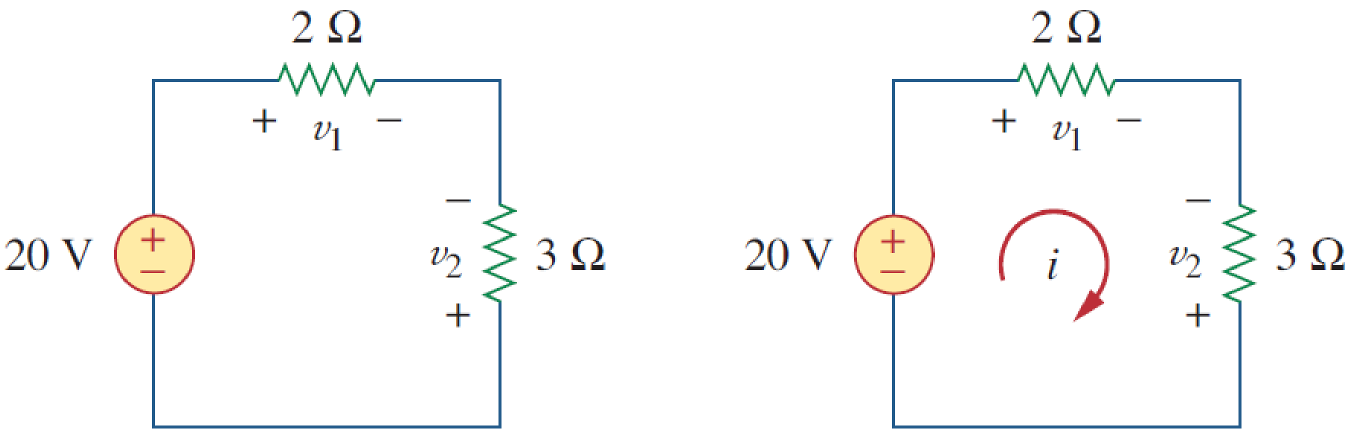


Figure 2.20
Voltage sources in series: (a) original circuit, (b) equivalent circuit.

Example



(a) (b)

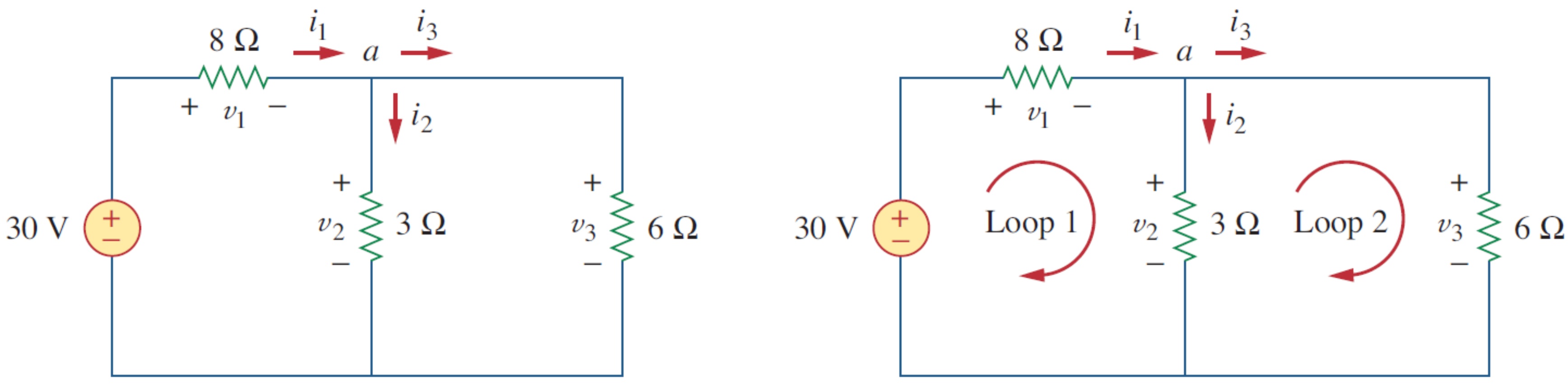
$$v_1 = 2i, \qquad v_2 = -3i$$

$$-20 + v_1 - v_2 = 0$$

$$-20 + 2i + 3i = 0 \quad \text{or} \quad 5i = 20 \quad \Rightarrow \quad i = 4\text{ A}$$

$$v_1 = 8\text{ V}, \qquad v_2 = -12\text{ V}$$

Example



(a) (b)

