Tutorial Solution 1-02-b

Question 1

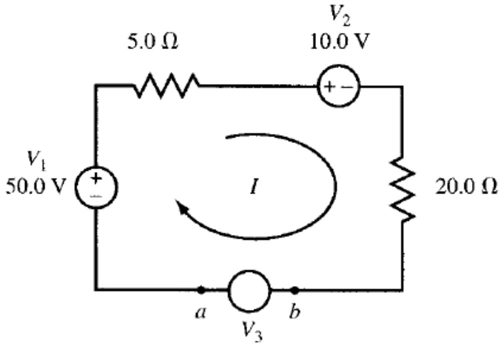

Fig. 3-7

Assume that V_3 has the same polarity as V_1. Applying KVL and starting from the lower left corner,

$$V_1 - I(5.0) - V_2 - I(20.0) + V_3 = 0$$
$$50.0 - 2.0 - 10.0 - 8.0 + V_3 = 0$$
$$V_3 = -30.0\,\text{V}$$

Terminal b is positive with respect to terminal a.

Question 2

a and b comprise one node. Applying KCL,

$$2.0 + 7.0 + I_1 = 3.0 \qquad \text{or} \qquad I_1 = -6.0\,\text{A}$$

Also, c and d comprise a single node. Thus,

$$4.0 + 6.0 = I_2 + 1.0 \qquad \text{or} \qquad I_2 = 9.0\,\text{A}$$

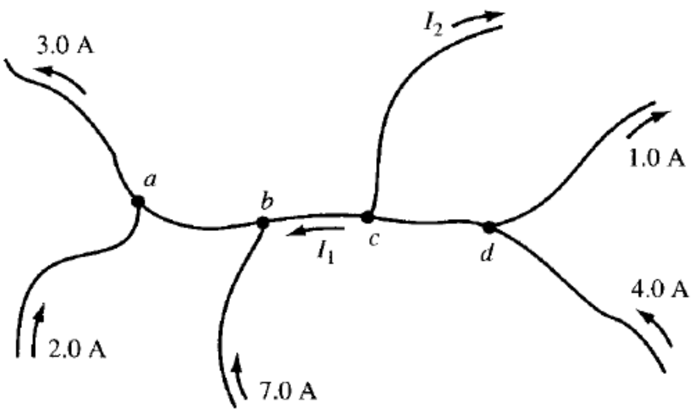

Fig. 3-8

Question 3

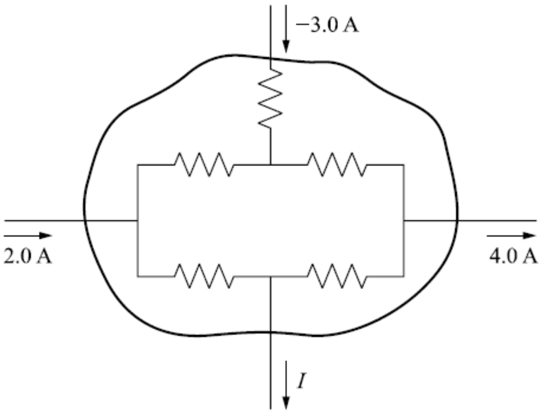

Fig. 3-9

The branch currents within the enclosed area cannot be calculated since no values of the resistors are given. However, KCL applies to the network taken as a single node. Thus,

