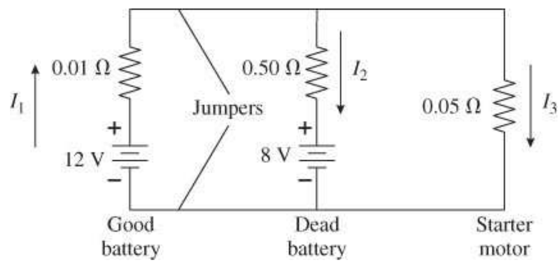
Problem 1

Model: The wires are ideal, but the batteries are not.

Visualize:



Solve: **(a)** The good battery alone can drive a current through the starter motor

$$I = \frac{12\text{ V}}{(0.01\ \Omega + 0.05\ \Omega)} = 200\text{ A}$$

(b) Alone, the dead battery drives a current

$$I = \frac{8.0\text{ V}}{(0.50\ \Omega + 0.05\ \Omega)} = 14.5\text{ A}$$

(c) Let I_1, I_2, I_3 be defined as shown in the figure above. Kirchhoff's laws applied to the good battery and dead battery loop, good battery and starter motor loop, and the top middle junction yield three equations in the three unknown currents:

$$12\text{ V} - I_1(0.01\ \Omega) - I_3(0.05\ \Omega) = 0$$

$$12\text{ V} - I_1(0.01\ \Omega) - I_2(0.50\ \Omega) - 8.0\text{ V} = 0$$

$$I_1 = I_2 + I_3$$

Substituting for I_1 from the third equation into the first and second equations gives

$$12\text{ V} - I_2(0.01\ \Omega) - I_3(0.06\ \Omega) = 0$$

$$4\text{ V} - I_2(0.51\ \Omega) - I_3(0.01\ \Omega) = 0$$

Solving for I_2 from the first equation,

$$I_2 = \frac{12\text{ V} - I_3(0.06\ \Omega)}{(0.01\ \Omega)}$$

Substituting into the second equation and solving for I_3 yields the current through the starter motor is 199 A.

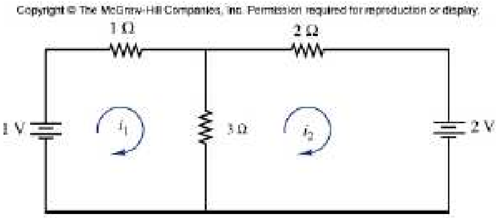
(d) Substituting the value for I_3 into the expression for I_2 yields the current through the dead battery is 3.9 A.

Assess: The good battery is charging the dead battery as well as running the started motor. A total of 203 A flows through the good battery.

Problem 2

Solution:

Circuit shown in Figure P3.14.



Find:

Current i_1 and i_2.

Analysis:

For mesh #1:

$$i_1(1+3)+i_2(-3)=1$$

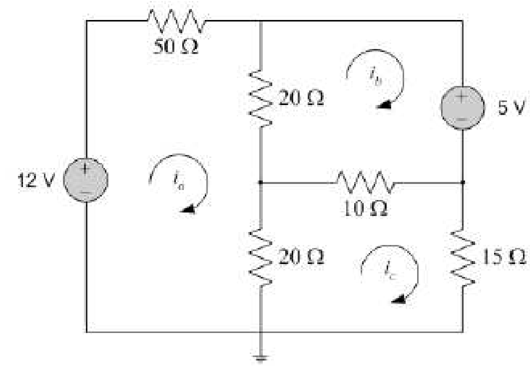
For mesh #2:

$$i_1(-3)+i_2(3+2)=-2$$

Solving,

$$i_1=-0.091\text{A}$$
$$i_2=-0.455\text{A}$$

Problem 3



Solution:

Known quantities:

The values of the resistors and of the voltage sources (see Figure P3.25).

Find:

The voltage across the 10 Ω resistor in the circuit of Figure P3.25 using mesh current analysis.

