YILDIZ ve ÜÇGEN ŞEKİLDE BAĞLI DİRENÇLER

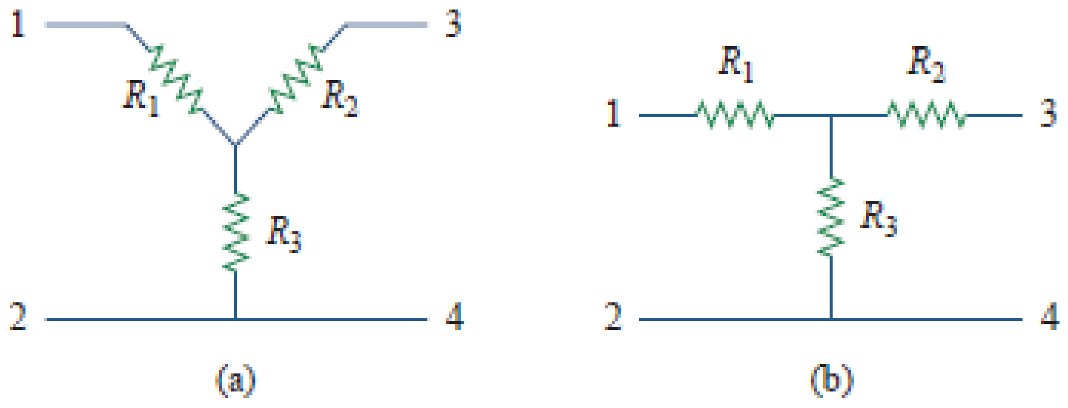


Figure 2.47
Two forms of the same network: (a) Y, (b) T.

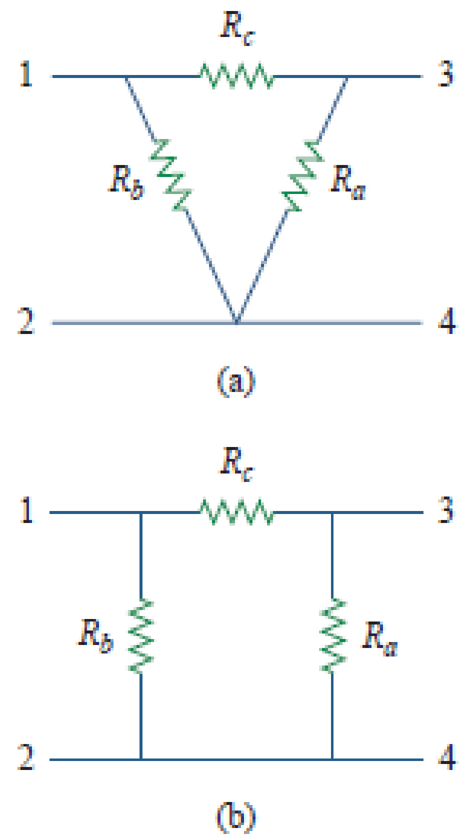
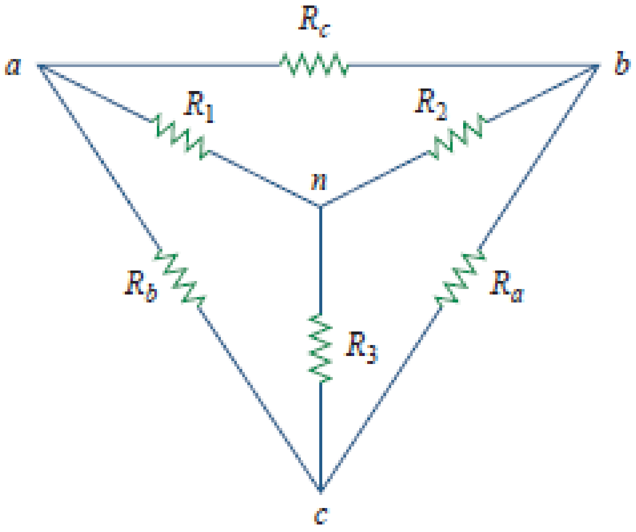


Figure 2.48
Two forms of the same network: (a) Δ, (b) Π.

YILDIZ-ÜÇGEN DÖNÜŞÜMÜ



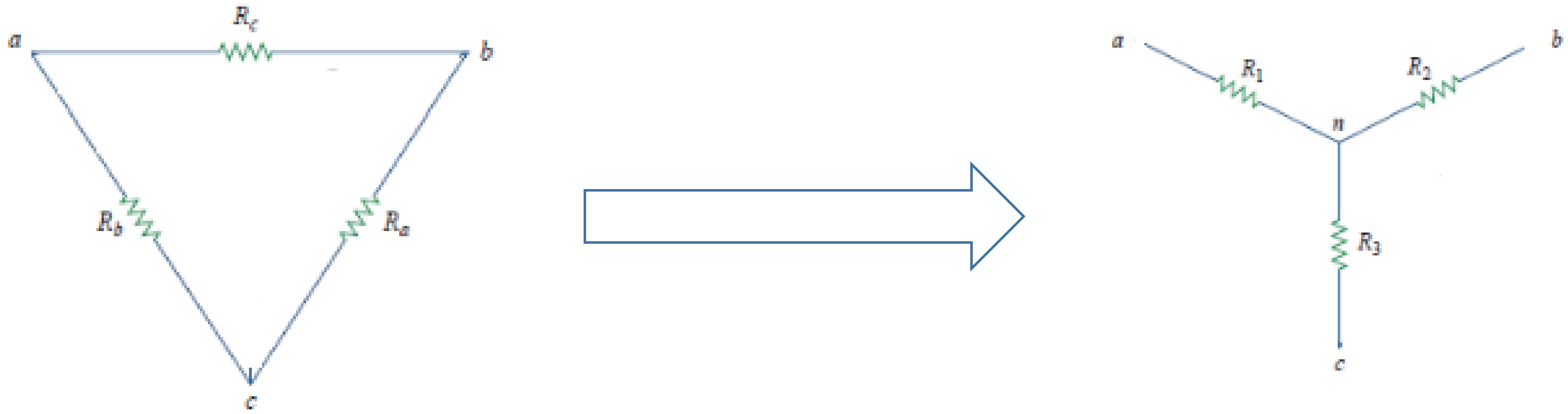
Hatırlatıcı

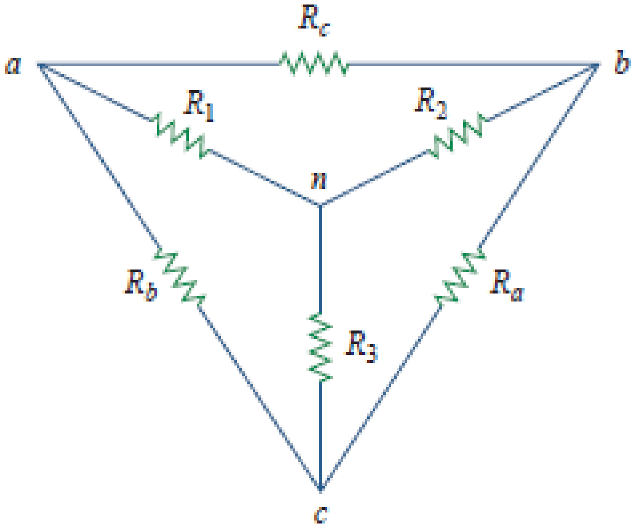
$$R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}$$

$$R_b = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2}$$

$$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}$$

ÜÇGEN-YILDIZ DÖNÜŞÜMÜ





Hatırlatıcı

$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}$$

$$R_2 = \frac{R_c R_a}{R_a + R_b + R_c}$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c}$$

Convert the Δ network in Fig. 2.50(a) to an equivalent Y network.

