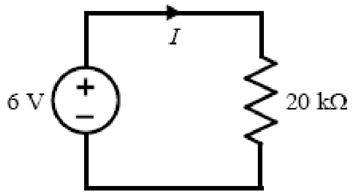
Exercícios retirados do livro: Basic Engineering Circuit Analysis, 7Ed.

Problem 2.1

Find the current I and the power supplied by the source in the network shown.



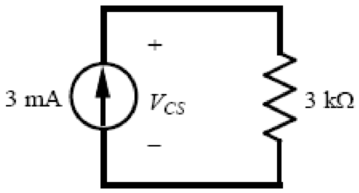
Suggested Solution

$$I = \frac{6}{20\times10^3} = 0.3 \text{ mA}$$

$$P = VI = (6)(0.3\times10^{-3}) = 1.8 \text{ mW}$$

Problem 2.2

In the circuit shown, find the voltage across the current source and the power absorbed by the resistor.



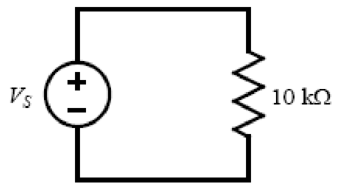
Suggested Solution

$$V_{CS} = (3\times10^{-3})(3\times10^{3}) = 9 \text{ V}$$

$$P = VI = (3\times10^{-3})(9) = 27 \text{ mW}$$

Problem 2.3

If the 10-kΩ resistor in the network shown absorbs 2.5 mW, find V_S.



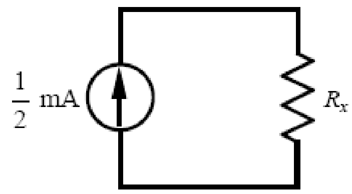
Suggested Solution

$$P = \frac{V_S^2}{10\ \text{k}\Omega}$$

or $V_S = \sqrt{P \times R} = \sqrt{(2.5\times10^{-3})(10\times10^{3})} = 5\ \text{V}$

Problem 2.4

In the network shown, the power absorbed by R_x is 5 mW. Find R_x.

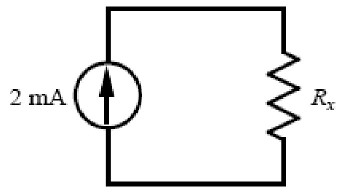


Suggested Solution

$$R_x = \frac{P}{I^2} = \frac{5\times10^{-3}}{(0.5\times10^{-3})^2} = 20\ \text{k}\Omega$$

Problem 2.5

In the network shown, the power absorbed by R_x is 20 mW. Find R_x.

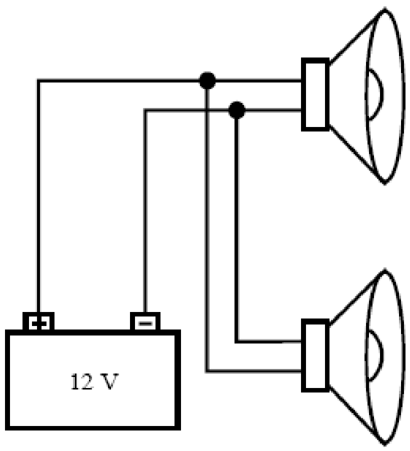


Suggested Solution

$$R = \frac{P}{I^2} = \frac{20\times10^{-3}}{(2\times10^{-3})^2} = 5\ \text{k}\Omega$$

Problem 2.7

An automobile uses two halogen headlights connected as shown. Determine the power supplied by the battery if each headlight draws 3 A of current.

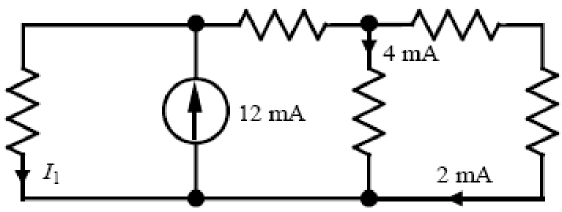


Suggested Solution

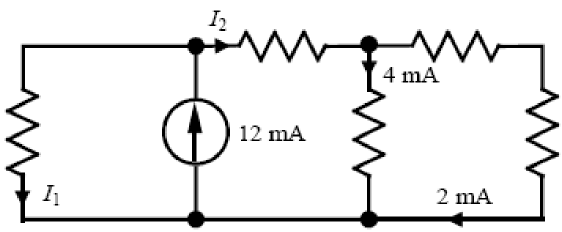
$P_S = VI = (12)(3+3) = 72 \text{ W}$

Problem 2.9

Find I_1 in the network shown.



Suggested Solution

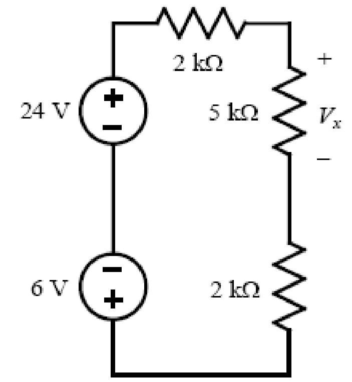


$I_2 = 0.004 + 0.002 = 0.006 \text{ A}$

$0.012 = I_1 + I_2$

Problem 2.25

Find V_x in the circuit shown.



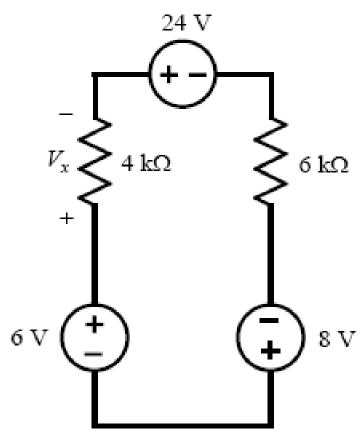
Suggested Solution

Using voltage division,

$$V_x = \left(\frac{5000}{2000+5000+2000}\right)(24-6) = 10 \text{ V}$$

Problem 2.26

Find V_x in the circuit shown.



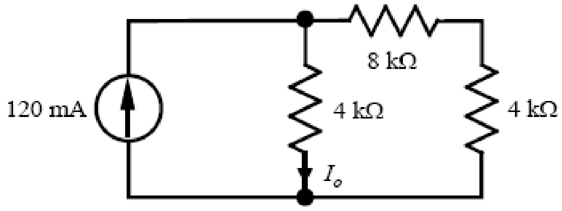
Suggested Solution

Using voltage division,

$$V_x = \left(\frac{4000}{4000+6000}\right)(6+8-24) = -4 \text{ V}$$

Problem 2.31

Find I_o in the circuit shown.



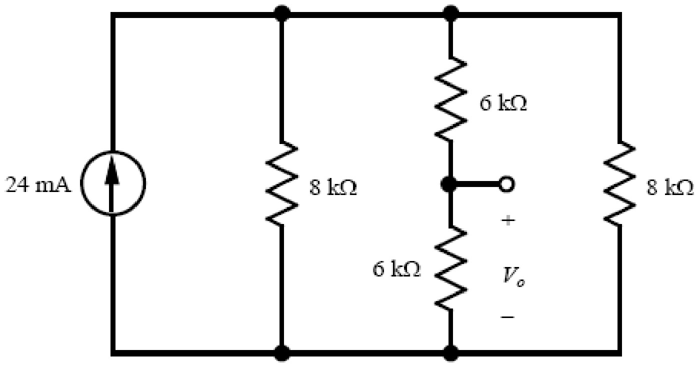
Suggested Solution

Using current division,

$$I_o = \left[\frac{\frac{1}{4000}}{\frac{1}{4000} + \frac{1}{8000+4000}} \right] (0.120) = 90 \text{ mA}$$

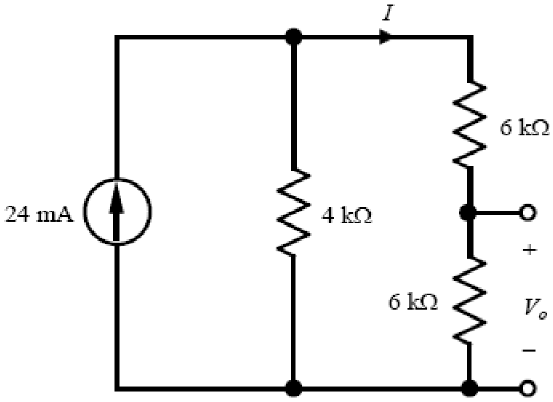
Problem 2.33

Find V_o in the circuit shown.



Suggested Solution

Combining the 8-kΩ resistors in parallel yields the following circuit.



Using current division,

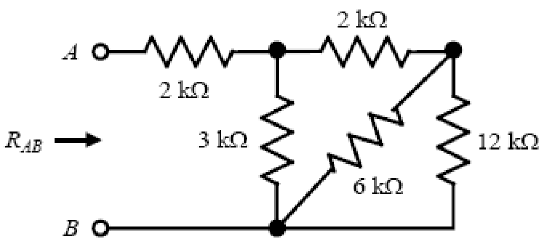
$$I = \left(\frac{\frac{1}{6000+6000}}{\frac{1}{4000} + \frac{1}{6000+6000}} \right)(0.024) = 6 \text{ mA}$$

Then,

$V_o = 6000I = 36$ V

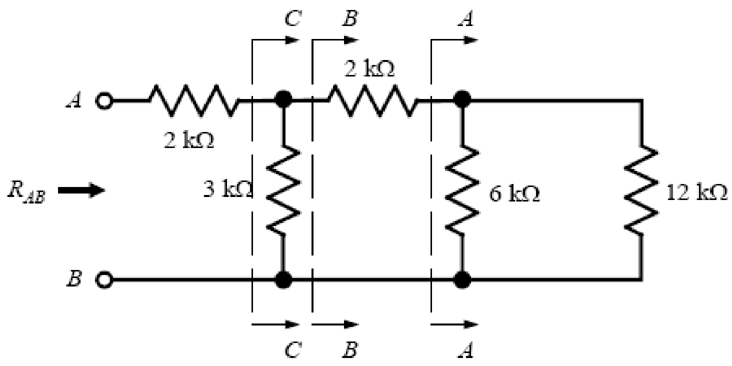
Problem 2.37

Find R_{AB} in the circuit shown.



Suggested Solution

The network can be redrawn as shown below.