Analysis:

For mesh (a):

$$i_a(50+20+20)-i_b(20)-i_c(20)=12$$

For mesh (b):

$$-i_a(20)+i_b(20+10)-i_c(10)+5=0$$

For mesh (c):

$$-i_a(20)-i_b(10)+i_c(20+10+15)=0$$

Solving,

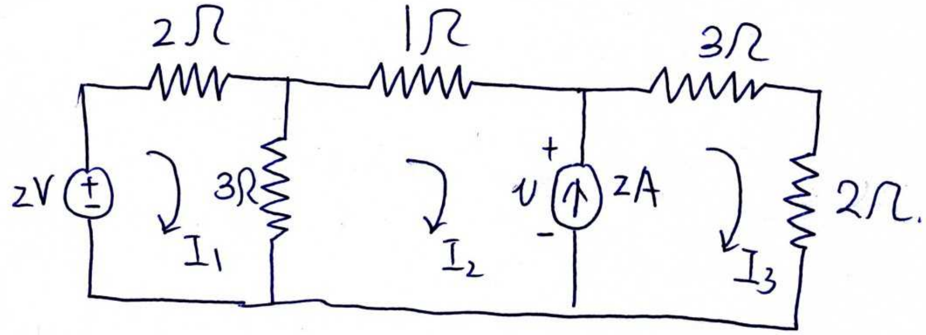
$i_a = 127.5$ mA

$i_b = -67.8$ mA

$i_c = 41.6$ mA

and $\quad v_{R_4} = 10\,(i_b - i_c) = 10\,(-0.109) = -1.09$ V.

Problem 4



$$(2+3)I_1 - 3I_2 = 2 \qquad (1)$$

$$(3+1)I_2 - 3I_1 = -v \qquad (2)$$

$$(3+2)\ I_3 = v \qquad (3)$$

$$I_3 - I_2 = 2 \qquad (4)$$

From (4) we have $I_3 = I_2 + 2$ (5)

From (1) we have $5\ I_1 = 3\ I_2 + 2$

$\therefore\quad I_1 = 0.6\ I_2 + 0.4$ (6)

(2) + (3) yields $4I_2 - 3I_1 + 5I_3 = 0$ (7)

Substitute (5) (6) into (7)

we have $I_2 = -1.22$ (A)

then $I_3 = 0.78$ (A)

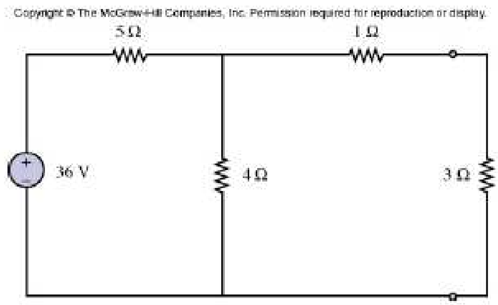
$I_1 = -0.33$ (A)

Problem 5

Solution:

Known quantities:

Circuit shown in Figure P3.51.



Find:

Thevenin equivalent circuit

Analysis:

$R_{TH} = 1\Omega + 4\Omega \| 5\Omega = 3.22\Omega$

$$R_{TH} = 1 + \frac{1}{\frac{1}{5}+\frac{1}{4}} = 1 + \frac{20}{9} = \frac{29}{9}\,\Omega = 3.222\,\Omega$$

Voltage divider gives

$$V = \left(\frac{4}{4+5}\right)36 = 16\text{ V}$$

KVL:

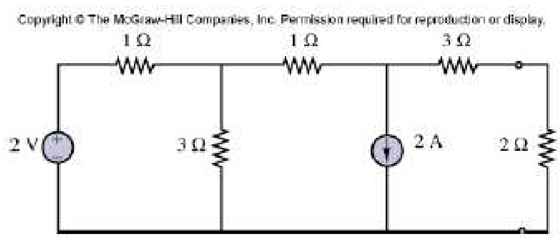
$v_{oc} = -0(1) + v = v = 16\text{V}$

Problem 6

Solution:

Known quantities:

Circuit shown in Figure P3.53.



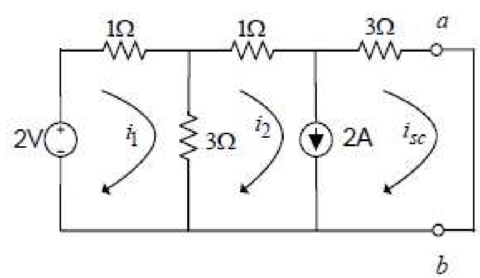
Find:

Norton equivalent circuit

Analysis:

$R_N = 3\Omega + 1\Omega + (3\Omega \| 1\Omega) = 4.75\Omega$

Using the mesh analysis approach



$4i_1 - 3i_2 = 2$

$-3i_1 + 4i_2 + 3i_{SC} = 0$

$i_2 - i_{SC} = 2$

Solving, $i_{SC} = -0.42\text{A} \Rightarrow i_N = -0.42\text{ A}$

It means the magnitude of i_{SC} is 0.42A and the direction of i_{SC} is count-clockwise.