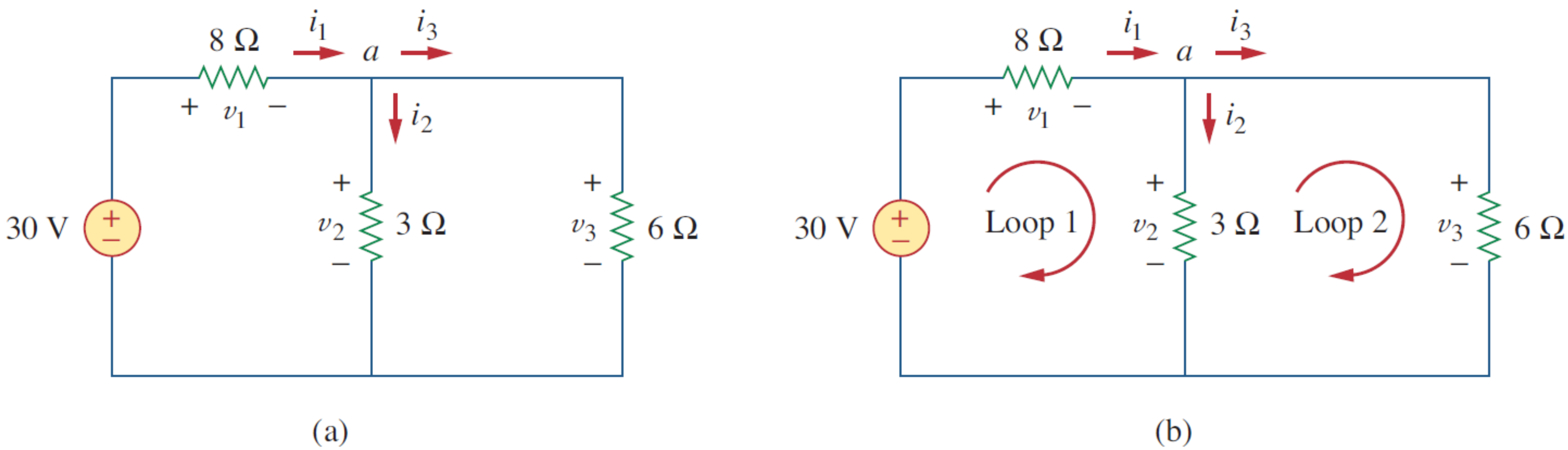
$$v_1 = 8i_1, \qquad v_2 = 3i_2, \qquad v_3 = 6i_3$$