Then,

At A-A: $6000 \| 12000 = 4\ \text{k}\Omega$

At B-B: $2000 + 4000 = 6\ \text{k}\Omega$

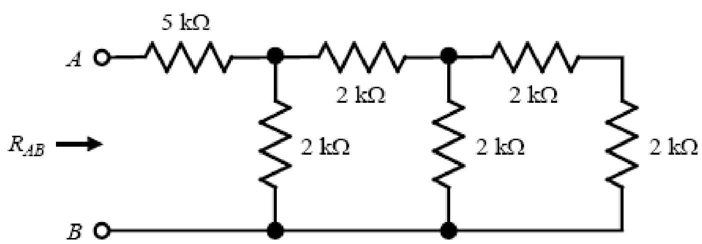
At C-C: $3000 \| 6000 = 2\ \text{k}\Omega$

and

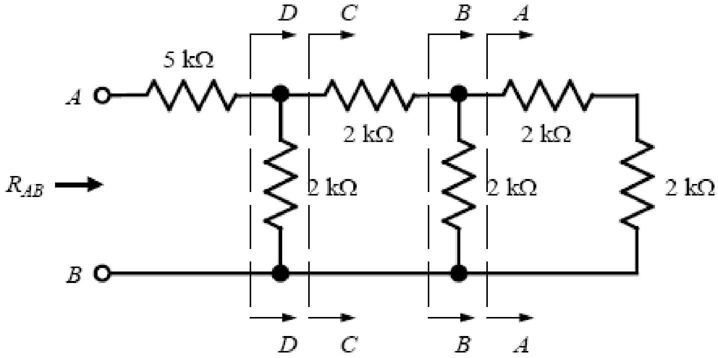
$R_{AB} = 2000 + 2000 = 4\ \text{k}\Omega$

Problem 2.38

Find R_{AB} in the circuit shown.



Suggested Solution



At *A-A*: $2000+2000=4\ \text{k}\Omega$

At *B-B*: $2000\|4000=\frac{4}{3}\ \text{k}\Omega$

At *C-C*: $2000+\frac{4000}{3}=\frac{10}{3}\ \text{k}\Omega$

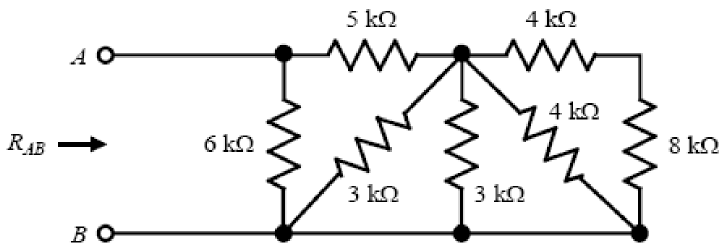
At *D-D*: $2000\left\|\frac{10000}{3}\right.=1250\ \Omega$

Then,

$R_{AB}=5000+1250=6250\ \Omega$

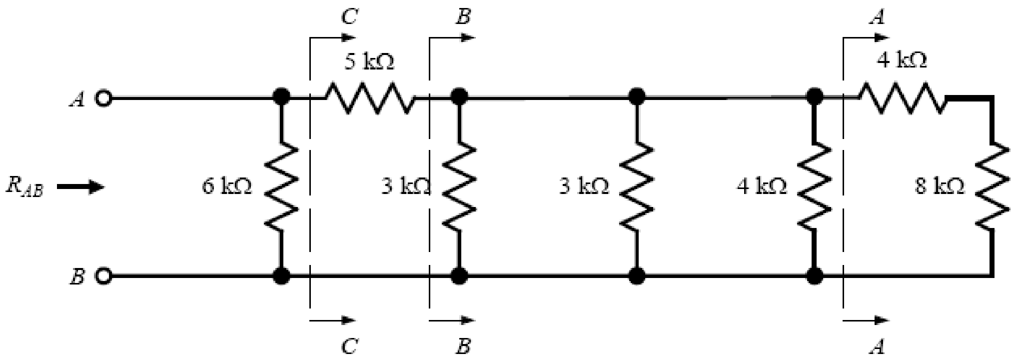
Problem 2.39

Find R_{AB} in the network shown.



Suggested Solution

The network can be redrawn as shown below.



At A-A: $4000+8000=12\ \text{k}\Omega$

At B-B: $3000\|3000\|4000\|12000=1\ \text{k}\Omega$

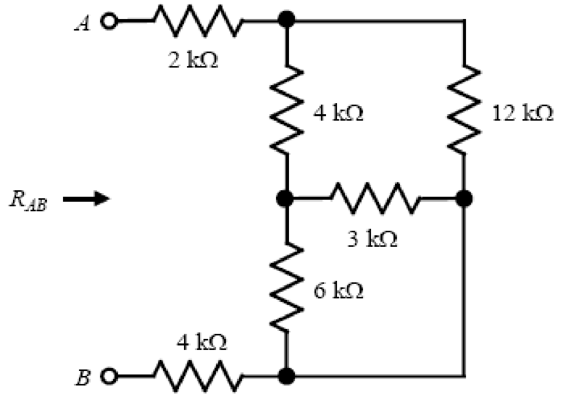
At C-C: $5000+1000=6\ \text{k}\Omega$

Therefore,

$R_{AB}=6000\|6000=3\ \text{k}\Omega$

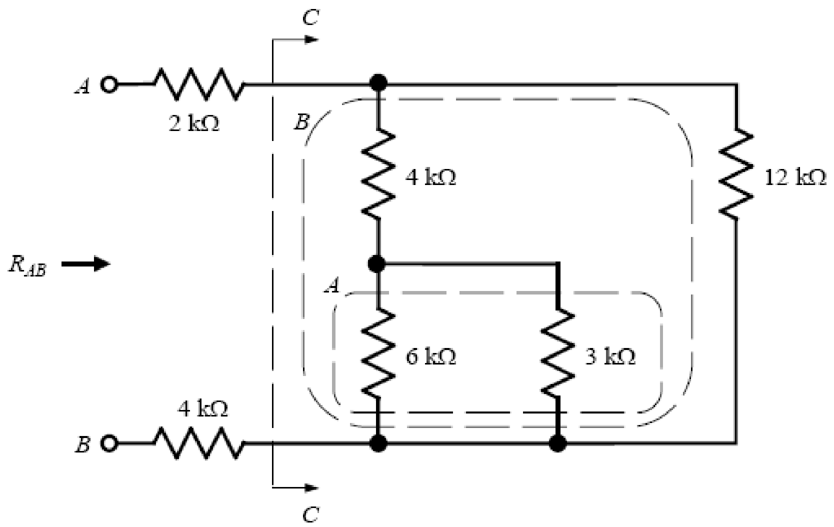
Problem 2.40

Find R_{AB} in the circuit shown.



Suggested Solution

The circuit can be redrawn as shown below.



At A: $6000 \| 3000 = 2\ \text{k}\Omega$

At B: $4000 + 2000 = 6\ \text{k}\Omega$

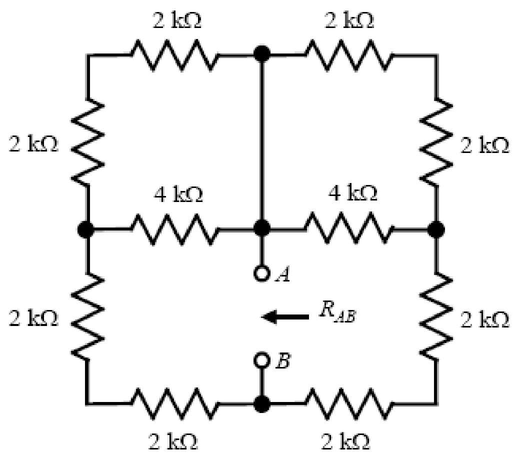
At C-C: $6000 \| 12000 = 4\ \text{k}\Omega$

Then,

$R_{AB} = 2000 + 4000 + 4000 = 10\ \text{k}\Omega$

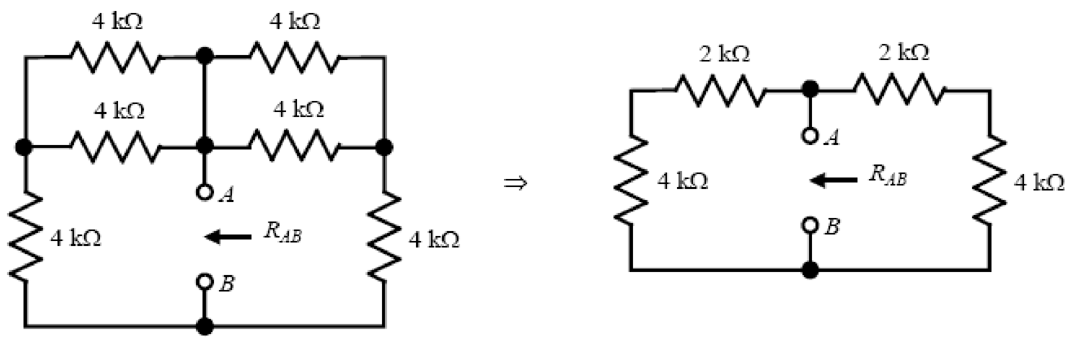
Problem 2.43

Find R_{AB} in the circuit shown.

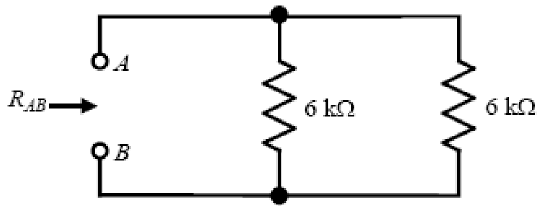


Suggested Solution

Combining each series pair of 2-kΩ resistors, the circuit can be redrawn as follows:



or

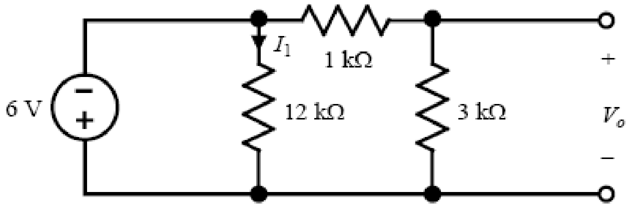


Then,

$R_{AB} = 6000 \| 6000 = 3\ \text{k}\Omega$

Problem 2.48

Find I_1 and V_o in the circuit shown.



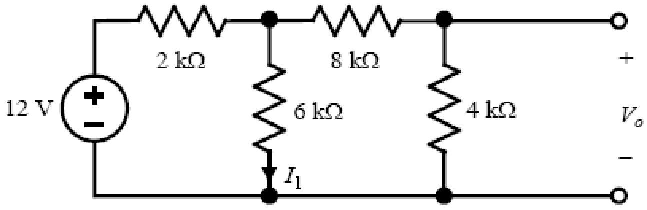
Suggested Solution

From Ohm's Law: $I_1 = \dfrac{-6 \text{ V}}{12 \text{ k}\Omega} = -0.5 \text{ mA}$

By application of voltage division: $V_o = \left(\dfrac{3 \text{ k}\Omega}{3 \text{ k}\Omega + 1 \text{ k}\Omega}\right)(-6 \text{ V}) = -4.5 \text{ V}$

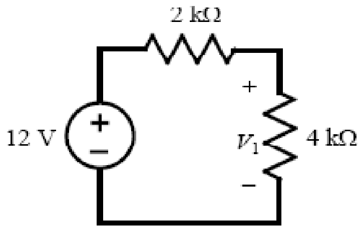
Problem 2.49

Find I_1 and V_o in the circuit shown.



