

Tutorial 5

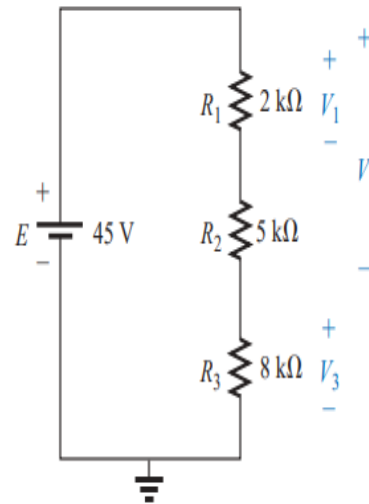
EXAMPLE 5.11 Using the voltage divider rule, determine the voltages V_1 and V_3 for the series circuit of Fig. 5.28.

Solution:

$$\begin{aligned} V_1 &= \frac{R_1 E}{R_T} = \frac{(2 \text{ k}\Omega)(45 \text{ V})}{2 \text{ k}\Omega + 5 \text{ k}\Omega + 8 \text{ k}\Omega} = \frac{(2 \text{ k}\Omega)(45 \text{ V})}{15 \text{ k}\Omega} \\ &= \frac{(2 \times 10^3 \Omega)(45 \text{ V})}{15 \times 10^3 \Omega} = \frac{90 \text{ V}}{15} = \mathbf{6 \text{ V}} \\ V_3 &= \frac{R_3 E}{R_T} = \frac{(8 \text{ k}\Omega)(45 \text{ V})}{15 \text{ k}\Omega} = \frac{(8 \times 10^3 \Omega)(45 \text{ V})}{15 \times 10^3 \Omega} \\ &= \frac{360 \text{ V}}{15} = \mathbf{24 \text{ V}} \end{aligned}$$

FIG. 5.27

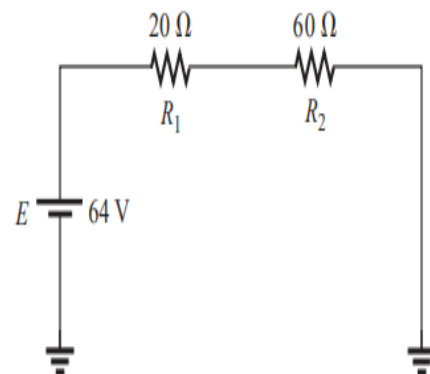
Example 5.10.



EXAMPLE 5.10 Determine the voltage V_1 for the network of Fig. 5.27.

Solution: Eq. (5.10):

$$V_1 = \frac{R_1 E}{R_T} = \frac{R_1 E}{R_1 + R_2} = \frac{(20 \Omega)(64 \text{ V})}{20 \Omega + 60 \Omega} = \frac{1280 \text{ V}}{80} = \mathbf{16 \text{ V}}$$



EXAMPLE 6.19 Determine the magnitude of the currents I_1 , I_2 , and I_3 for the network of Fig. 6.37.

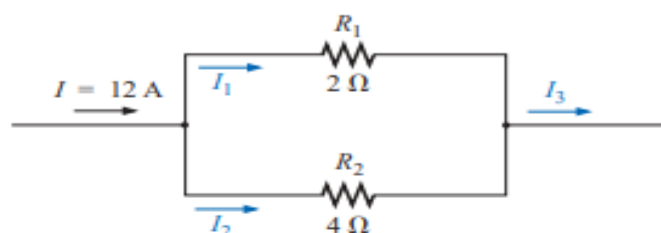


FIG. 6.37
Example 6.19.

Solution: By Eq. (6.10), the current divider rule,

$$I_1 = \frac{R_2 I}{R_1 + R_2} = \frac{(4 \Omega)(12 \text{ A})}{2 \Omega + 4 \Omega} = 8 \text{ A}$$

Applying Kirchhoff's current law,

$$I = I_1 + I_2$$

and $I_2 = I - I_1 = 12 \text{ A} - 8 \text{ A} = 4 \text{ A}$

or, using the current divider rule again,

$$I_2 = \frac{R_1 I}{R_1 + R_2} = \frac{(2 \Omega)(12 \text{ A})}{2 \Omega + 4 \Omega} = 4 \text{ A}$$

The total current entering the parallel branches must equal that leaving. Therefore,

$$I_3 = I = 12 \text{ A}$$

EXAMPLE 7.3 Another possible variation of Fig. 7.2 appears in Fig. 7.8.

$$R_A = R_{1\parallel 2} = \frac{(9 \Omega)(6 \Omega)}{9 \Omega + 6 \Omega} = \frac{54 \Omega}{15} = 3.6 \Omega$$