$$2.0 - 3.0 - 4.0 - I = 0 \qquad \text{or} \qquad I = -5.0\,\text{A}$$

Question 4

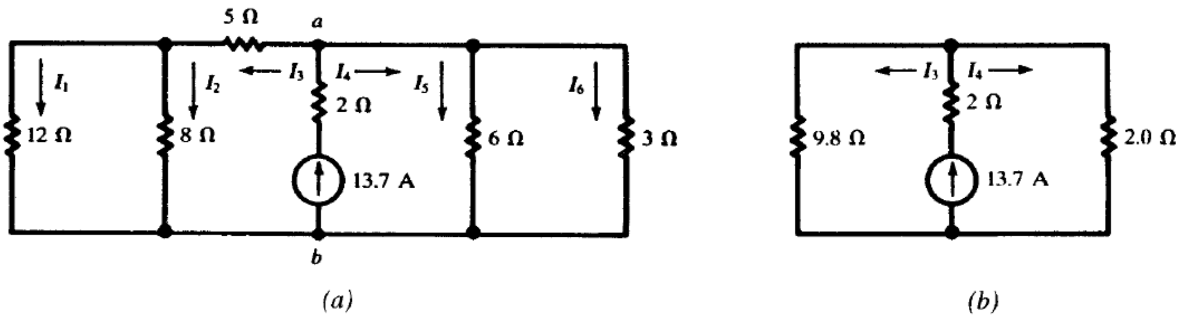

Fig. 3-14

The equivalent resistances to the left and right of nodes a and b are

$$R_{\text{eq(left)}} = 5 + \frac{(12)(8)}{20} = 9.8\,\Omega$$

$$R_{\text{eq(right)}} = \frac{(6)(3)}{9} = 2.0\,\Omega$$

Now referring to the reduced network of Fig. 3-14(b),

$$I_3 = \frac{2.0}{11.8}(13.7) = 2.32\,\text{A}$$

$$I_4 = \frac{9.8}{11.8}(13.7) = 11.38\,\text{A}$$

Then referring to the original network,

$$I_1 = \frac{8}{20}(2.32) = 0.93\,\text{A} \qquad I_2 = 2.32 - 0.93 = 1.39\,\text{A}$$

$$I_5 = \frac{3}{9}(11.38) = 3.79\,\text{A} \qquad I_6 = 11.38 - 3.79 = 7.59\,\text{A}$$

Question 5

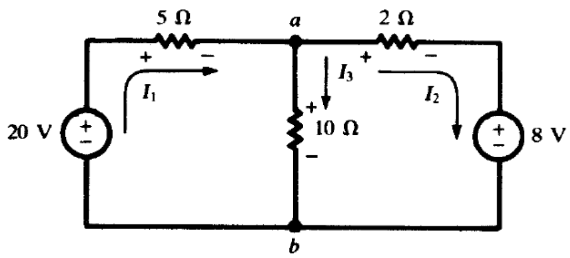

Fig. 4-1

Currents I_1, I_2, and I_3 are assigned to the branches as shown. Applying KCL at node a,

$$I_1 = I_2 + I_3 \tag{1}$$

The voltage V_{ab} can be written in terms of the elements in each of the branches; $V_{ab} = 20 - I_1(5)$, $V_{ab} = I_3(10)$ and $V_{ab} = I_2(2) + 8$. Then the following equations can be written

$$20 - I_1(5) = I_3(10) \tag{2}$$
$$20 - I_1(5) = I_2(2) + 8 \tag{3}$$

Solving the three equations (*1*), (*2*), and (*3*) simultaneously gives $I_1 = 2\,\text{A}$, $I_2 = 1\,\text{A}$, and $I_3 = 1\,\text{A}$.

Question 6

EXAMPLE 4.2 Obtain the current in each branch of the network shown in Fig. 4-2 (same as Fig. 4-1) using the mesh current method.

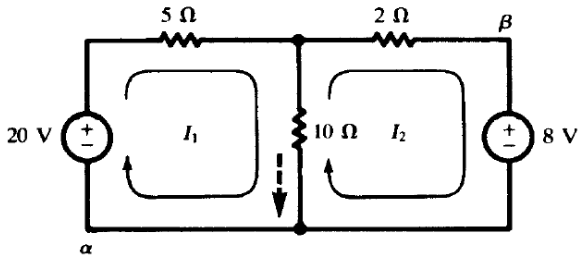

Fig. 4-2

The currents I_1 and I_2 are chosen as shown on the circuit diagram. Applying KVL around the left loop, starting at point α,

$$-20 + 5I_1 + 10(I_1 - I_2) = 0$$

and around the right loop, starting at point β,

$$8 + 10(I_2 - I_1) + 2I_2 = 0$$

Rearranging terms,

$$15I_1 - 10I_2 = 20 \tag{4}$$
$$-10I_1 + 12I_2 = -8 \tag{5}$$

Solving (*4*) and (*5*) simultaneously results in $I_1 = 2\,\text{A}$ and $I_2 = 1\,\text{A}$. The current in the center branch, shown dotted, is $I_1 - I_2 = 1\,\text{A}$. In Example 4.1 this was branch current I_3.