Suggested Solution

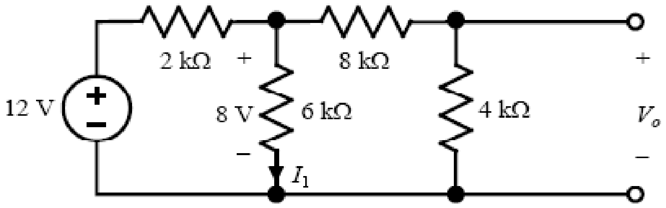
Combining resistors $\left[6\text{ k}\Omega \| (8\text{ k}\Omega + 4\text{ k}\Omega) = 4\text{ k}\Omega\right]$ reduces the network to the following:



Using voltage division, then

$$V_1 = \left(\frac{4000}{2000+4000}\right)(12\text{ V}) = 8\text{ V}.$$

Looking back at the original circuit,



Ohm's Law: $I_1 = \dfrac{8\text{ V}}{6\text{ k}\Omega} = \dfrac{4}{3}\text{ mA}$

Voltage division: $V_o = \left(\dfrac{4000}{8000+4000}\right)(8) = \dfrac{8}{3}\text{ V}$

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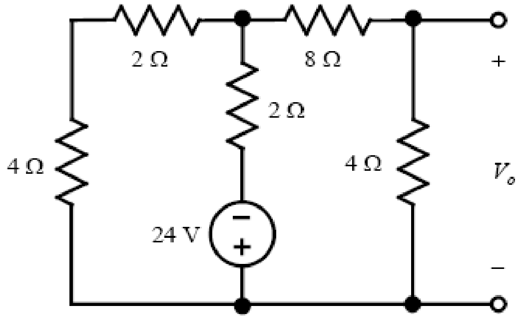
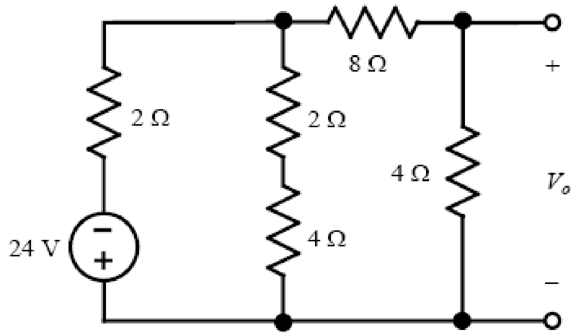
Problem 2.52

Find V_o in the network shown.

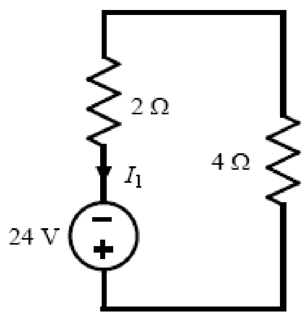


Suggested Solution

The network can be redrawn as:

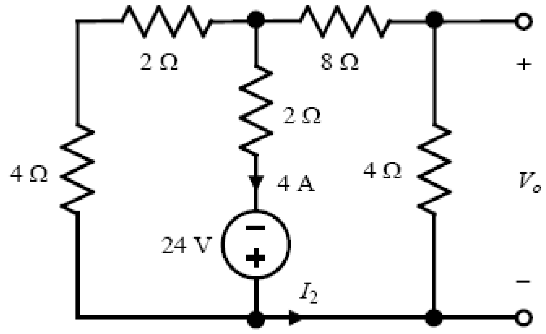


Combining the four resistors on the right-hand side $\left[(4\ \Omega + 2\ \Omega) \| (8\ \Omega + 4\ \Omega) = 4\ \Omega\right]$ yields:



and $I_1 = \dfrac{24\text{ V}}{(2\ \Omega + 4\ \Omega)} = 4\text{ A}$.

Then, reconsidering the original circuit,



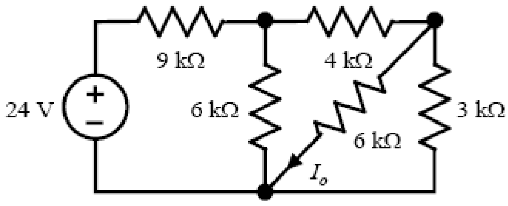
$$I_2 = \left[\frac{(4+2)}{(4+2)+(8+4)}\right](4\text{ A}) = \frac{4}{3}\text{ A}$$

and

$$V_o = -(4\text{ A})\left(\frac{4}{3}\text{ A}\right) = -\frac{16}{3}\text{ V}$$

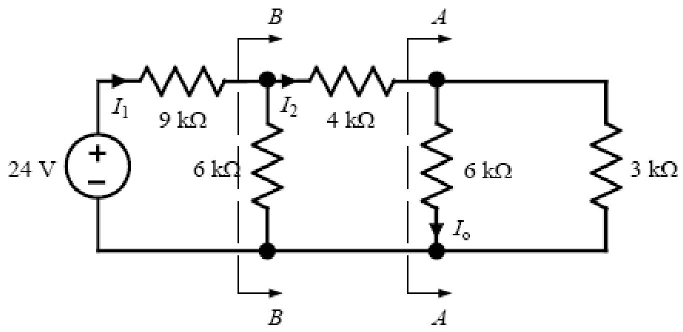
Problem 2.53

Find I_o in the circuit shown.



Suggested Solution

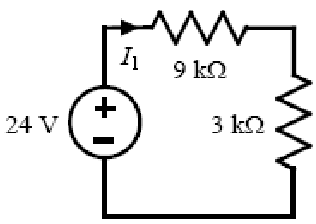
The circuit can be redrawn as:



At A-A: $6000 \| 3000 = 2 \text{ k}\Omega$

At B-B: $6000 \| (4000 + 2000) = 3 \text{ k}\Omega$

The circuit simplifies to:

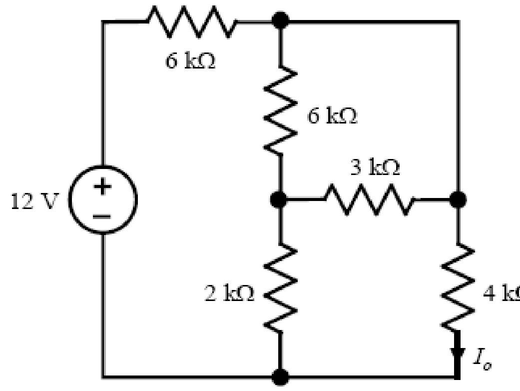


Then, $I_1 = \dfrac{24}{9000+3000} = 2 \text{ mA} \Rightarrow I_2 = \left[\dfrac{6000}{6000+(4000+2000)}\right] I_1 = 1 \text{ mA}$

and $I_o = \left(\dfrac{3000}{3000+6000}\right) I_2 = \dfrac{1}{3} \text{ mA}$.

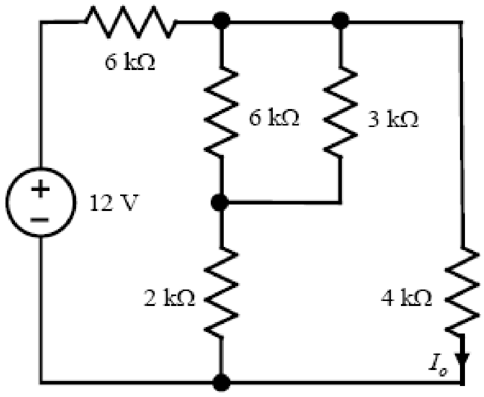
Problem 2.57

Find I_o in the circuit shown.



Suggested Solution

The circuit can be redrawn as:



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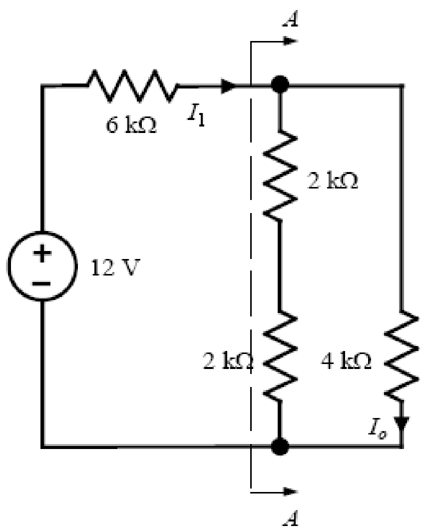


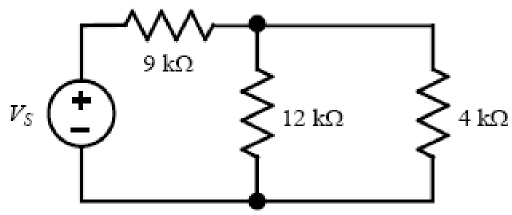
At A-A: $(2000+2000)\|4000 = 2\text{ k}\Omega$

$$I_1 = \frac{12}{6000+2000} = 1.5\text{ mA}$$

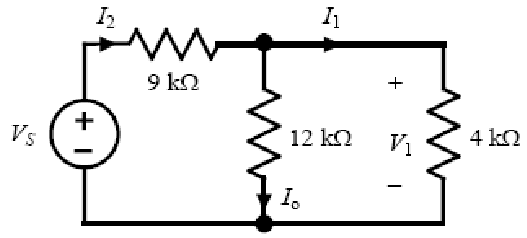
Using current division, $I_o = \left[\dfrac{(2000+2000)}{(2000+2000)+4000}\right] I_1 = 0.75\text{ mA}$

Problem 2.60

If the power absorbed by the 4-kΩ resistor in the circuit shown is 36 mW, find V_S.



Suggested Solution



$$P_{4\,\text{k}\Omega} = 36\text{ mW} = \frac{V_1^2}{4000} \quad \Rightarrow \quad V_1 = 12\text{ V}$$

$$I_o = \frac{V_1}{12\text{ k}\Omega} = 1\text{ mA}$$

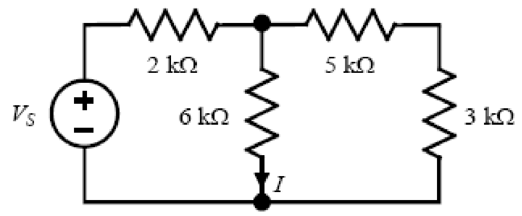
$$I_1 = \frac{V_1}{4\text{ k}\Omega} = 3\text{ mA}$$

$$I_2 = I_o + I_1 = 1\text{ mA} + 3\text{ mA} = 4\text{ mA}$$

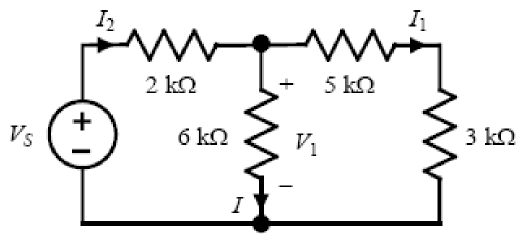
$$V_S = (9\text{ k}\Omega)I_2 + V_1 = 48\text{ V}$$

Problem 2.63

In the circuit shown, $I = 4$ mA. Find V_S.