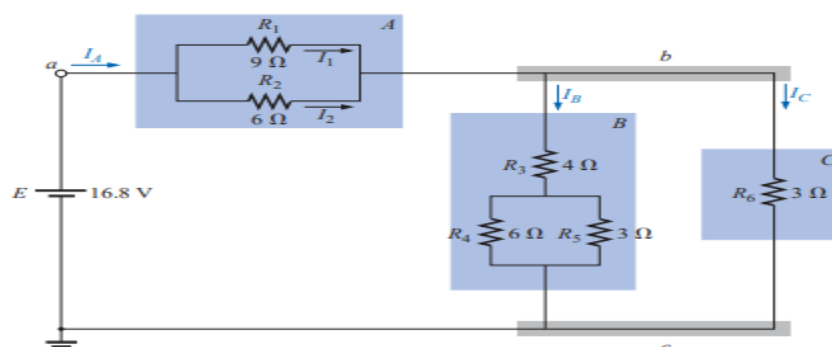


FIG. 7.8
Example 7.3.

$$R_B = R_3 + R_{4||5} = 4\ \Omega + \frac{(6\ \Omega)(3\ \Omega)}{6\ \Omega + 3\ \Omega} = 4\ \Omega + 2\ \Omega = 6\ \Omega$$

$$R_C = 3\ \Omega$$

The network of Fig. 7.8 can then be redrawn in reduced form, as shown in Fig. 7.9. Note the similarities between this circuit and the circuits of Figs. 7.3 and 7.7.

$$R_T = R_A + R_{B||C} = 3.6\ \Omega + \frac{(6\ \Omega)(3\ \Omega)}{6\ \Omega + 3\ \Omega}$$

$$= 3.6\ \Omega + 2\ \Omega = \mathbf{5.6\ \Omega}$$

$$I_s = \frac{E}{R_T} = \frac{16.8\ \text{V}}{5.6\ \Omega} = \mathbf{3\ \text{A}}$$

$$I_A = I_s = \mathbf{3\ \text{A}}$$

Applying the current divider rule yields

$$I_B = \frac{R_C I_A}{R_C + R_B} = \frac{(3\ \Omega)(3\ \text{A})}{3\ \Omega + 6\ \Omega} = \frac{9\ \text{A}}{9} = \mathbf{1\ \text{A}}$$

By Kirchhoff's current law,

$$I_C = I_A - I_B = 3\ \text{A} - 1\ \text{A} = \mathbf{2\ \text{A}}$$

By Ohm's law,

$$V_A = I_A R_A = (3\ \text{A})(3.6\ \Omega) = \mathbf{10.8\ \text{V}}$$

$$V_B = I_B R_B = V_C = I_C R_C = (2\ \text{A})(3\ \Omega) = \mathbf{6\ \text{V}}$$

Returning to the original network (Fig. 7.8) and applying the current divider rule,

$$I_1 = \frac{R_2 I_A}{R_2 + R_1} = \frac{(6\ \Omega)(3\ \text{A})}{6\ \Omega + 9\ \Omega} = \frac{18\ \text{A}}{15} = \mathbf{1.2\ \text{A}}$$

By Kirchhoff's current law,

$$I_2 = I_A - I_1 = 3\ \text{A} - 1.2\ \text{A} = \mathbf{1.8\ \text{A}}$$

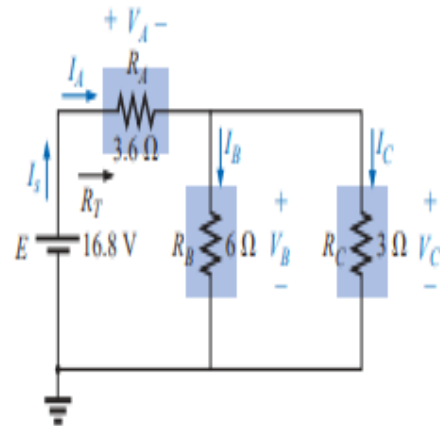


FIG. 7.9

Reduced equivalent of Fig. 7.8.

EXAMPLE 7.10 This example demonstrates the power of Kirchhoff's voltage law by determining the voltages V_1 , V_2 , and V_3 for the network of Fig. 7.25. For path 1 of Fig. 7.26,

$$E_1 - V_1 - E_3 = 0$$

and $V_1 = E_1 - E_3 = 20\text{ V} - 8\text{ V} = 12\text{ V}$

For path 2,

$$E_2 - V_1 - V_2 = 0$$

and $V_2 = E_2 - V_1 = 5\text{ V} - 12\text{ V} = -7\text{ V}$

indicating that V_2 has a magnitude of 7 V but a polarity opposite to that appearing in Fig. 7.25. For path 3,

$$V_3 + V_2 - E_3 = 0$$

and $V_3 = E_3 - V_2 = 8\text{ V} - (-7\text{ V}) = 8\text{ V} + 7\text{ V} = 15\text{ V}$

Note that the polarity of V_2 was maintained as originally assumed, requiring that -7 V be substituted for V_2 .

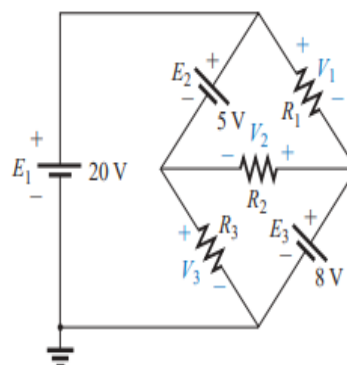


FIG. 7.25

Example 7.10.