Example 2.14

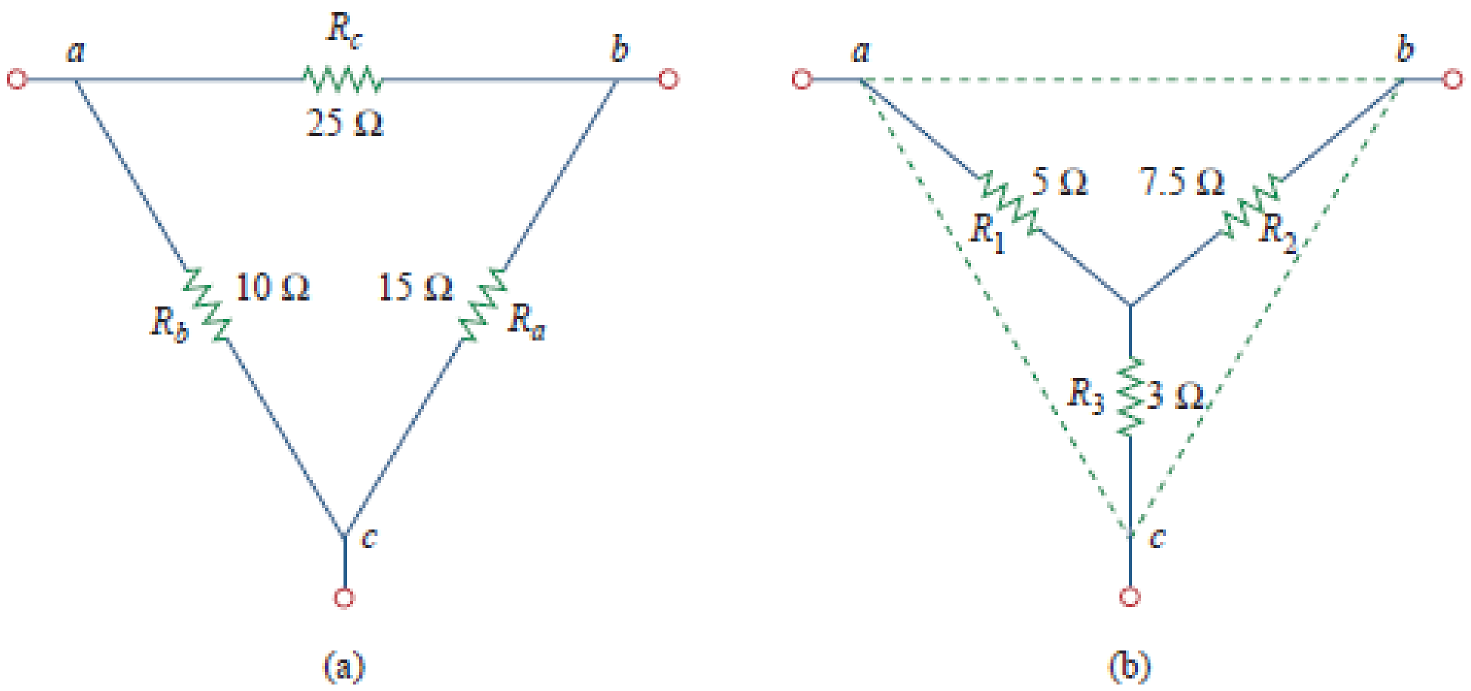


Figure 2.50
For Example 2.14: (a) original Δ network, (b) Y equivalent network.

Solution:

Using Eqs. (2.49) to (2.51), we obtain

$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c} = \frac{10 \times 25}{15 + 10 + 25} = \frac{250}{50} = 5\ \Omega$$

$$R_2 = \frac{R_c R_a}{R_a + R_b + R_c} = \frac{25 \times 15}{50} = 7.5\ \Omega$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c} = \frac{15 \times 10}{50} = 3\ \Omega$$

The equivalent Y network is shown in Fig. 2.50(b).

Practice Problem 2.14

Transform the wye network in Fig. 2.51 to a delta network.

Answer: $R_a = 140\ \Omega$, $R_b = 70\ \Omega$, $R_c = 35\ \Omega$.

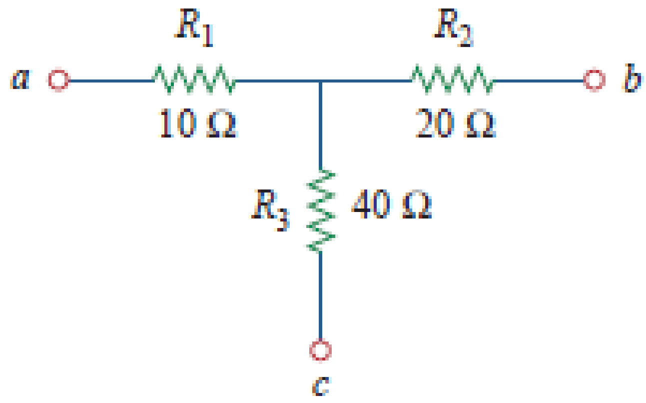


Figure 2.51
For Practice Prob. 2.14.

Example 2.15

Obtain the equivalent resistance R_{ab} for the circuit in Fig. 2.52 and use it to find current i.

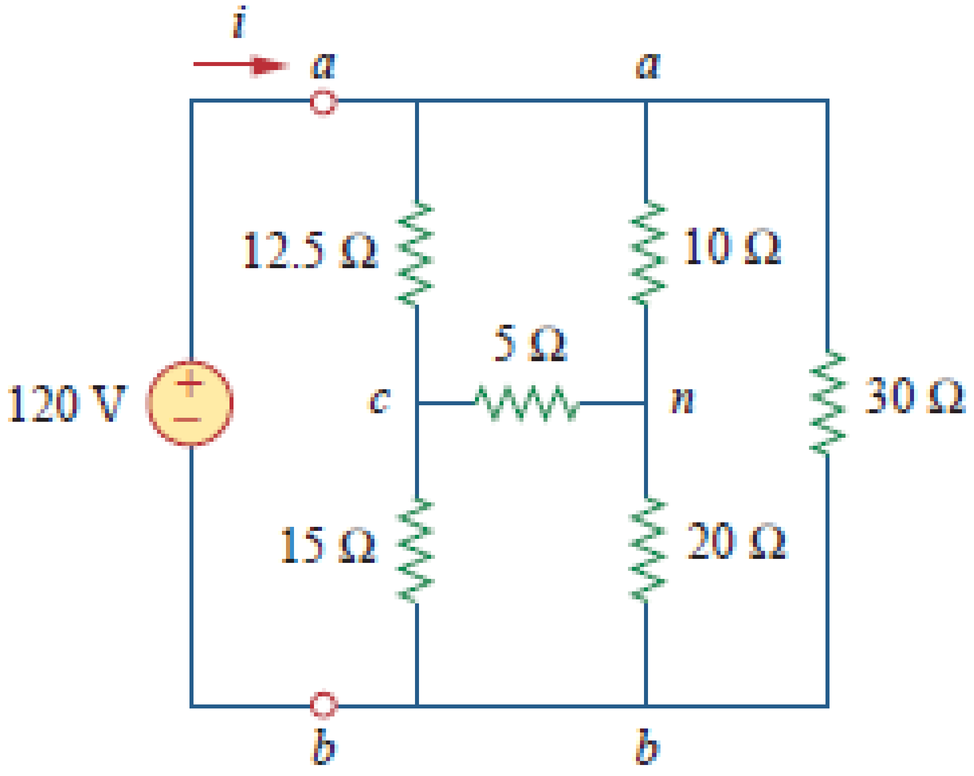


Figure 2.52
For Example 2.15.