Suggested Solution



$$V_1 = (6\text{ k}\Omega)I = 24 \text{ V}$$

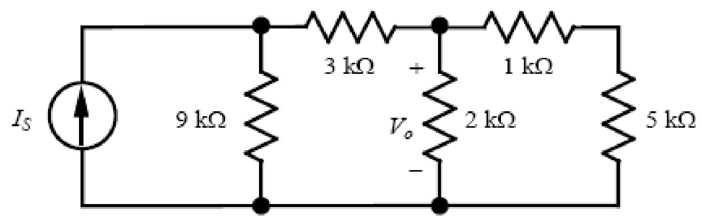
$$I_1 = \frac{V_1}{5\text{ k}\Omega + 3\text{ k}\Omega} = \frac{24}{8000} = 3 \text{ mA}$$

$$I_2 = I + I_1 = 0.004 + 0.003 = 7 \text{ mA}$$

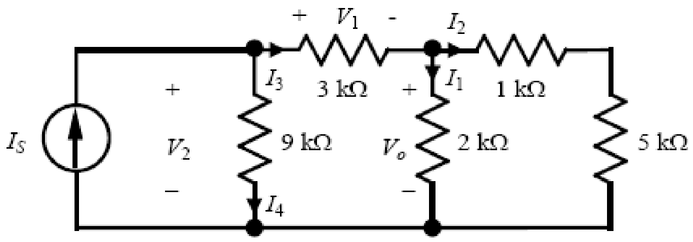
$$V_S = (2\text{ k}\Omega)I_2 + V_1 = 14 + 24 = 38 \text{ V}$$

Problem 2.67

In the network shown, $V_o = 6$ V. Find I_S.



Suggested Solution



$$I_1 = \frac{V_o}{2\text{ k}\Omega} = \frac{6}{2000} = 3\text{ mA}$$

$$I_2 = \frac{V_o}{1\text{ k}\Omega + 5\text{ k}\Omega} = \frac{6}{6000} = 1\text{ mA}$$

$$I_3 = I_1 + I_2 = 0.003 + 0.001 = 4\text{ mA}$$

$$V_1 = (3\text{ k}\Omega)I_3 = 12\text{ V}$$

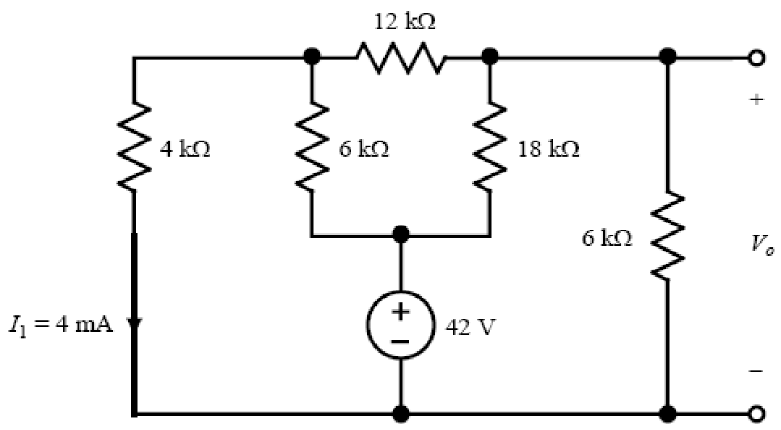
$$V_2 = V_1 + V_o = 12 + 6 = 18\text{ V}$$

$$I_4 = \frac{V_2}{9\text{ k}\Omega} = \frac{18}{9000} = 2\text{ mA}$$

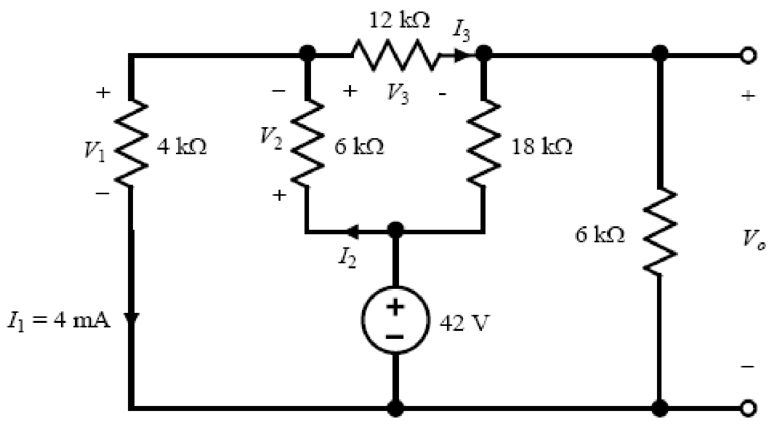
$$I_S = I_3 + I_4 = 0.004 + 0.003 = 6\text{ mA}$$

Problem 2.71

Find V_o in the circuit shown.



Suggested Solution



$V_1 = (4\ \text{k}\Omega) I_1 = 16\ \text{V}$

$V_2 = 42\ \text{V} - V_1 = 42 - 16 = 26\ \text{V}$

$I_2 = \dfrac{V_2}{6\ \text{k}\Omega} = \dfrac{26}{6000} = \dfrac{13}{3}\ \text{mA}$

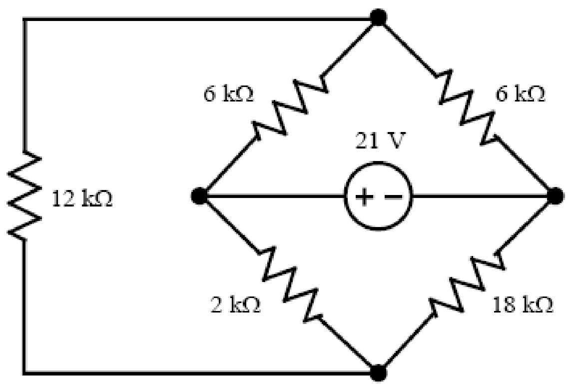
$I_3 = I_2 - I_1 = \dfrac{13}{3}\ \text{mA} - 4\ \text{mA} = \dfrac{1}{3}\ \text{mA}$

$V_3 = (12\ \text{k}\Omega) I_3 = 4\ \text{V}$

$V_o = V_1 - V_3 = 16 - 4 = 12\ \text{V}$

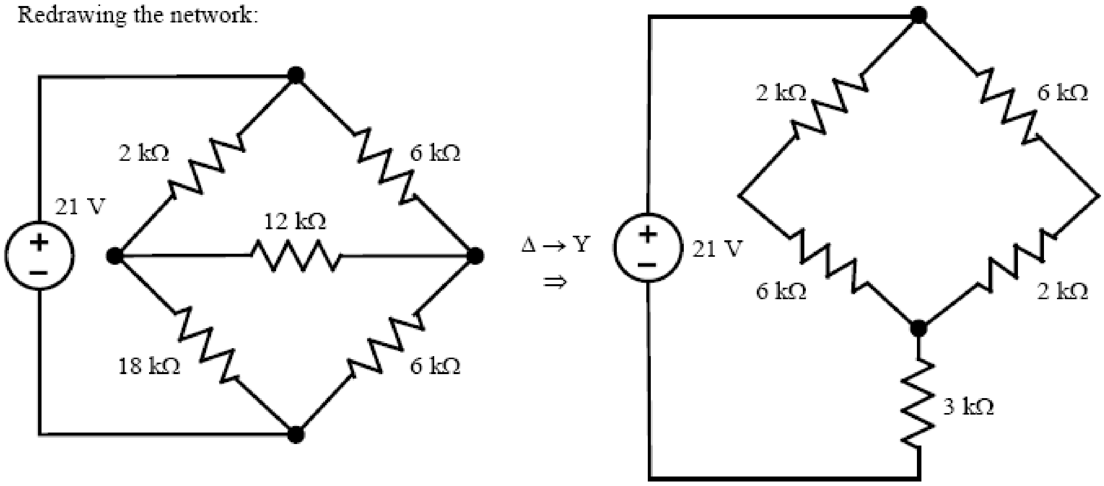
Problem 2.72

Find the power absorbed by the network shown.



Suggested Solution

Redrawing the network:



The equivalent resistance seen by the source is:

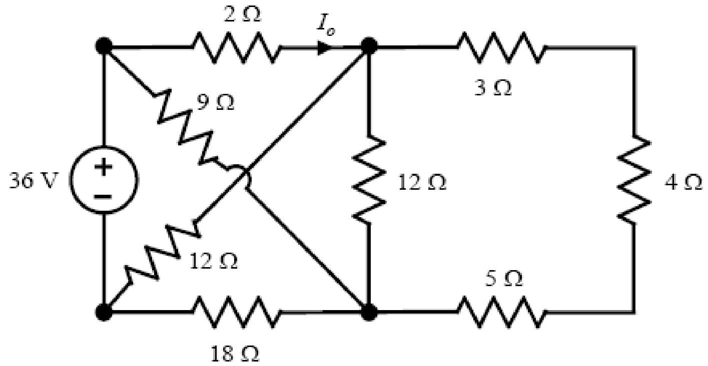
$$R_{eq} = \left[(2\text{ k}\Omega + 6\text{ k}\Omega) \| (6\text{ k}\Omega + 2\text{ k}\Omega)\right] + 3\text{ k}\Omega$$
$$= 4\text{ k}\Omega + 3\text{ k}\Omega$$
$$= 7\text{ k}\Omega$$

Then,

$$P = \frac{(21\text{ V})^2}{R_{eq}} = \frac{441}{7000} = 63\text{ mA}$$

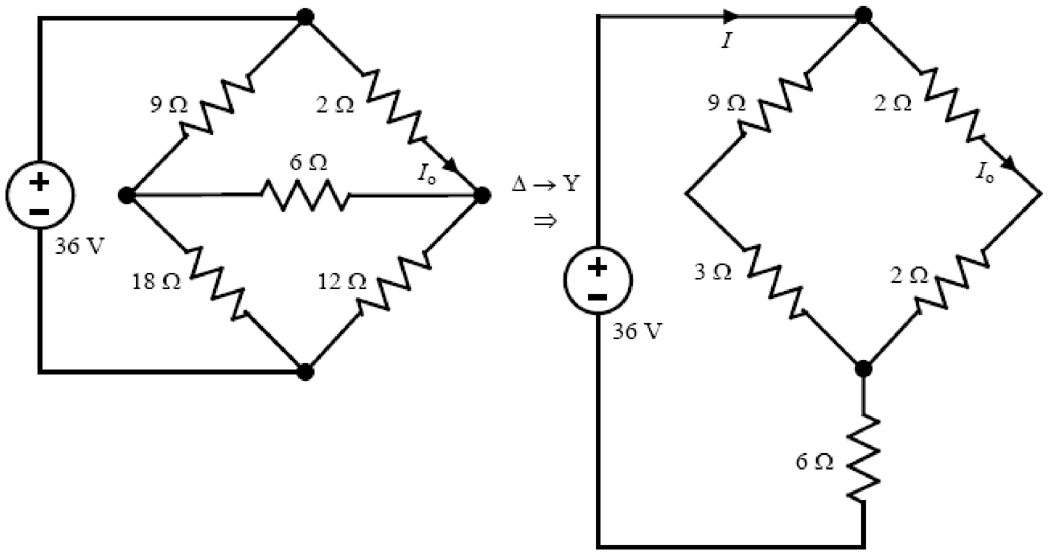
Problem 2.73

Find I_o in the circuit shown.