$$i_1 - i_2 - i_3 = 0$$

$$-30 + v_1 + v_2 = 0$$

$$-30 + 8i_1 + 3i_2 = 0$$

Example



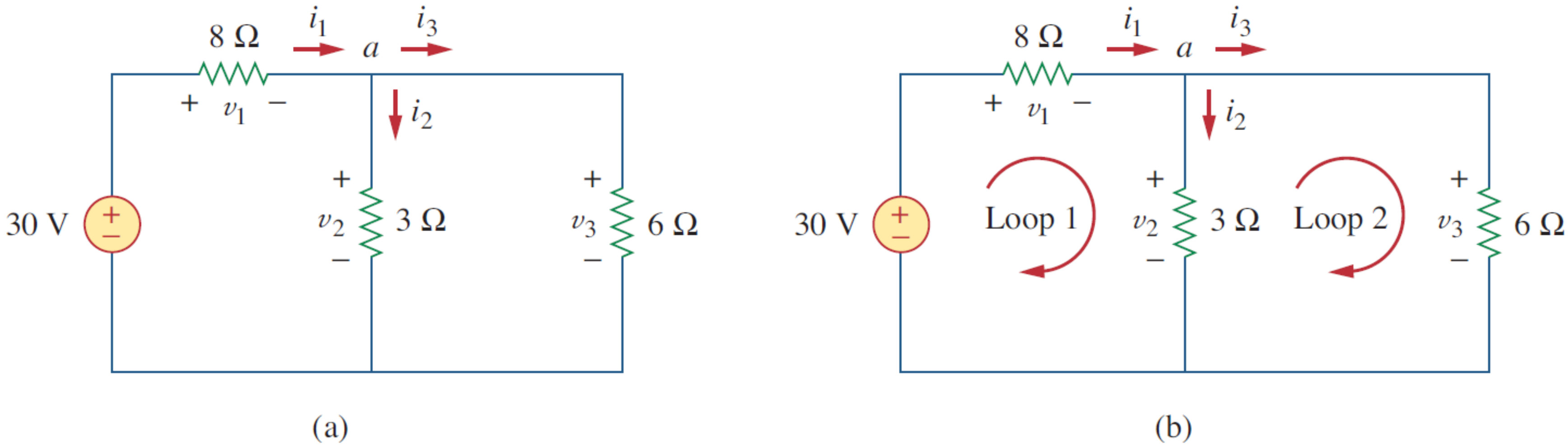
$$-v_2 + v_3 = 0 \quad \Rightarrow \quad v_3 = v_2$$