ÇÖZÜM

4. **Attempt.** In this circuit, there are two Y networks and three Δ networks. Transforming just one of these will simplify the circuit. If we convert the Y network comprising the 5-Ω, 10-Ω, and 20-Ω resistors, we may select

$$R_1 = 10\ \Omega, \qquad R_2 = 20\ \Omega, \qquad R_3 = 5\ \Omega$$

Thus from Eqs. (2.53) to (2.55) we have

$$R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1} = \frac{10 \times 20 + 20 \times 5 + 5 \times 10}{10}$$

$$= \frac{350}{10} = 35\ \Omega$$

$$R_b = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2} = \frac{350}{20} = 17.5\ \Omega$$

$$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3} = \frac{350}{5} = 70\ \Omega$$

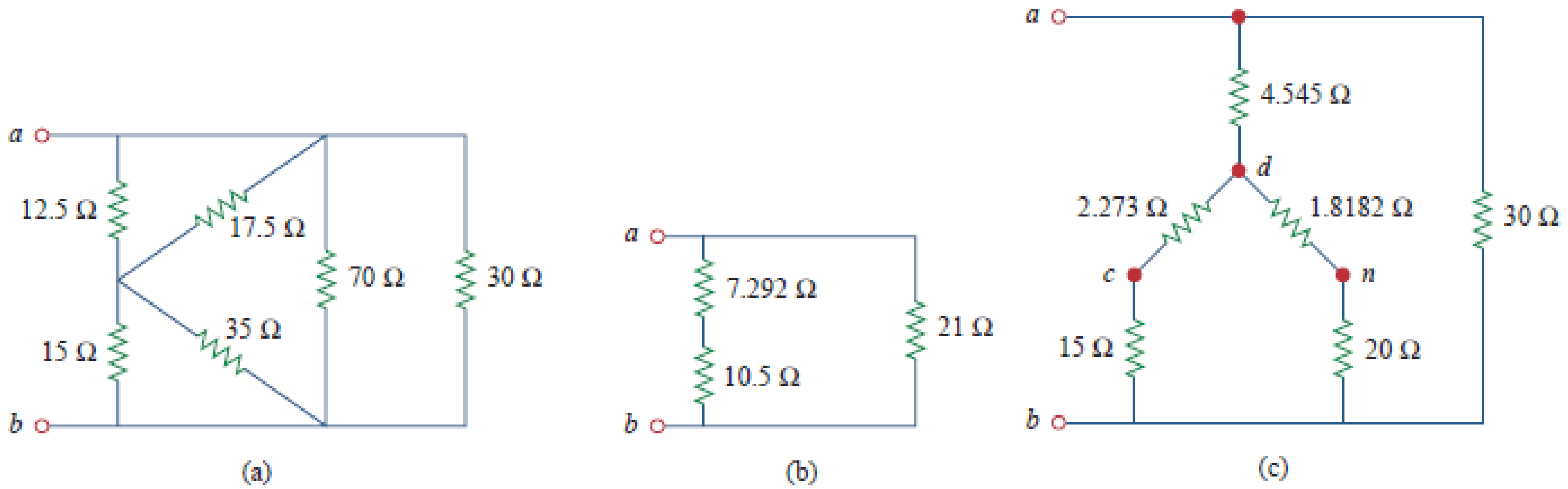


Figure 2.53
Equivalent circuits to Fig. 2.52, with the voltage source removed.

With the Y converted to Δ, the equivalent circuit (with the voltage source removed for now) is shown in Fig. 2.53(a). Combining the three pairs of resistors in parallel, we obtain

$$70 \parallel 30 = \frac{70 \times 30}{70 + 30} = 21\ \Omega$$

$$12.5 \parallel 17.5 = \frac{12.5 \times 17.5}{12.5 + 17.5} = 7.292\ \Omega$$

$$15 \parallel 35 = \frac{15 \times 35}{15 + 35} = 10.5\ \Omega$$

so that the equivalent circuit is shown in Fig. 2.53(b). Hence, we find

$$R_{ab} = (7.292 + 10.5) \parallel 21 = \frac{17.792 \times 21}{17.792 + 21} = \mathbf{9.632\ \Omega}$$

Then

$$i = \frac{v_s}{R_{ab}} = \frac{120}{9.632} = \mathbf{12.458\ A}$$

We observe that we have successfully solved the problem. Now we must evaluate the solution.

Practice Problem 2.15

For the bridge network in Fig. 2.54, find R_{ab} and i.

Answer: 40 Ω, 2.5 A.

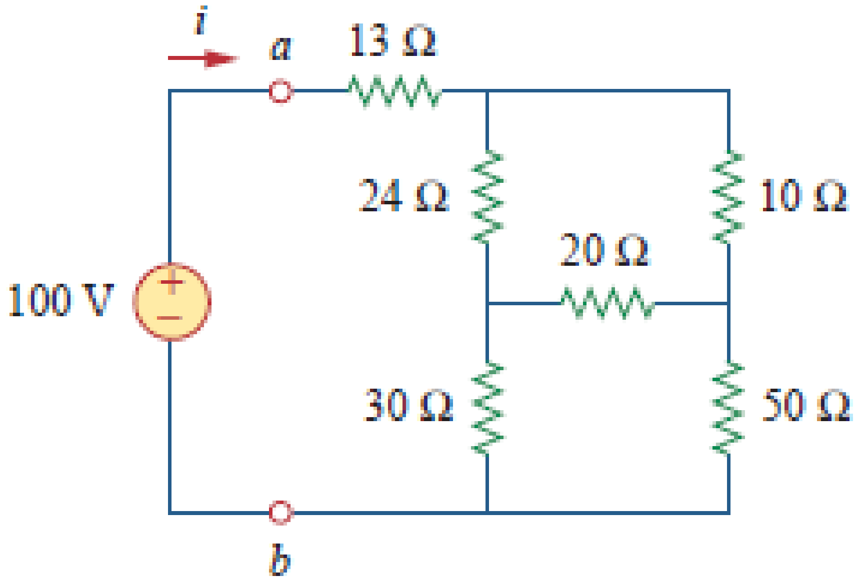
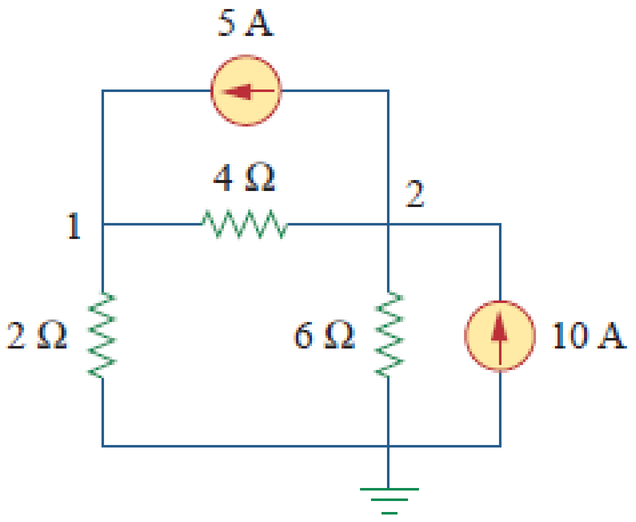


Figure 2.54
For Practice Prob. 2.15.

Düğüm Analizi Soruları- TEKRAR

Example 3.1 Calculate the node voltages in the circuit shown in Fig. 3.3(a).

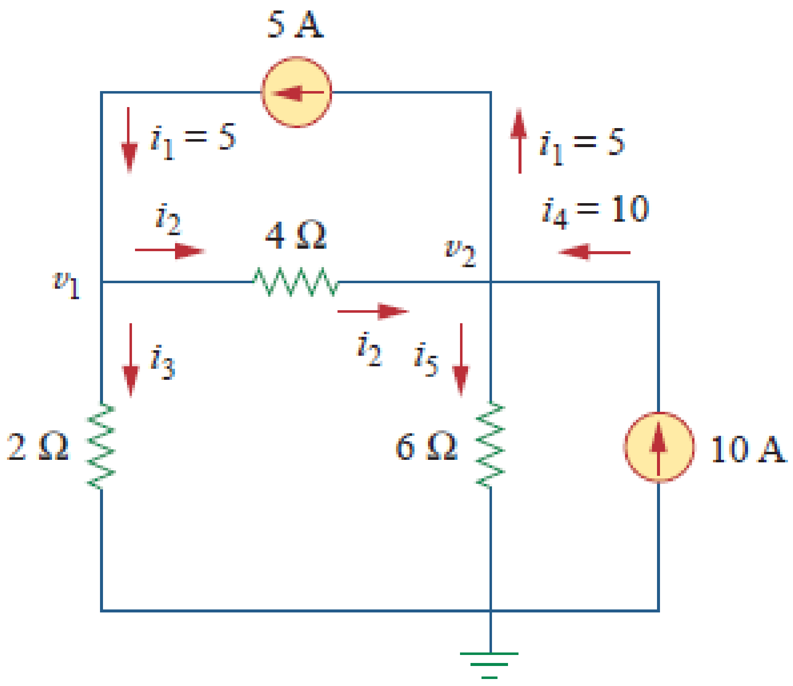


ÖNEMLİ !!!

Current flows from a higher potential to a lower potential in a resistor.