Suggested Solution

Note that the four right-most resistors can be combined as $(3\ \Omega + 4\ \Omega + 5\ \Omega)\|12\ \Omega = 6\ \Omega$. Then the circuit can be redrawn as:

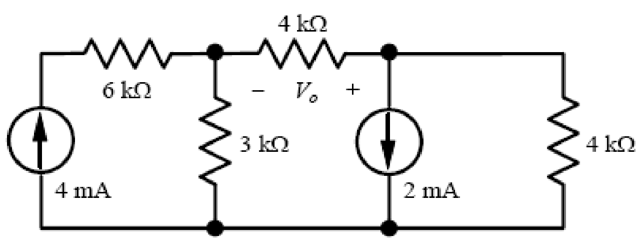


$$I = \frac{36\ \text{V}}{\left[(9\ \Omega + 3\ \Omega)\|(2\ \Omega + 2\ \Omega)\right] + 6\ \Omega} = 4\ \text{A}$$

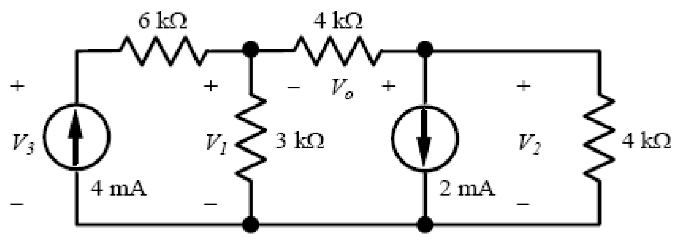
$$I_o = \left[\frac{(9+3)}{(9+3)+(2+2)}\right] I = 3\ \text{A}$$

Problem 3.4

Use nodal analysis to find V_o in the circuit shown.



Suggested Solution



$$\frac{V_3 - V_1}{6\ \text{k}\Omega} = 4\ \text{mA}$$

$$\frac{V_1 - V_3}{6\ \text{k}\Omega} + \frac{V_1}{3\ \text{k}\Omega} + \frac{V_1 - V_2}{4\ \text{k}\Omega} = 0$$

$$\frac{V_2 - V_1}{4\ \text{k}\Omega} + \frac{V_2}{4\ \text{k}\Omega} = -2\ \text{mA}$$

In matrix form:

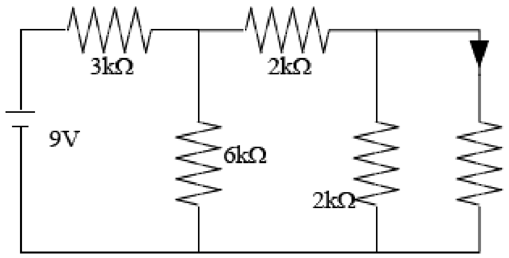
$$\begin{bmatrix} -\frac{1}{6000} & 0 & \frac{1}{6000} \\ \frac{1}{6000}+\frac{1}{3000}+\frac{1}{4000} & -\frac{1}{4000} & -\frac{1}{6000} \\ -\frac{1}{4000} & \frac{1}{4000}+\frac{1}{4000} & 0 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 0.004 \\ 0 \\ -0.002 \end{bmatrix} \quad \Rightarrow \quad \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 6.5455 \\ -0.7273 \\ 30.5455 \end{bmatrix}$$

$$\therefore\ V_o = V_2 - V_1 = -0.73 - 6.55 = -7.28\ \text{V}$$

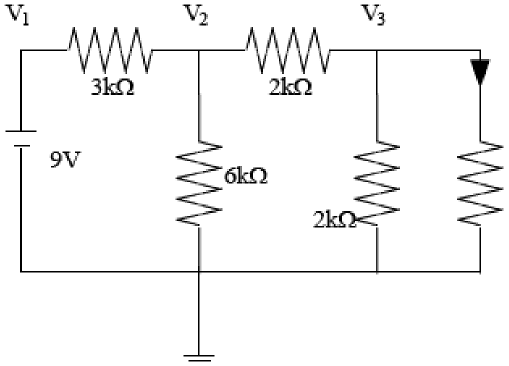
Alternately, since we know the current through the $6\ \text{k}\Omega$ resistor is 4 mA, we know that $V_3 = V_1 + 24\ \text{V}$. Therefore, we really need only 2 equations to solve this problem. Those are:

Problem 3.5

Find I_0 in the circuit using nodal analysis



Suggested Solution



$V_1 = 9V$

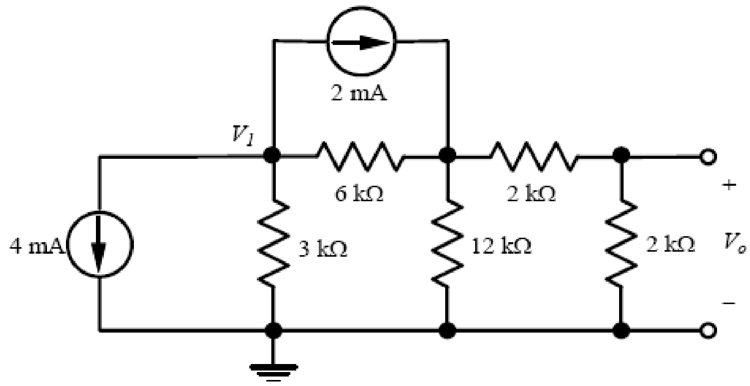
$$\frac{9 - V_2}{3k} = \frac{V_2}{6k} + \frac{V_2 - V_3}{2k}$$

$$V_3 = 1.2V$$
$$I_0 = 0.6mA$$

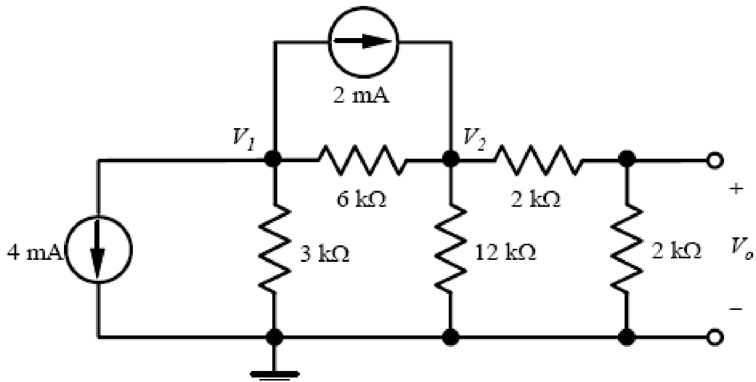
$$\frac{V_3 - V_2}{2k} + \frac{V_3}{2k} + \frac{V_3}{2k} = 0 \Rightarrow V_3 = 1.2V, I_0 = \frac{1.2}{2k} = 0.6mA$$

Problem 3.6

Use nodal analysis to find both V_1 and V_o in the circuit shown.



Suggested Solution



$$\frac{V_1}{3\text{ k}\Omega}+\frac{V_1-V_2}{6\text{ k}\Omega}=-4\text{ mA}-2\text{ mA}$$

$$\frac{V_2-V_1}{6\text{ k}\Omega}+\frac{V_2}{12\text{ k}\Omega}+\frac{V_2}{2\text{ k}\Omega+2\text{ k}\Omega}=2\text{ mA}$$

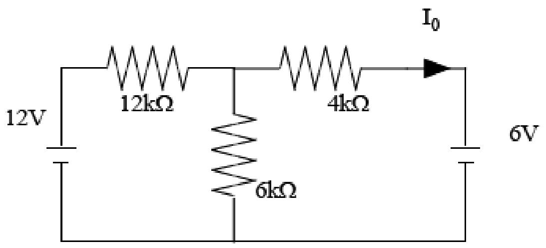
In matrix form:

$$\begin{bmatrix} \frac{1}{3000}+\frac{1}{6000} & -\frac{1}{6000} \\ -\frac{1}{6000} & \frac{1}{6000}+\frac{1}{12000}+\frac{1}{4000} \end{bmatrix}\begin{bmatrix} V_1 \\ V_2 \end{bmatrix}=\begin{bmatrix} -0.006 \\ 0.002 \end{bmatrix} \quad \Rightarrow \quad \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}=\begin{bmatrix} -12 \\ 0 \end{bmatrix}$$

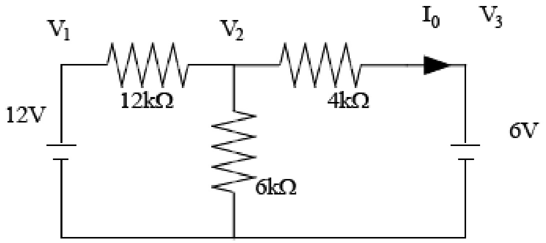
$$\therefore\ V_1=-12\text{ V and } V_o=\frac{2000}{2000+2000}V_2=0\text{ V}$$

Problem 3.8

Find I_0 in the network using nodal analysis



Suggested Solution



$$V_1=12V;V_3=-6V$$

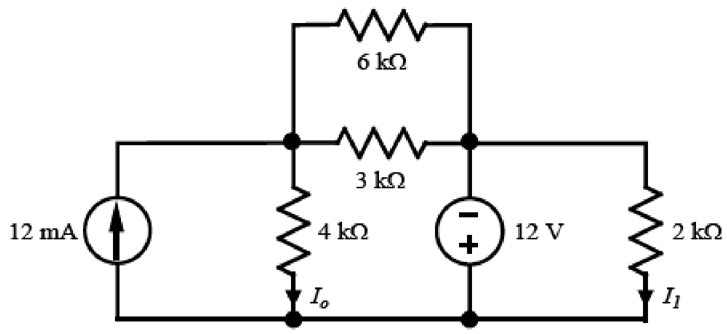
$$\frac{V_2-12}{12K}+\frac{V_2}{6k}+\frac{V_2+6}{4k}=0\Rightarrow V_2=-1V$$

$$V_2=-1V;I_0=1.25mA$$

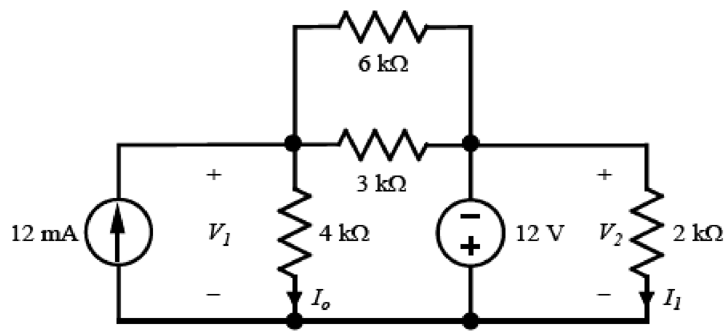
$$I_0=\frac{V_2-V_3}{4k}=\frac{-1+6}{4k}=1.25mA$$

Problem 3.10

Use nodal analysis to find I_o and I_1 in the circuit shown.