$$6i_3 = 3i_2 \quad \Rightarrow \quad i_3 = \frac{i_2}{2}$$

$$i_2 = 2\text{ A} \qquad i_1 = 3\text{ A}, \qquad i_3 = 1\text{ A}$$

$$v_1 = 24\text{ V}, \qquad v_2 = 6\text{ V}, \qquad v_3 = 6\text{ V}$$

Example

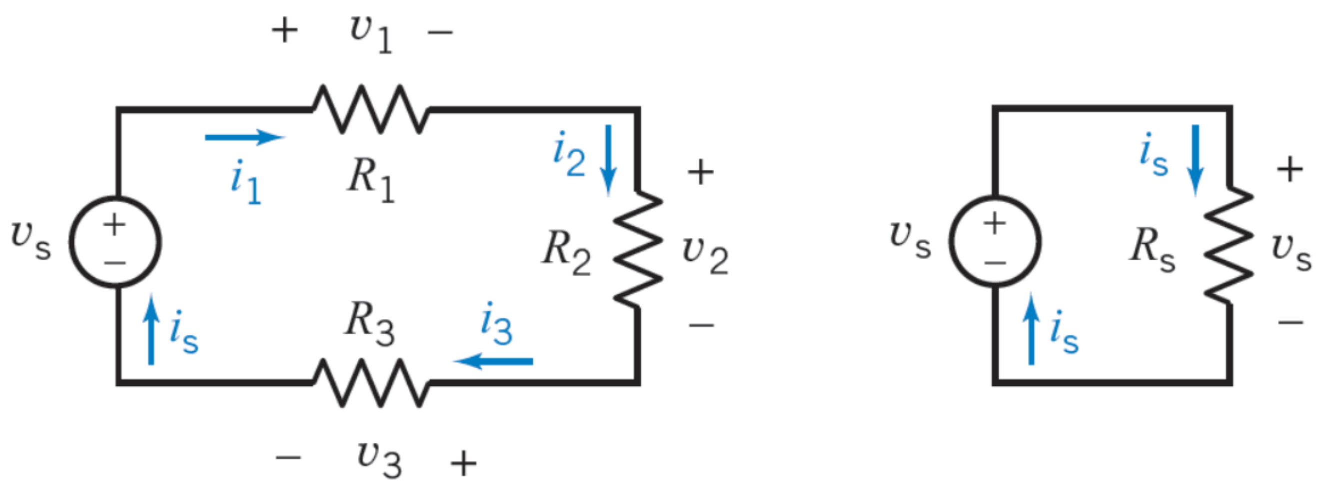


$$-30 + v_1 + v_2 = 0$$

$$-v_2 + v_3 = 0 \quad \Rightarrow \quad v_3 = v_2$$

$$\frac{v_1}{8} = \frac{v_2}{3} + \frac{v_3}{6}$$

Series Resistors



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

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

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

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

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

$$R_s = R_1 + R_2 + R_3$$

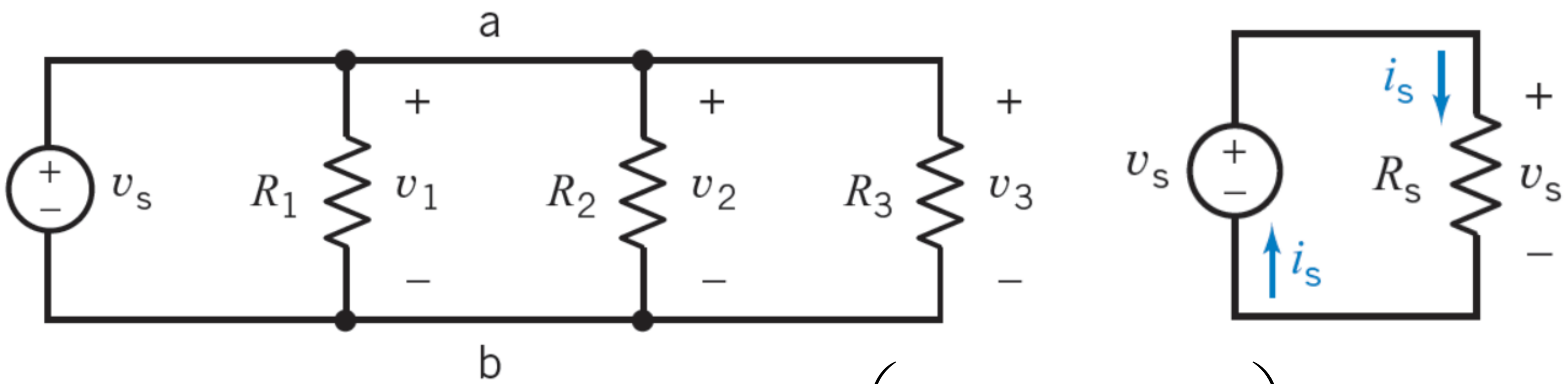
Voltage Division

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

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

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

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

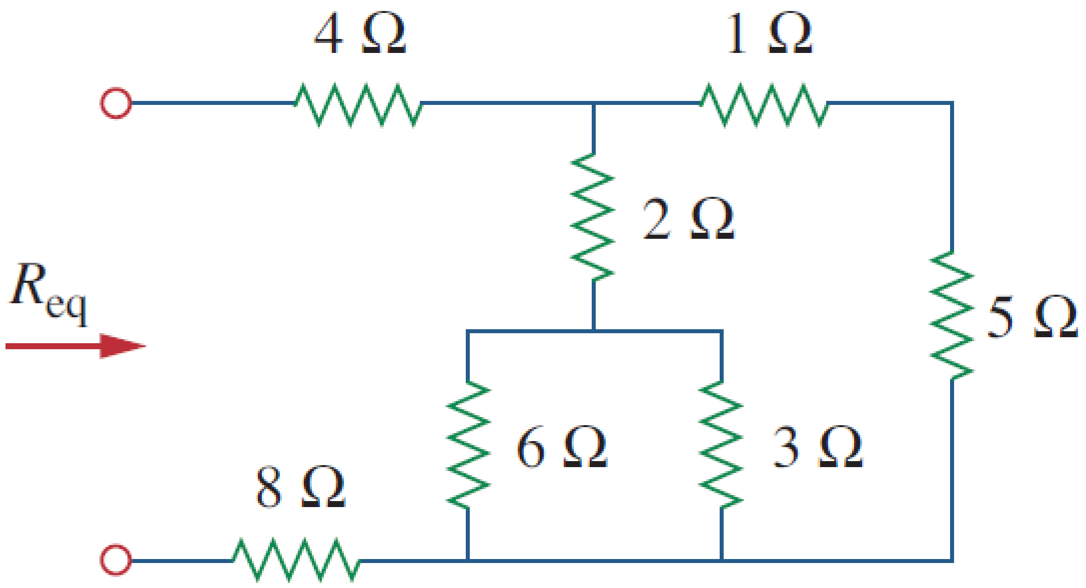
$$i_1 = \frac{v_S}{R_1} = \frac{1}{R_1} R_S i_S = \frac{\frac{1}{R_1}}{\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)} i_S$$