We can express this principle as

$$\boxed{i = \frac{v_{\text{higher}} - v_{\text{lower}}}{R}} \tag{3.3}$$



(b)

At node 1, applying KCL and Ohm's law gives

$$i_1 = i_2 + i_3 \quad \Rightarrow \quad 5 = \frac{v_1 - v_2}{4} + \frac{v_1 - 0}{2}$$

Multiplying each term in the last equation by 4, we obtain

$$20 = v_1 - v_2 + 2v_1$$

or

$$3v_1 - v_2 = 20 \tag{3.1.1}$$

At node 2, we do the same thing and get

$$i_2 + i_4 = i_1 + i_5 \quad \Rightarrow \quad \frac{v_1 - v_2}{4} + 10 = 5 + \frac{v_2 - 0}{6}$$

Multiplying each term by 12 results in

$$3v_1 - 3v_2 + 120 = 60 + 2v_2$$

or

$$-3v_1 + 5v_2 = 60 \tag{3.1.2}$$

METHOD 1 Using the elimination technique, we add Eqs. (3.1.1) and (3.1.2).

$$4v_2 = 80 \qquad \Rightarrow \qquad v_2 = 20 \text{ V}$$

Substituting $v_2 = 20$ in Eq. (3.1.1) gives

$$3v_1 - 20 = 20 \qquad \Rightarrow \qquad v_1 = \frac{40}{3} = 13.333 \text{ V}$$

SORU

3.1 Find I_o in the circuit in Fig. P3.1 using nodal analysis. CS

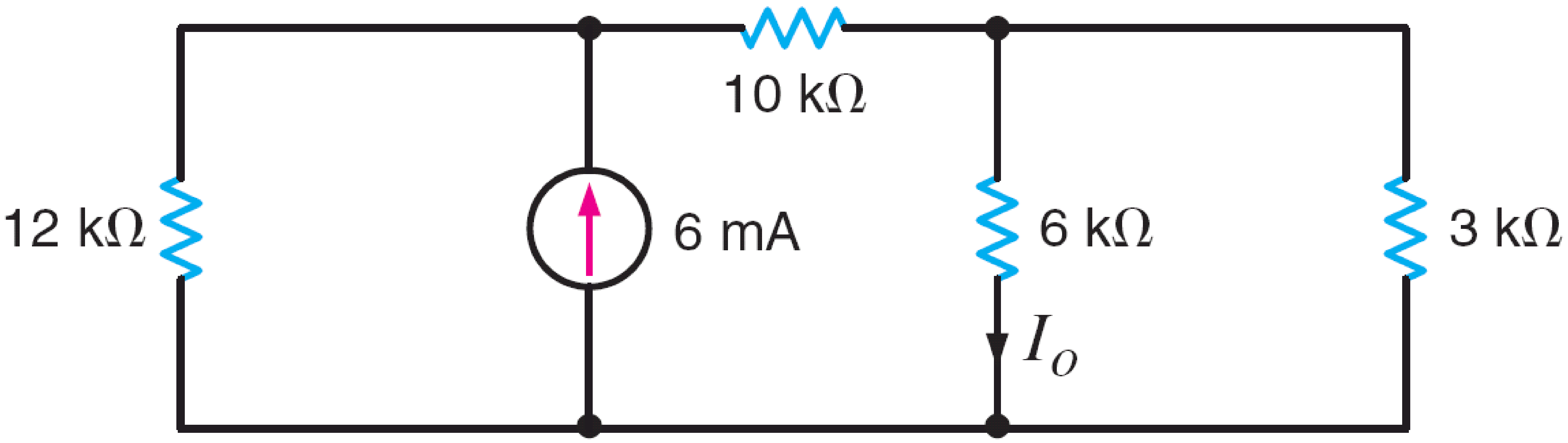
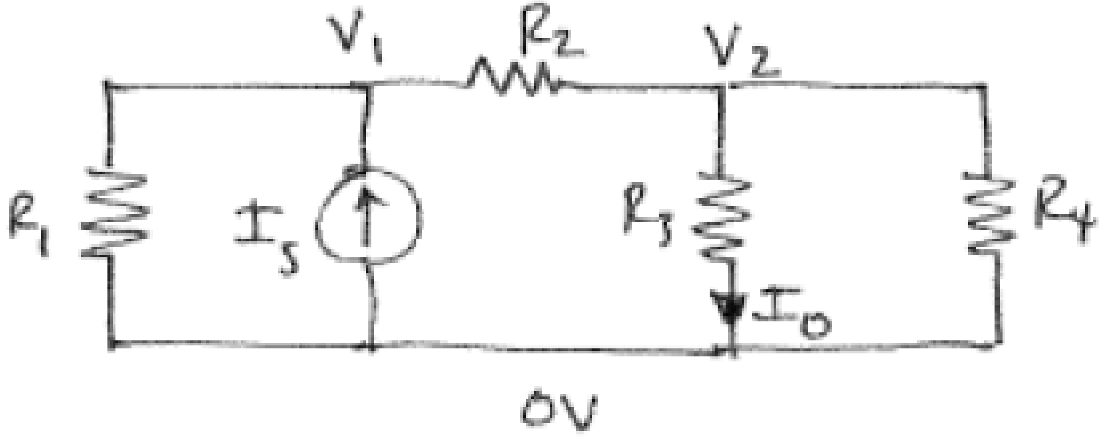


Figure P3.1

SOLUTION:

I_o via nodal.



$R_1 = 12k\Omega$ $R_2 = 10k\Omega$ $R_3 = 6k\Omega$

$R_4 = 3k\Omega$ $I_S = 6mA$

@ V_1: $$\frac{V_1}{R_1} - I_S + \frac{V_1 - V_2}{R_2} = 0$$

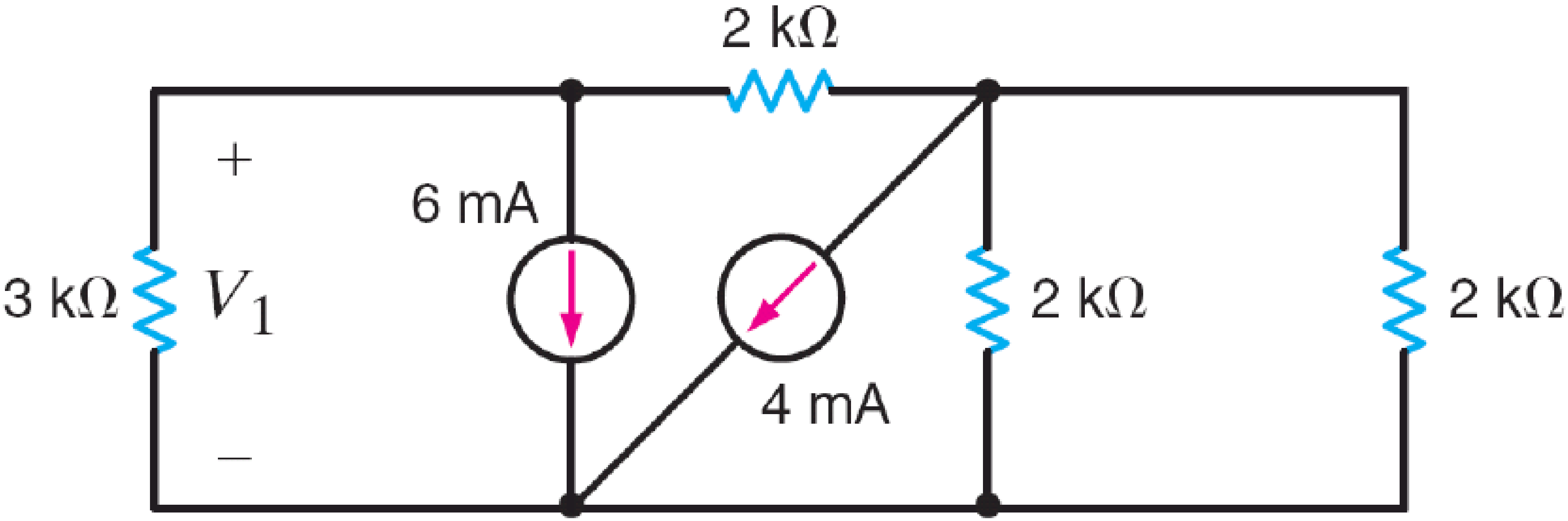
@ V_2: $$\frac{V_2 - V_1}{R_2} + \frac{V_2}{R_3} + \frac{V_2}{R_4} = 0$$