Suggested Solution



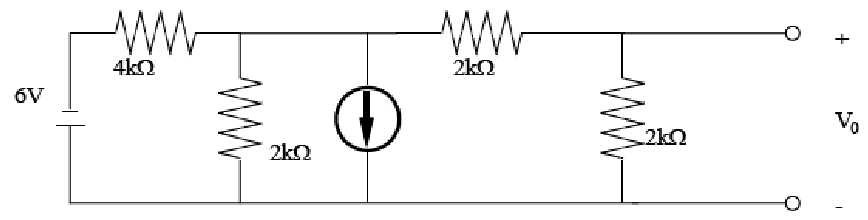
$$V_2 = -12 \text{ V} \quad \Rightarrow \quad I_1 = \frac{V_2}{2 \text{ k}\Omega} = \frac{-12}{2000} = -6 \text{ mA}$$

$$-12 \text{ mA} + \frac{V_1}{4 \text{ k}\Omega} + \frac{V_1 - (-12 \text{ V})}{6 \text{ k}\Omega} + \frac{V_1 - (-12 \text{ V})}{3 \text{ k}\Omega} = 0 \quad \Rightarrow \quad V_1 = 8 \text{ V} \quad \Rightarrow \quad I_o = \frac{V_1}{4 \text{ k}\Omega} = \frac{8}{4000} = 2 \text{ mA}$$

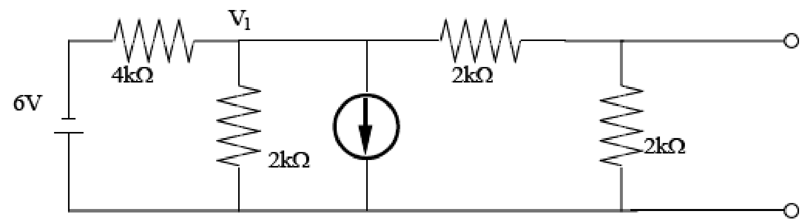
$$\boxed{I_o = 2 \text{ mA}\ ,\ I_1 = -6 \text{ mA}}$$

Problem 3.12

Use nodal analysis to find V_0 in the network



Suggested Solution



$$\frac{V_1-(-6)}{4k}+\frac{V_1}{2k}+\frac{2}{k}+\frac{V_1}{2k+2k}=0$$

$\Rightarrow$

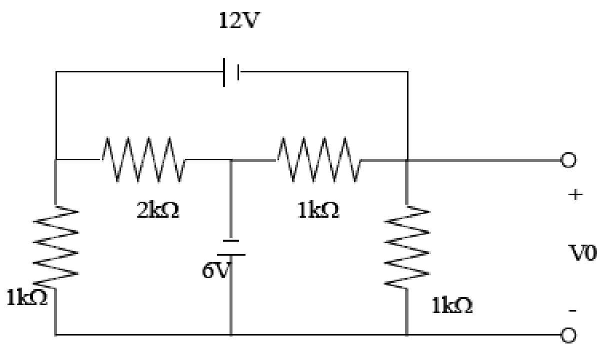
$$V_1=\frac{-7}{2}V;\therefore V_0=\frac{-7}{2}\left(\frac{2k}{2k+2k}\right)$$

$$V_0=\frac{-7}{4}V$$

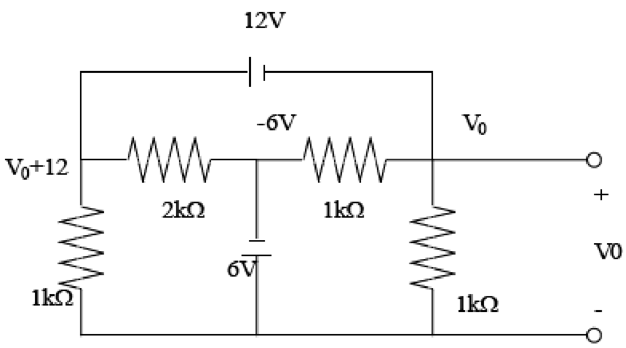
$$V_1=\frac{-7}{2}V$$
$$V_0=\frac{-7}{4}V$$

Problem 3.22

Find V_0 in the circuit shown using Nodal Analysis



Suggested Solution



$$\frac{V_0+12}{1k}+\frac{V_0+12+6}{2k}+\frac{V_0+6}{1k}+\frac{V_0}{1k}=0$$

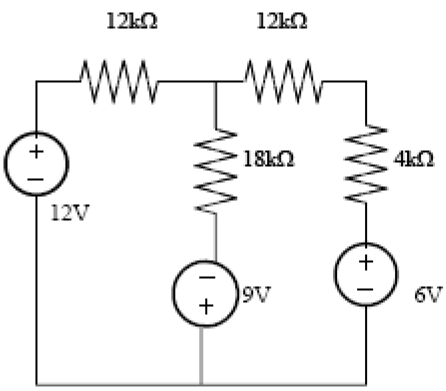
$$V_0(\frac{7}{2k})=\frac{-27}{1k}$$

$$\therefore V_0=-7.17V$$

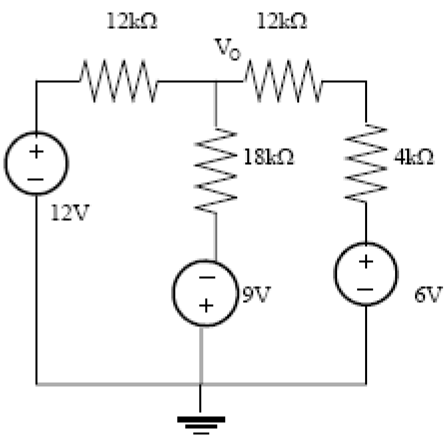
$$V_0=-7.17V$$

Problem 3.26

Find the V_O in the circuit shown using nodal analysis.



Suggested Solution



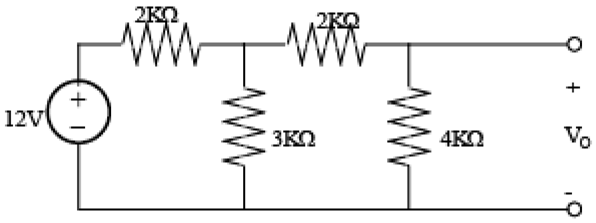
$$\frac{V_0 - 12}{12K} + \frac{V_0 + 9}{18K} + \frac{V_0 + 6}{16K} = 0$$

$$V_0 = 0.621V$$

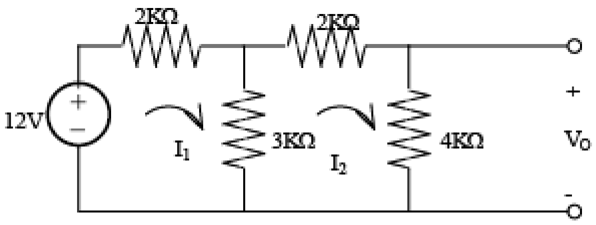
$$V_0\left(\frac{1}{12} + \frac{1}{18} + \frac{1}{16}\right) = 0.621V$$

Problem 3.42

Use mesh equations to find Vo in the circuit shown.



Suggested Solution



$$\begin{bmatrix} 5K & -3K \\ -3K & 4K \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 12 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 5K & -3K \\ -3K & 4K \end{bmatrix}^{-1} \begin{bmatrix} 1_2 \\ 0 \end{bmatrix}$$

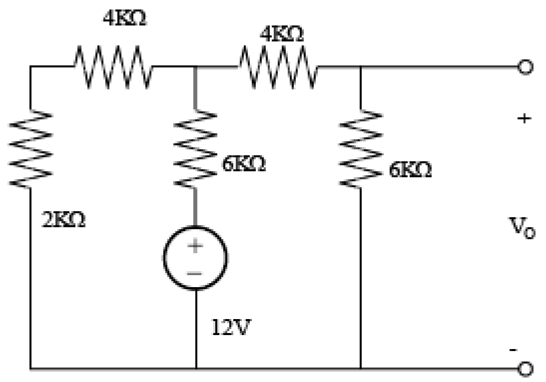
$$V_0 = 4V$$

$$I_2 = \frac{1}{K} A$$

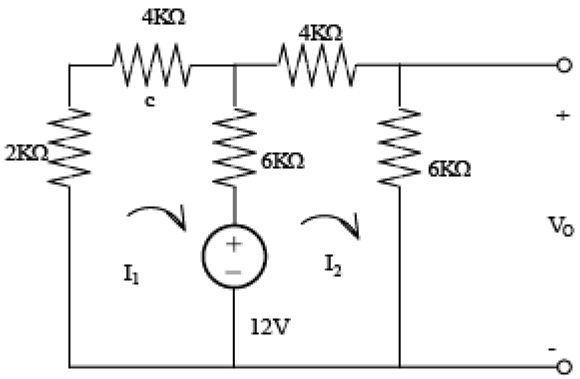
$$V_0 = 4V$$

Problem 3.44

Use mesh analysis to find Vo in the circuit shown.



Suggested Solution



$$\begin{bmatrix} 12K & -6K \\ -6K & 12K \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} -12 \\ 12 \end{bmatrix}$$

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 12K & -6K \\ -6K & 12K \end{bmatrix}^{-1} \begin{bmatrix} -12 \\ 12 \end{bmatrix}$$

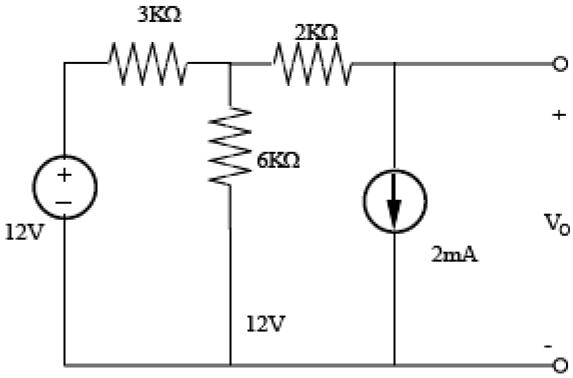
$$V_0 = \frac{4}{3}V$$

$$I_2 = \frac{2}{3}mA$$

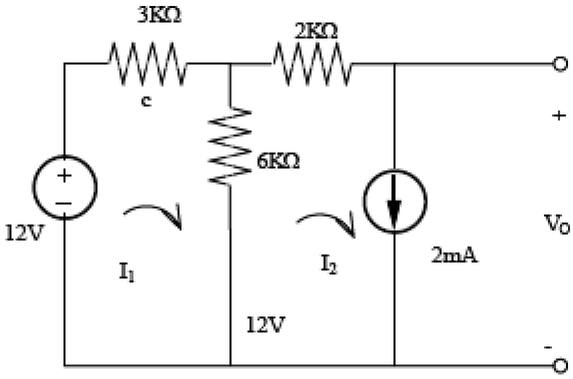
$$V_0 = \frac{4}{3}V$$

Problem 3.45

Use mesh analysis to find Vo in the network shown.