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

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

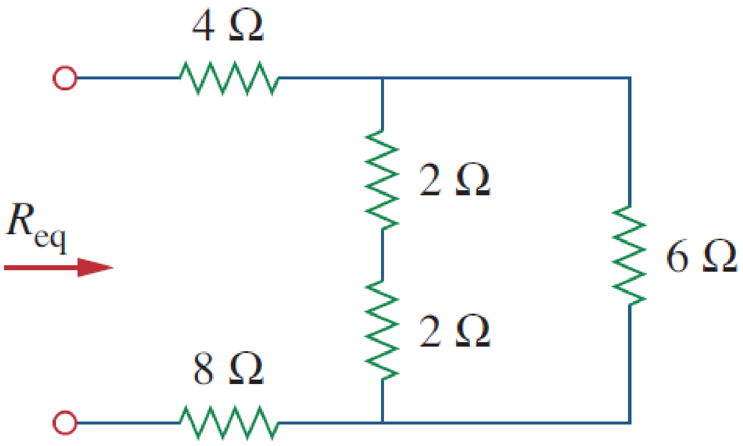
$$\frac{1}{R_S} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow R_S = \frac{1}{\left(\frac{1}{R_1} + \frac{1}{R_2}\right)} = \frac{R_1 R_2}{R_1 + R_2}$$

Example



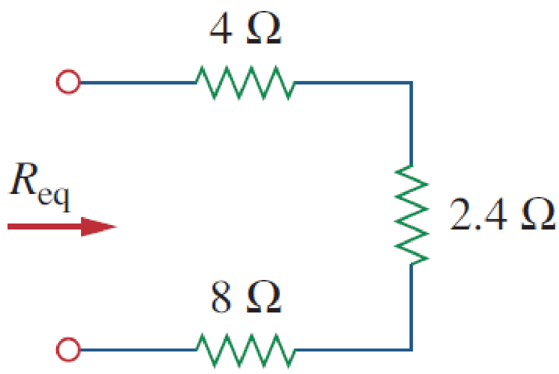
$$6\ \Omega \,\|\, 3\Omega = \frac{6 \times 3}{6 + 3} = 2\ \Omega$$