$\$$: $I_o = V_2 / R_3$

$$\boxed{I_o = 1\,mA}$$

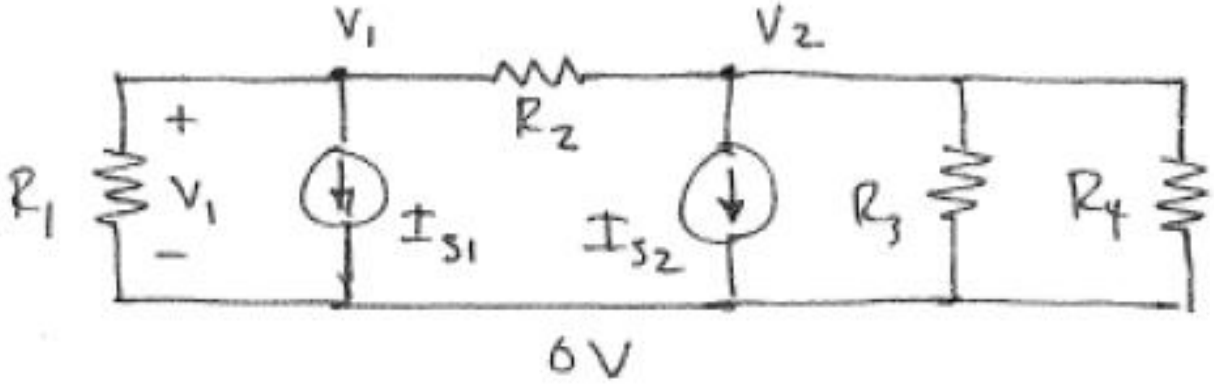
SORU

3.2 Use nodal analysis to find V_1 in the circuit in Fig. P3.2.



ÇÖZÜM

3.2 Find V_1 via nodal.



$R_1 = 3k\Omega \quad R_2 = R_3 = R_4 = 2k\Omega$

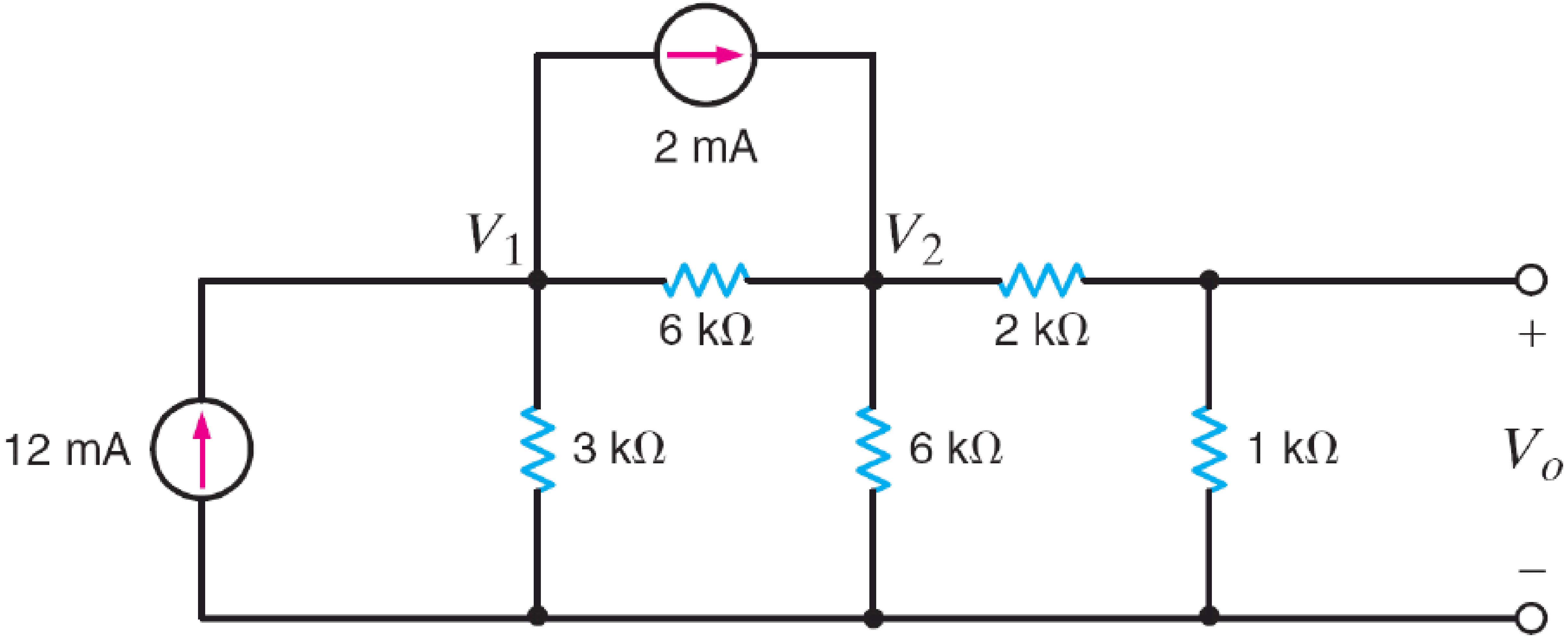
$I_{S1} = 6mA \quad I_{S2} = 4mA$

@ V_1: $\frac{V_1}{R_1} + I_{S1} + \frac{V_1 - V_2}{R_2} = 0$

@ V_2: $\frac{V_2 - V_1}{R_2} + \frac{V_2}{R_3} + \frac{V_2}{R_4} + I_{S2} = 0$

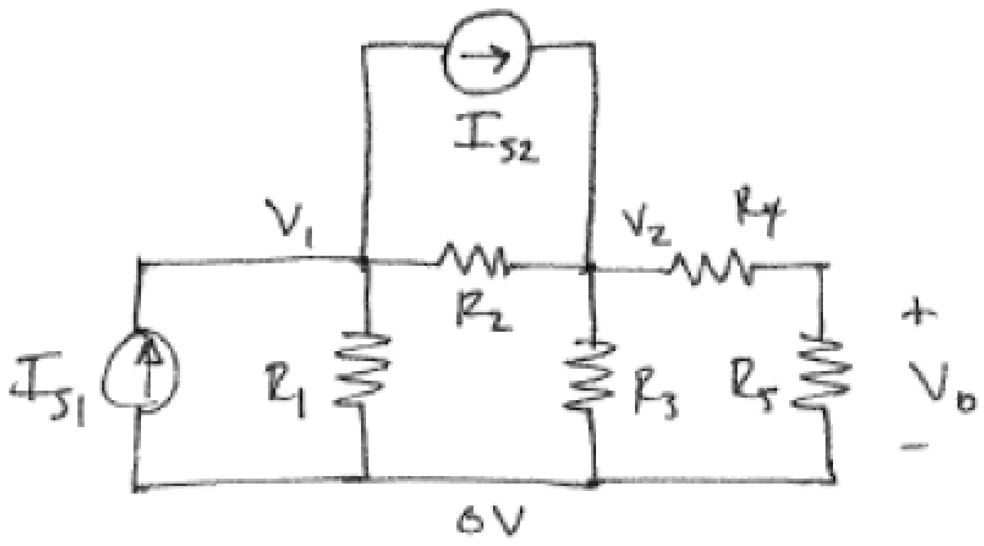
$\boxed{V_1 = -11V}$

SORU **3.3** Use nodal analysis to find both V_1 and V_o in the circuit in Fig. P3.3. **PSV**