Suggested Solution



$$-12 + 3KI_1 + K(I_1 - I_2) = 0$$

$$I_2 = \frac{2}{K}$$

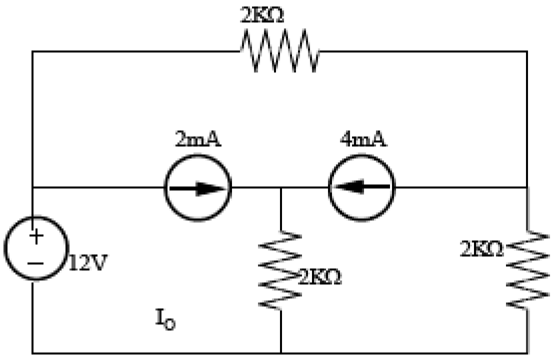
$$I_1 = \frac{8}{3K}$$

$$-12 + 3K(\frac{8}{3K}) + 2K(\frac{2}{K}) = V_0 = 0V$$

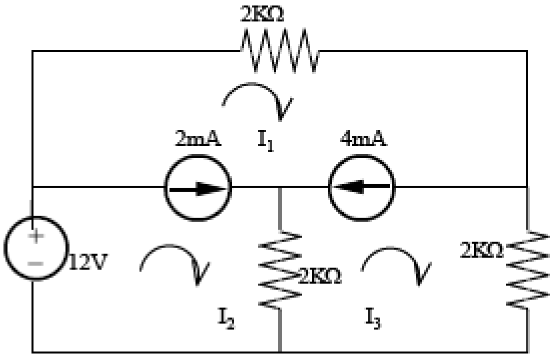
$$V_0 = 0V$$

Problem 3.47

Use loop analysis to find Io in the circuit shown.



Suggested Solution



$$12 = 2KI_2 + 2KI_3$$

$$I_1 - I_2 = \frac{2}{K}$$

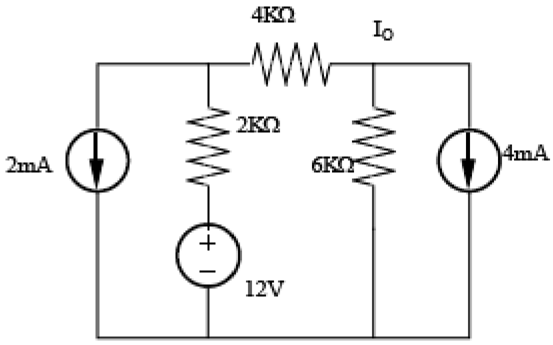
$$I_2 - I_3 = \frac{4}{K}$$

$I_1 = I_0 = 7mA$

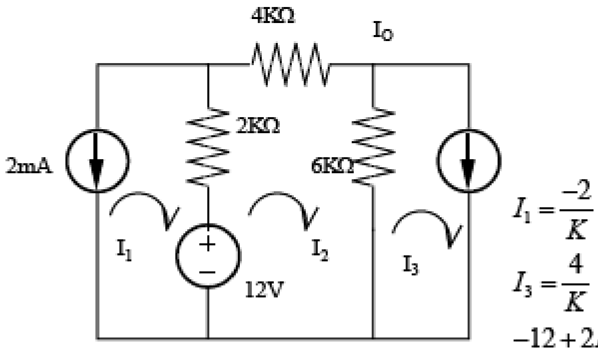
$$I_1 = I_0 = 7mA$$

Problem 3.49

Find Io in the network shown using mesh analysis.



Suggested Solution



$$I_1 = \frac{-2}{K}$$

$$I_3 = \frac{4}{K}$$

$$-12 + 2K(I_2 - I_1) + 4KI_2 + 6K(I_2 - I_3) = 0$$

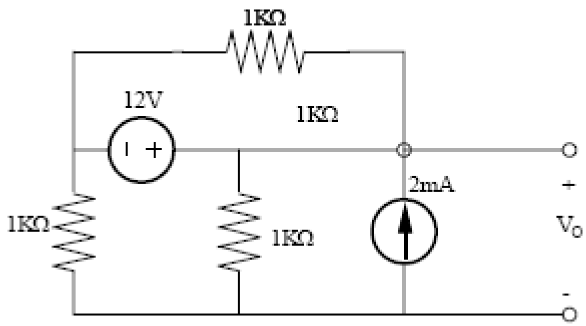
$$I_2 = \frac{16}{6} mA$$

$$I_0 = I_2 = 2.67mA$$

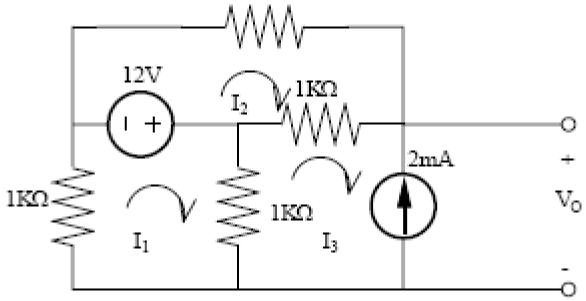
$$I_0 = I_2 = 2.67mA$$

Problem 3.51

Find Vo in the circuit shown using mesh analysis.



Suggested Solution



$$2KI_1 - 1KI_3 = -12$$
$$2KI_2 - 1KI_3 = 12$$
$$I_3 = \frac{-2}{K}$$
$$\Rightarrow$$
$$2KI_1 + 2 = -12$$
$$2KI_2 + 2 = 12$$

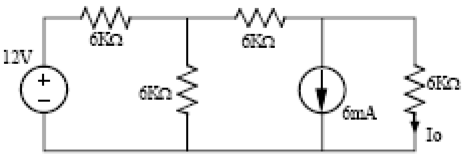
$$V_0 = 2V$$

$$I_1 = \frac{-7}{K}, I_2 = \frac{5}{K}$$

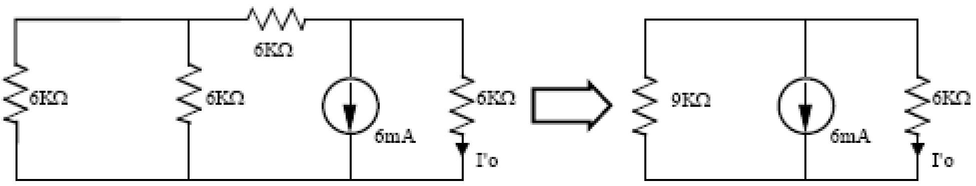
$$V_O = \frac{7}{K}(1K) - \frac{5}{K}(1K) = 2V$$
$$V_0 = 2V$$

Problem 4.5

In the network shown find Io using superposition

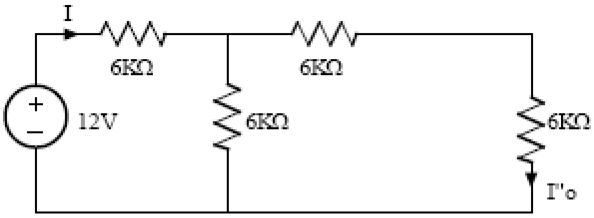


Suggested Solution



Zero the indep. voltage source

$$I'_o = -0.006\left(\tfrac{9K}{9K+6K}\right) = -\tfrac{18}{5}\,mA$$



Zero the indep. current souce

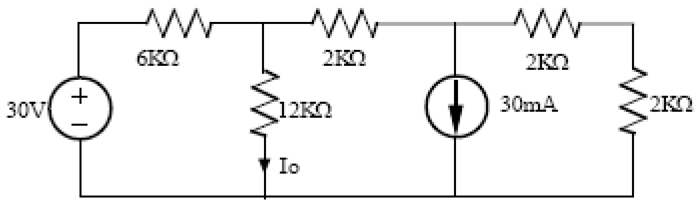
$$I = \frac{12}{6K+6K\,\|\,(6K+6K)} = \tfrac{6}{5}\,mA$$

$$I''_o = I\left(\tfrac{6K}{6K+12K}\right) = \tfrac{2}{5}\,mA$$

$$\boxed{I_o = I'_o + I''_o = \left(-\tfrac{18}{5}+\tfrac{2}{5}\right)mA = -\tfrac{16}{5}\,mA}$$

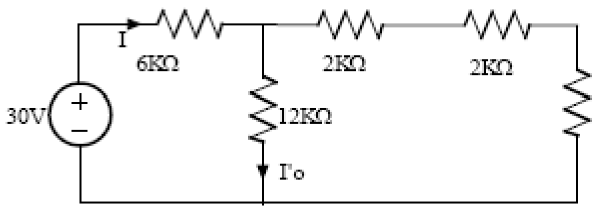
Problem 4.6

Find Io in the circuit shown using superposition



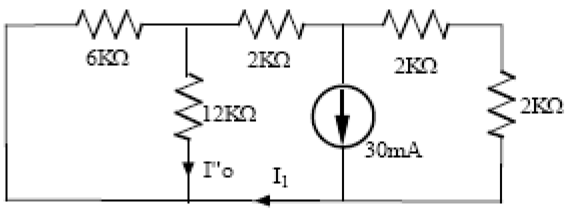
Suggested Solution

Zero the indep. current source



$I = \frac{30}{6K+12K||6K} = 3mA, \qquad I'o = I\frac{6K}{18K} = 1mA$

Zero the indep. voltage source



$I_1 = 0.03(\frac{4K}{4K+2K+6K||12K}) = 12mA$

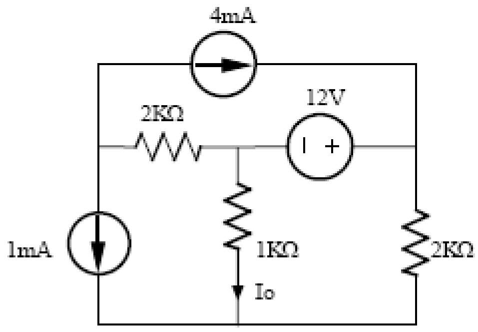
$I"o = -0.012(\frac{6K}{18K}) = -4mA$

$\boxed{Io = I'o + I"o = 3mA}$

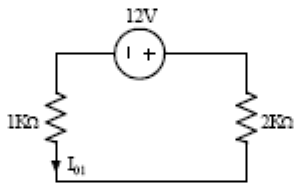
~

Problem 4.16

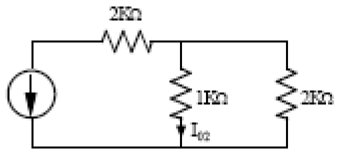
Find Io in the network shown using superposition.