$$1\ \Omega + 5\ \Omega = 6\ \Omega$$



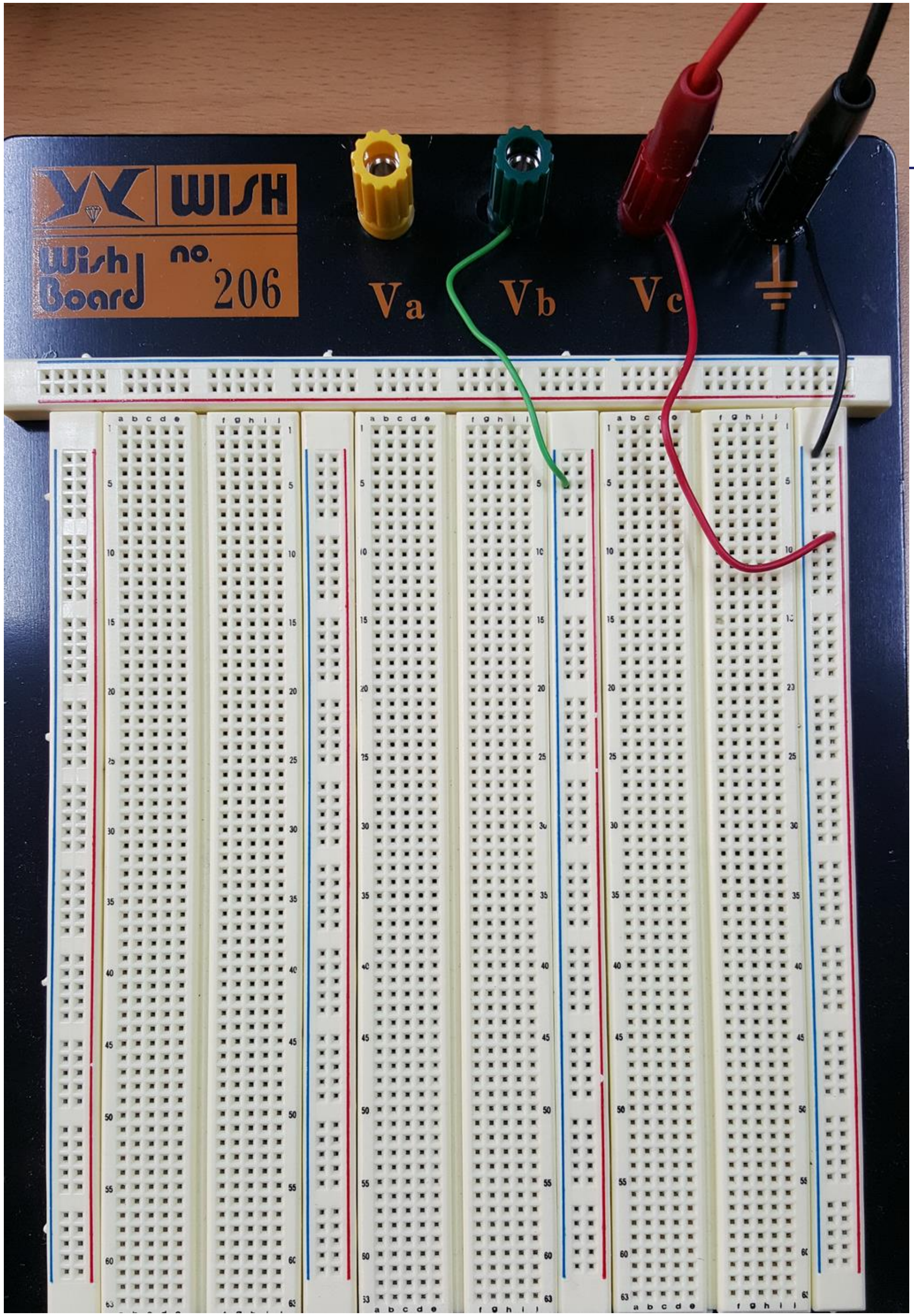
(a)

$$4\ \Omega \parallel 6\ \Omega = \frac{4 \times 6}{4 + 6} = 2.4\ \Omega$$

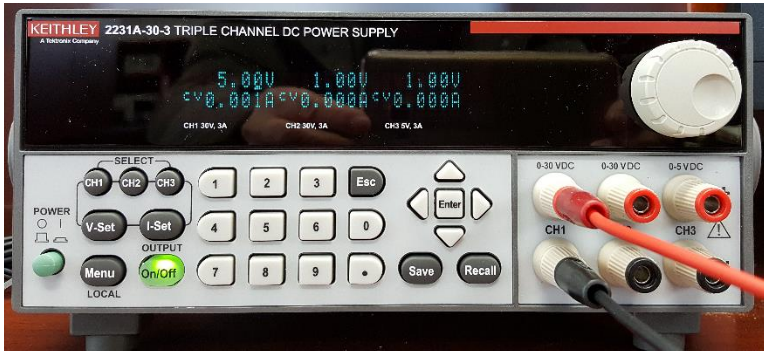


(b)

$$R_{eq} = 4\ \Omega + 2.4\ \Omega + 8\ \Omega = 14.4\ \Omega$$


WISH
Wish Board
no. 206
Va
Vb
Vc

Breadboard


KEITHLEY
2231A-30-3 TRIPLE CHANNEL DC POWER SUPPLY
5.00V 1.00V 1.00V
0.001A 0.000A 0.000A
SELECT
CH1
CH2
CH3
POWER
V-Set
I-Set
OUTPUT
On/Off
Menu
LOCAL
Esc
Enter
Save
Recall
0-30 VDC
0-30 VDC
0-5 VDC
CH1
CH3