ÇÖZÜM

3.3 Find V_o & V_1 by nodal.



$R_1 = 3k\Omega \quad R_2 = R_3 = 6k\Omega \quad R_4 = 2k\Omega$

$R_5 = 1k\Omega \quad I_{S1} = 12mA \quad I_{S2} = 2mA$

@ V_1: $$I_{S2} - I_{S1} + \frac{V_1}{R_1} + \frac{V_1 - V_2}{R_2} = 0$$

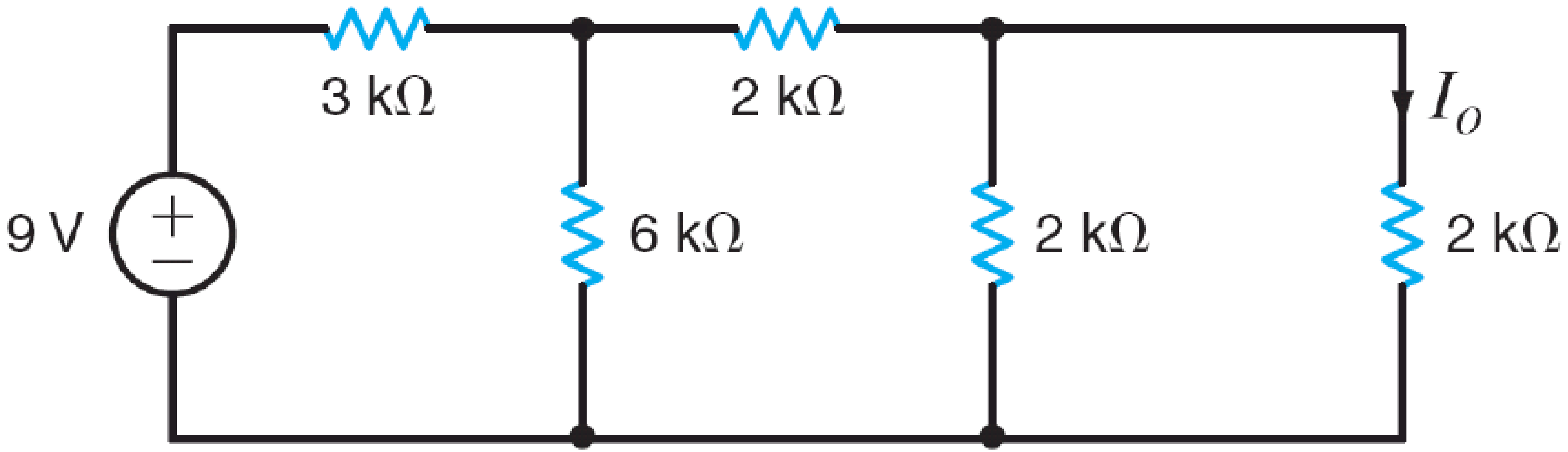
@ V_2: $$-I_{S2} + \frac{V_2 - V_1}{R_2} + \frac{V_2}{R_3} + \frac{V_2 - V_o}{R_4} = 0$$