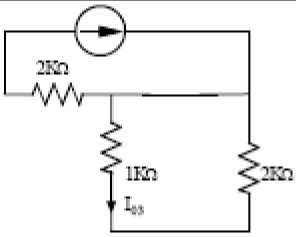
Suggested Solution



Io due to 12V source



Io due to 2mA source



Io due to 4mA source

I_{01}= -12/(1K+12K) = -4mA

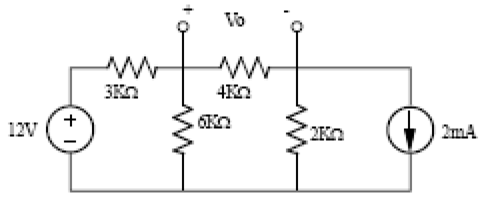
I_{02} = 2m[2K/(2K+3K)] = -1.33mA

I_{03}=0A

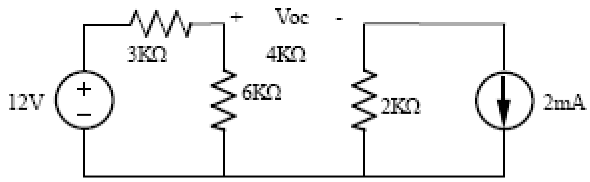
$\boxed{Io = I_{01} + I_{02} + I_{03} = -5.33mA}$

Problem 4.32

Use Thevenin's Theorem to find Vo in the network shown.

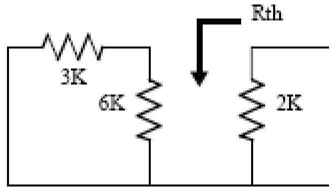


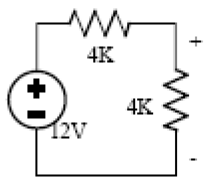
Suggested Solution



Voc = 12 (6K / 9K) + 2m 2K = 12V

Rth = 3K || 6K + 12K = 4K

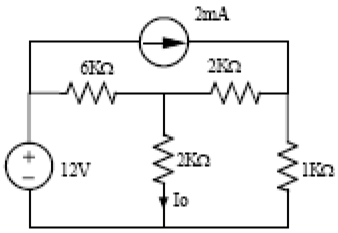




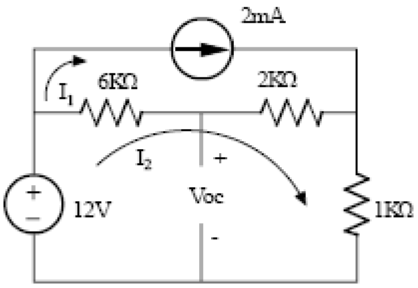
$\boxed{Vo = 6V}$

Problem 4.34

Use Thevenin's Theorem to find Io in the network shown.



Suggested Solution

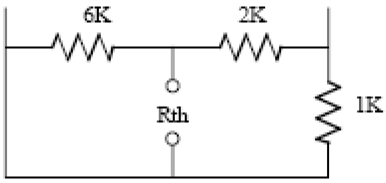


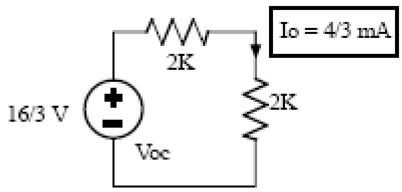
$I_1 = 2mA$

$-I_2 + 6K(I_2 - 2m) + 2K(I_2 - 2m) + 1K I_2 = 0$

$I2 = 28 / 9$ mA

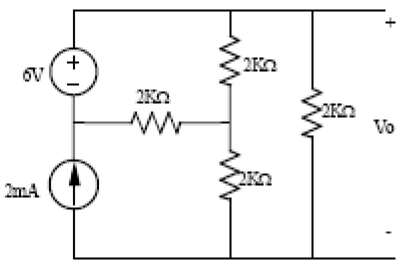
Then $Voc = 12 - 6K(I2 - 2m) = 16 / 3V$



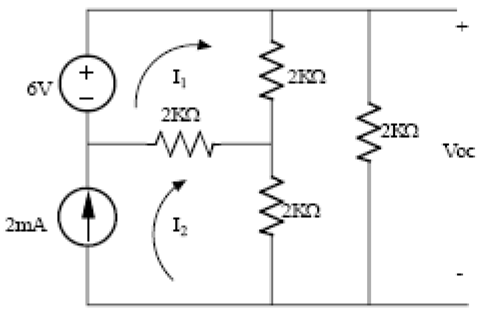


Problem 4.40

Find Vo in the circuit shown using Thevenin's Theorem.



Suggested Solution

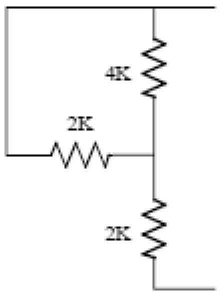


$I_2 = 2m$

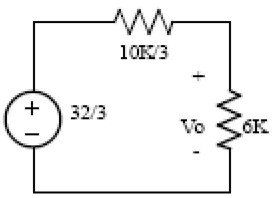
$-6 + 4K I_1 + 2K(I_1 - 2m) = 0$

$I_1 = 10/6K = 5/3$ mA

$Voc = 4K I_1 + 2K I_2 = 4K(5/3m) + 2K\,2m = 32/3V$



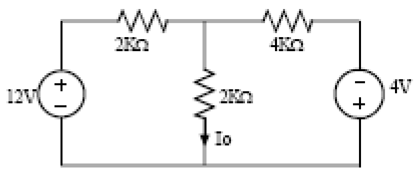
Rth = 2K + 4K || 2K = 10K/3



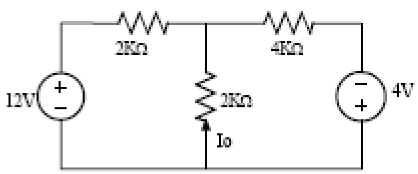
$\boxed{Vo = 32/3\ [6K/(6K + 10/3\ K)] = 48/7\ V}$

Problem 4.62

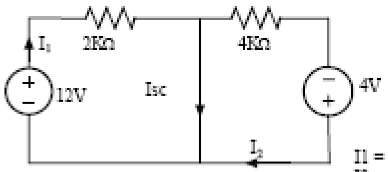
Find Io in the network shown using Norton's Theorem



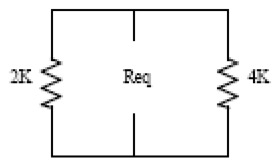
Suggested Solution



Find Isc

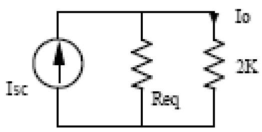


I1 = 12 / 2K = 6mA
I2 = 4 / 4K = 1mA
Isc = I1 - I2 = 5mA



Req = 2K || 4K

Req = 1.33 KΩ

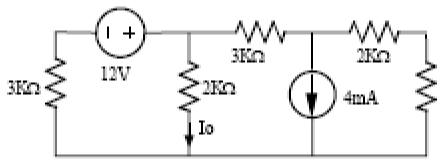


Io = Isc[Req/(Req + 2K)]

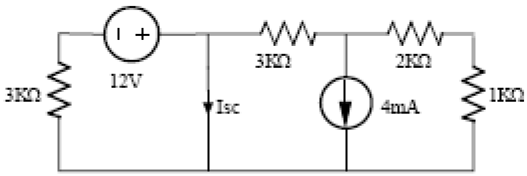
$\boxed{Io = 2mA}$

Problem 4.63

Use Norton's Theorem to find Io in the circuit shown.

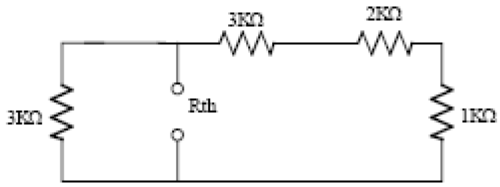


Suggested Solution

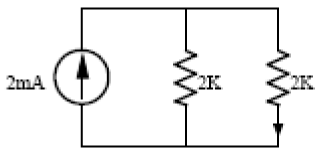


$Isc = 12 / 3K - 4m[3K / (3K + 3K)]$

$Isc = 2mA$



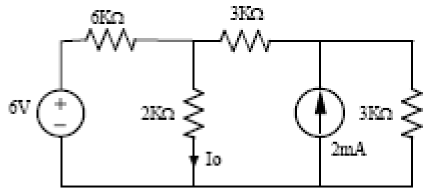
$Rth = 3K \parallel 6K = 2K\Omega$



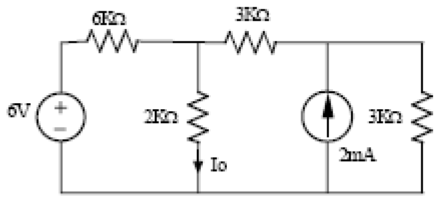
$\boxed{Io = 1mA}$

Problem 4.64

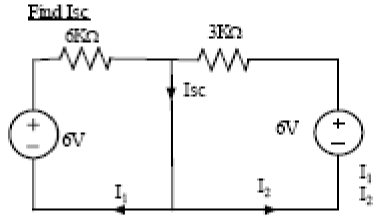
Find Io in the network shown using Norton's Theorem.



Suggested Solution



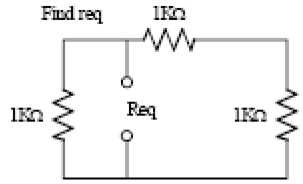
Find Isc



$I_1 = 6 / 6K = 1mA$
$I_2 = 6 / 6K = 1mA$

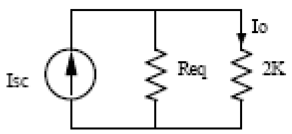
$Isc = I_1 + I_2 = 2mA$

Find req



Req = 6K || (3K + 3K)

Req = 3KΩ

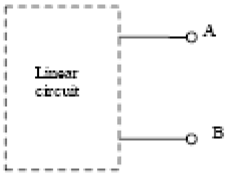


Io = Isc [Req / (Req + 2K)]

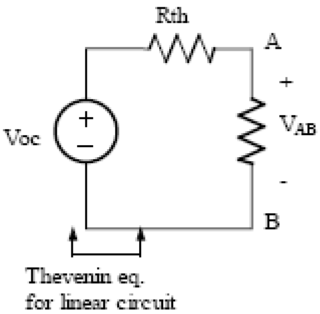
$\boxed{Io = 1.2 \text{ mA}}$

Problem 4.69

If an 8-KΩ load is connected to the terminals of the network shown, $V_{AB} = 16V$. If a 2-KΩ load is connected to the terminals $V_{AB} = 8V$. Find V_{AB} if a 20KΩ load is connected to the terminals.



Suggested Solution



$V_{AB} = Voc[\ R_L\ /\ (R_L + Rth)\ ] \Rightarrow Voc = V_{AB}\ [\ 1 + Rth\ /\ R_L\ ]$

If $R_L = 8K\Omega$, $V_{AB} = 16V \Rightarrow Voc = 16\ [\ 1 + Rth\ /\ 8K\ ]$

If $R_L = 2K\Omega$, $V_{AB} = 8V \Rightarrow Voc = 8\ [\ 1 + Rth\ /\ 2K\ ]$

yield: $Rth = 4K\Omega$ and $Voc = 24V$

If $RL = 20K\Omega$, $V_{AB} = 24\ [\ 20\ /\ (20 + 4)\ ]$

$\boxed{V_{AB} = 20\ V}$