@ V_o: $$\frac{V_2 - V_o}{R_4} = \frac{V_o}{R_5}$$

$$\boxed{V_o = 2.91V \quad V_1 = 22.9V}$$

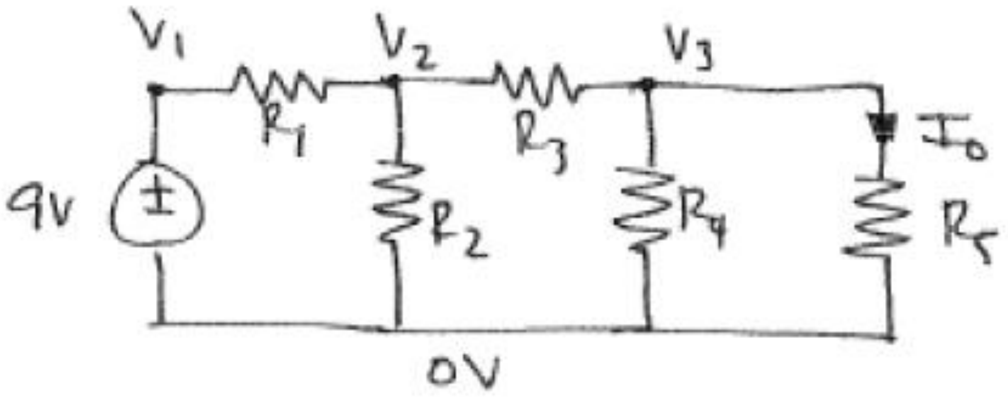
SORU

3.5 Find I_o in the circuit in Fig. P3.5 using nodal analysis. CS



ÇÖZÜM

3.5 Find I_o by nodal.



$R_1 = 3k\Omega \quad R_2 = 6k\Omega \quad R_3 = R_4 = R_5 = 2k\Omega$

@ V_1: $V_1 = 9V$

@ V_2: $\dfrac{V_2 - V_1}{R_1} + \dfrac{V_2}{R_2} + \dfrac{V_2 - V_3}{R_3} = 0$

@ V_3: $\dfrac{V_3 - V_2}{R_3} + \dfrac{V_3}{R_4} + \dfrac{V_3}{R_5} = 0$

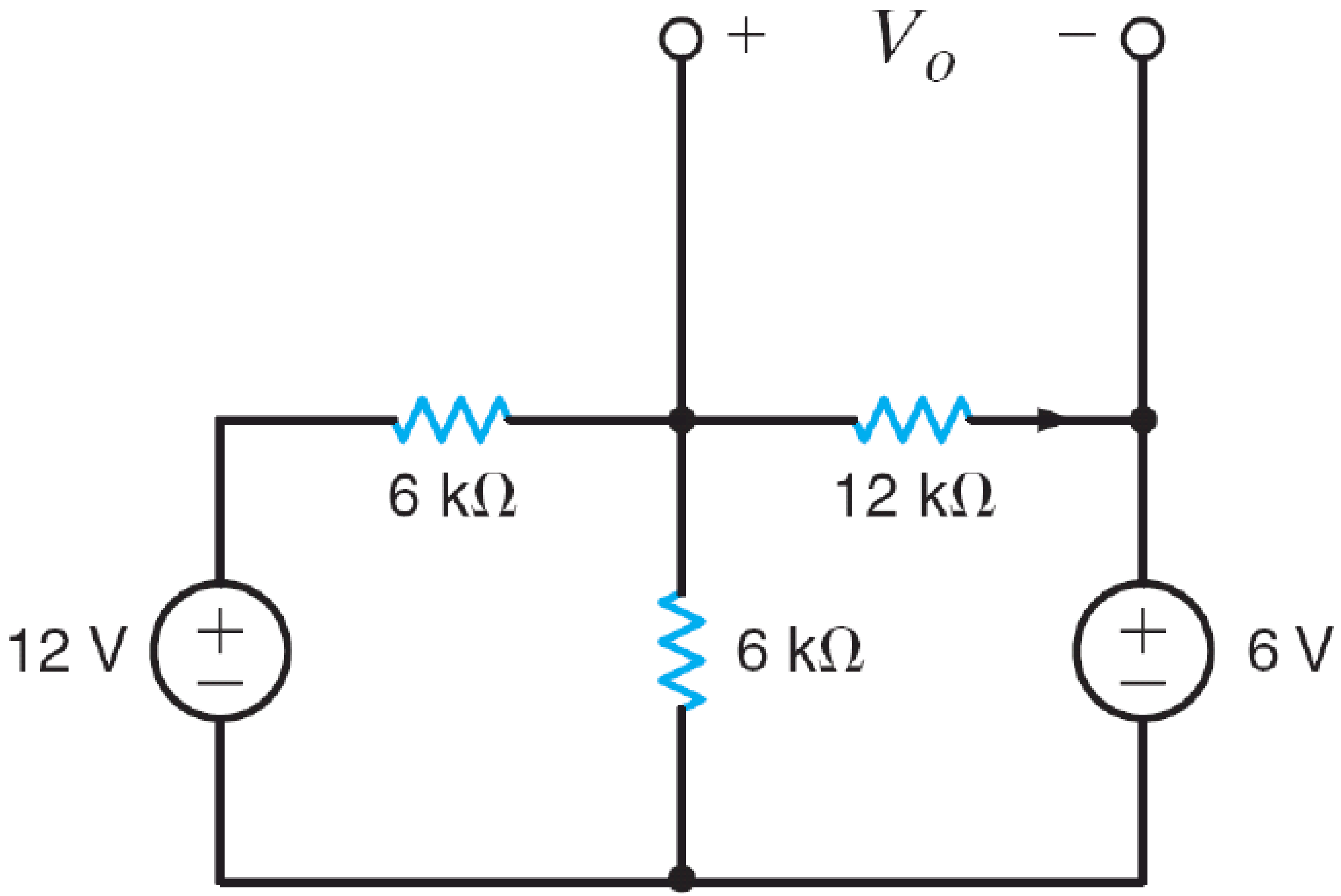
and $I_o = V_3/R_5$

$\boxed{I_o = 0.6mA}$

3.7 Find V_o in the network in Fig. P3.7 using nodal analysis.

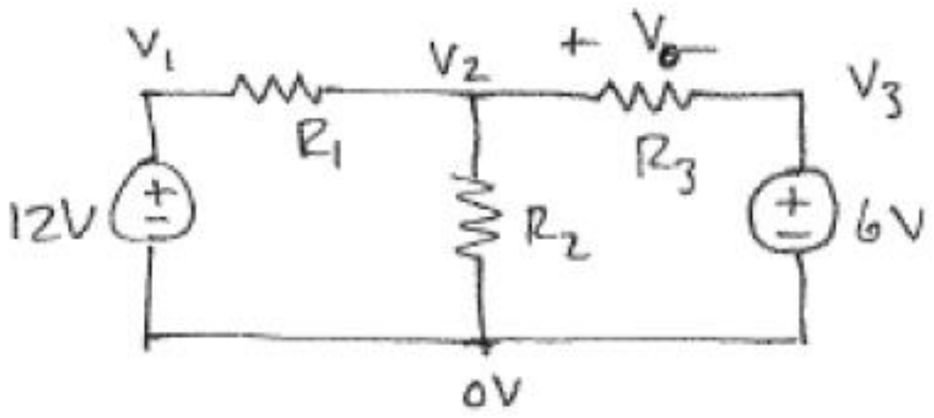
CS

SORU



ÇÖZÜM

3.7 Find V_o by nodal.



$R_1 = R_2 = 6k\Omega$

$R_3 = 12k\Omega$

@ V_1: $\quad V_1 = 12V$

@ V_2: $\quad \dfrac{V_2 - V_1}{R_1} + \dfrac{V_2}{R_2} + \dfrac{V_2 - V_3}{R_3} = 0$

@ V_3: $\quad V_3 = 6V$

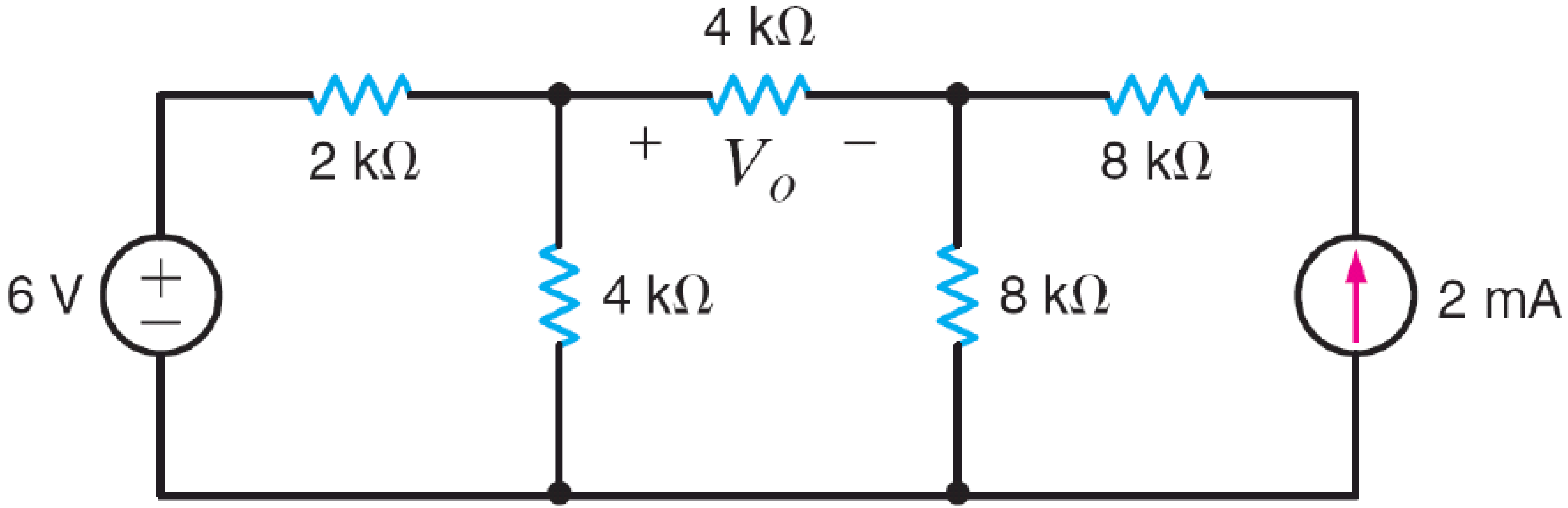
and $V_o = V_2 - V_3$

$V_2 = 6V$

$\boxed{V_o = 0V}$

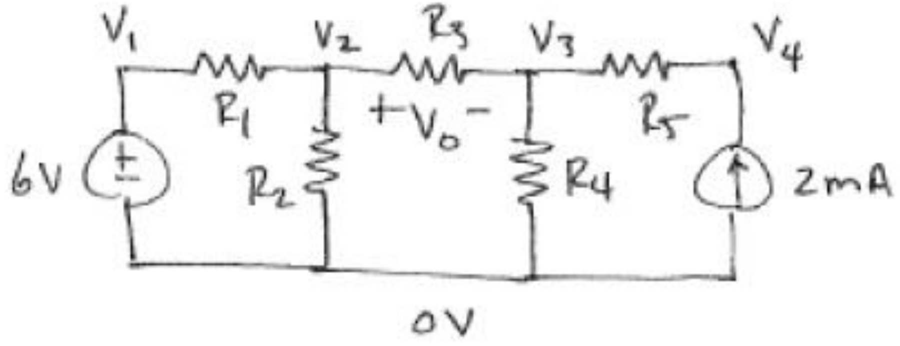
SORU

3.9 Use nodal analysis to find V_o in the circuit in Fig. P3.9.



ÇÖZÜM

3.9 Find V_o by nodal.



$R_1 = 2k\Omega \quad R_2 = R_3 = 4k\Omega$

$R_4 = R_5 = 8k\Omega$

$V_1 = 6V$

@ V_2: $$\frac{V_2 - V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_2 - V_3}{R_3} = 0$$

@ V_3: $$\frac{V_3 - V_2}{R_3} + \frac{V_3}{R_4} + \frac{V_3 - V_4}{R_5} = 0$$

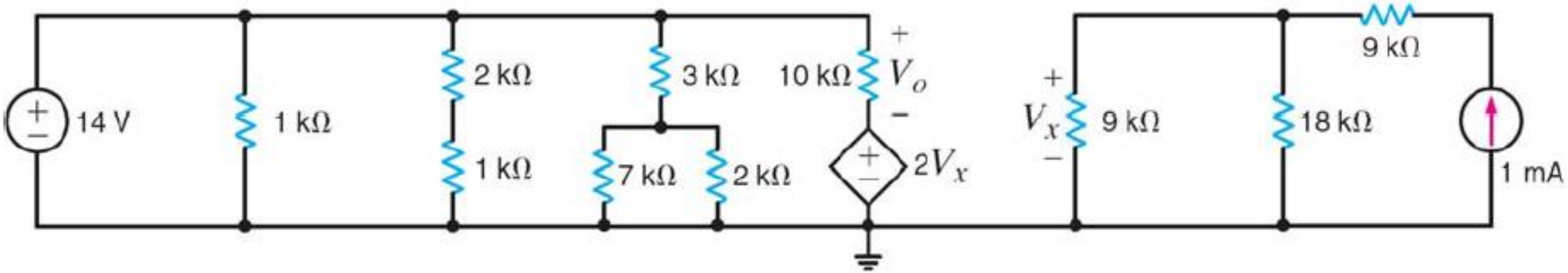
@ V_4: $$\frac{V_4 - V_3}{R_5} = 2\times10^{-3}$$

and $V_o = V_2 - V_3$

$V_2 = 5.2V, \quad V_3 = 8.8V \quad \boxed{V_o = -3.6V}$

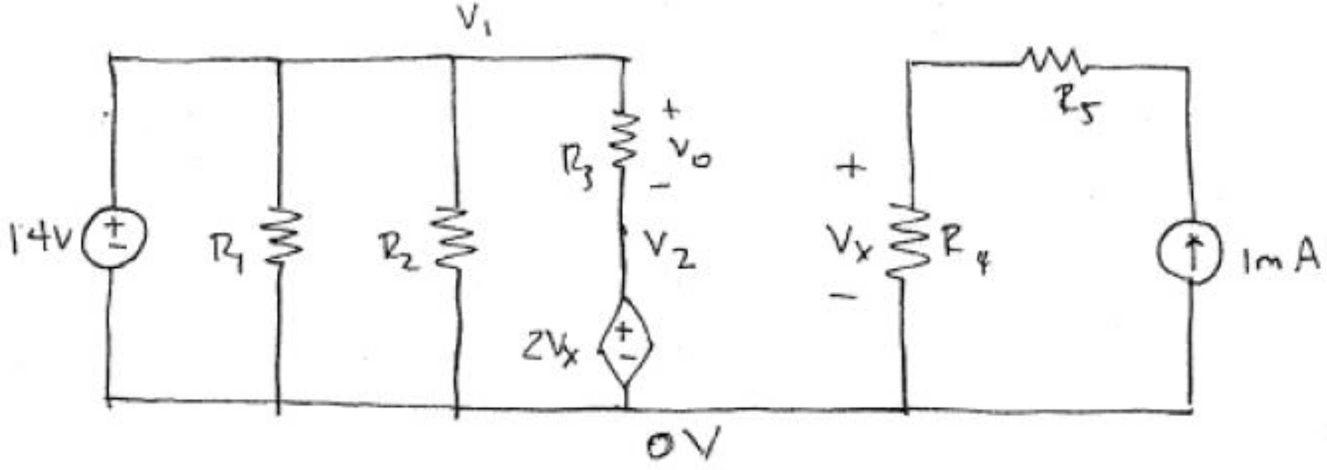
SORU

3.19 Use nodal analysis to find V_o in the network in Fig P3.19.



ÇÖZÜM

3.19 Find V_o by nodal



$R_1 = 1000 \,//\, (2000 + 1000) = 750\Omega$ $\quad R_3 = 10k\Omega \quad R_5 = 9k\Omega$

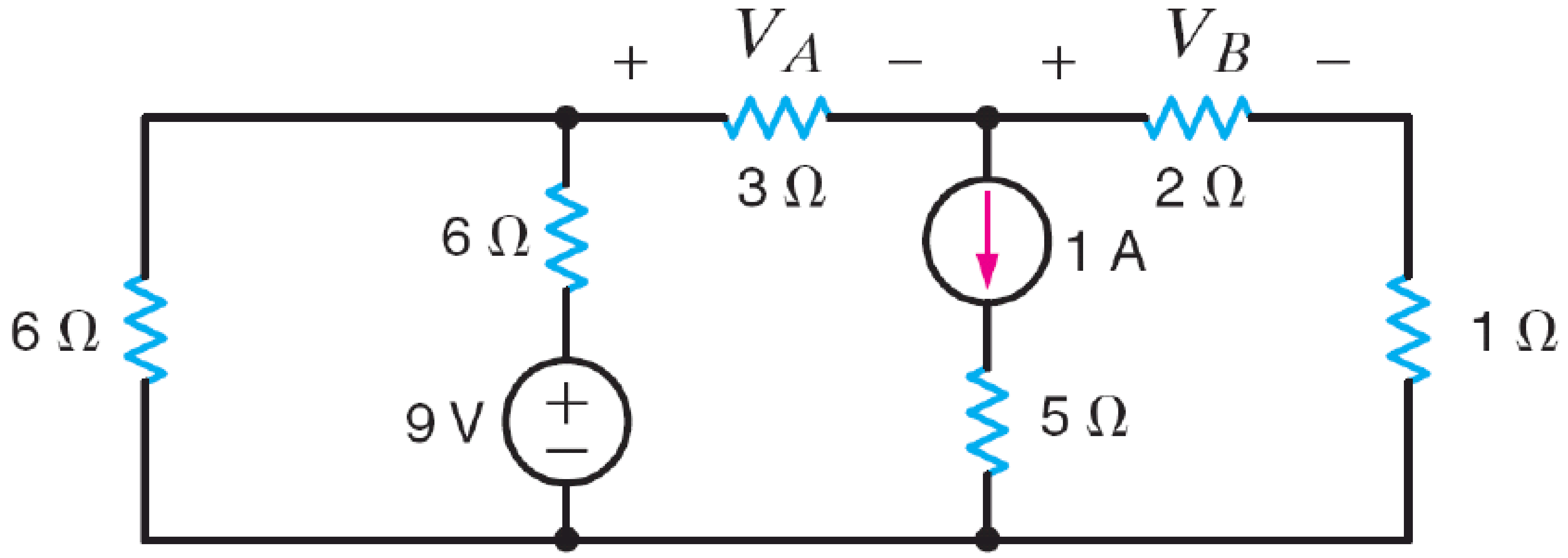
$R_4 = 9000 // 18000 = 6k\Omega$ $\quad R_2 = 3000 + (7000 // 2000) = 4.55k\Omega$

$V_1 = 14V \quad V_2 = 2V_x \quad V_x = 1\times10^{-3}\,(R_4) = 6V$

$V_o = V_1 - V_2 \qquad \boxed{V_o = 2V}$

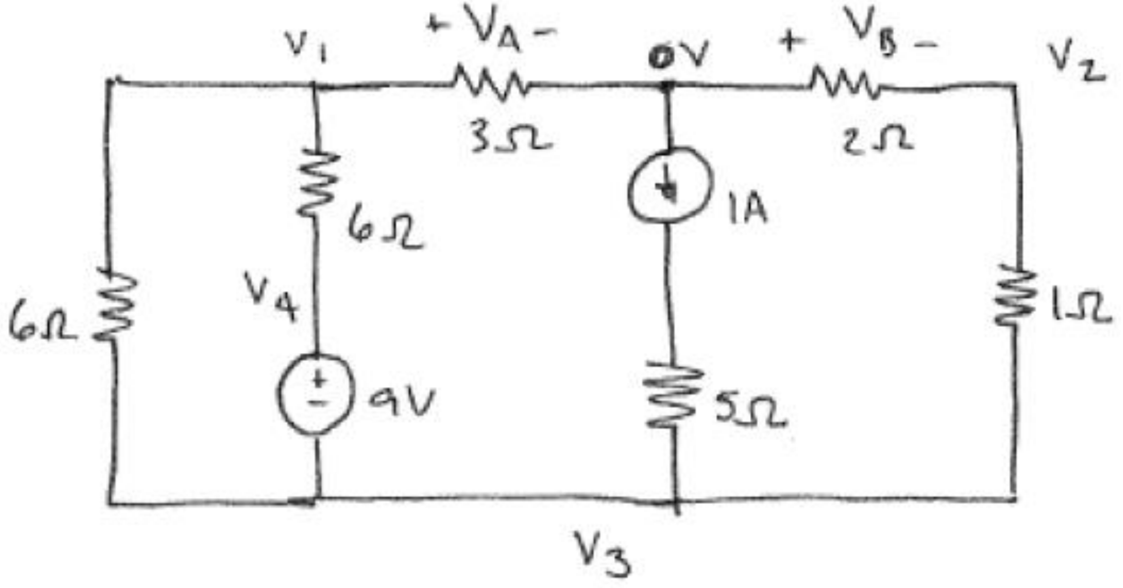
SORU

3.20 Use nodal analysis to find V_A and V_B in the network in Fig. P3.20. Simplify the analysis by making an insightful choice for the reference node.



ÇÖZÜM

3.20 Find V_A & V_B by nodal



$$V_4 - V_3 = 9$$

$$\frac{V_1 - V_4}{6} + \frac{V_1}{3} + \frac{V_1 - V_3}{6} = 0$$

$$\frac{V_1}{3} + \frac{V_2}{2} = 1$$

$$\frac{V_2}{2} + \frac{V_2 - V_3}{1} = 0$$

$V_A = V_1$

$V_B = -V_2$

$$\boxed{\begin{aligned} V_A &= 2.5\,V \\ V_B &= -0.33\,V \end{aligned}}$$