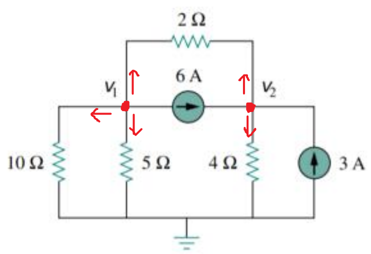
CSE231 - HW2

ABDULLAH ÇELİK
171044002

Figure 3.50 For Prob. 3.1.

3.2 For the circuit in Fig. 3.51, obtain v_1 and v_2.



① $\frac{V_1}{10} + \frac{V_1}{5} + \frac{V_1 - V_2}{2} + 6 = 0$

$8V_1 - 5V_2 = -60$

② $\frac{V_2 - V_1}{2} + \frac{V_2}{4} - 6 - 3 = 0$

$-2V_1 + 3V_2 = 36$

$V_1 = 0\ V$

$V_2 = 12\ V$

3.4 Given the circuit in Fig. 3.53, calculate the currents i_1 through i_4.

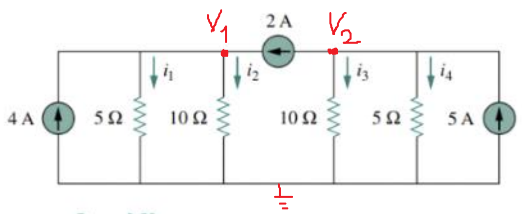


Figure 3.53 For Prob. 3.4.

① $-4 + \frac{V_1}{5} + \frac{V_1}{10} - 2 = 0$

$V_1 = 20\ V$

② $2 + \frac{V_2}{10} + \frac{V_2}{5} - 5 = 0$

$V_2 = 10\ V$

$i_1 = \frac{V_1}{5} = 4\ A$, $i_2 = \frac{V_1}{10} = 2A$

$i_3 = \frac{V_2}{10} = 1\ A$, $i_4 = \frac{V_2}{5} = 2A$

3.6 Use nodal analysis to obtain v_o in the circuit in Fig. 3.55.

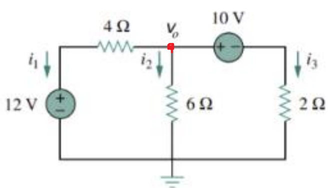


Figure 3.55 For Prob. 3.6.

$$\frac{V_0 - 12}{4} + \frac{V_0}{6} + \frac{V_0 - 10}{2} = 0$$

$$V_0 = \frac{96}{11} = 8,727\ V$$

3.8 Calculate v_o in the circuit in Fig. 3.57.

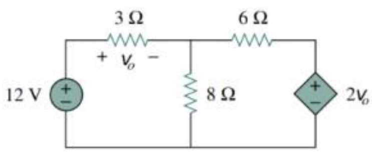
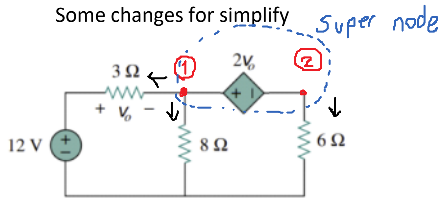


Figure 3.57 For Prob. 3.8.

Some changes for simplify



(1) $V_1 - 12 = -V_0$

(2) $\frac{V_1 - 12}{3} + \frac{V_1}{8} + \frac{V_2}{6} = 0$

$11V_1 + 4V_2 = 96$

(3) $V_1 - V_2 = 2V_0$

$V_1 - V_2 = 2(12 - V_1)$

$3V_1 - V_2 = 24$

$V_1 = 8,348$ V

$V_2 = 15,652$ V

$V_0 = 12 - V_1 = 3,652$ V

3.10 Solve for i_1 and i_2 in the circuit in Fig. 3.22 (Section 3.5) using nodal analysis.

The figure mentioned above is not in the pdf.
Therefore, this question didn't solved.

3.12 Calculate v_1 and v_2 in the circuit in Fig. 3.60 using nodal analysis.

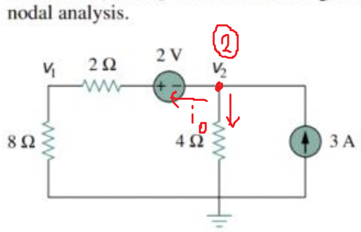


Figure 3.60 For Prob. 3.12.

(1) $\frac{V_2 + 2}{10} + \frac{V_2}{4} - 3 = 0 \Rightarrow V_2 = 8$ V

$i_0 = \frac{V_2 + 2}{10} = 1$ A

$\frac{V_2 + 2 - V_1}{2} = 1 \Rightarrow V_2 = V_1 = 8$ V

3.14 Apply nodal analysis to find i_o and the power dissipated in each resistor in the circuit of Fig. 3.62.

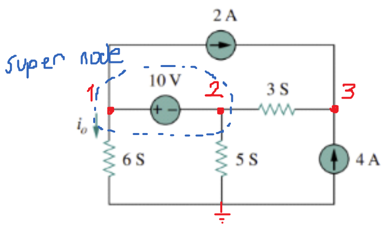


Figure 3.62 For Prob. 3.14.

* $S = \frac{1}{\Omega}$

* $V_1 - 10 = V_2 \Rightarrow V_1 - V_2 = 10$

(1-2) $\frac{V_1}{1/6} + \frac{V_2}{1/5} + \frac{V_2 - V_3}{1/3} + 2 = 0$

$6V_1 + 8V_2 - 3V_3 = -2$

(3) $\frac{V_3 - V_2}{1/3} - 2 - 4 = 0$

$3V_3 - 3V_2 = 6$

$V_1 = \frac{54}{11}$ V

$V_2 = -\frac{56}{11}$ V

$V_3 = -\frac{34}{11}$ V

$i_0 = 6 \cdot V_1 = \frac{324}{11}$ A

$P_{6S} = i_0 \cdot V_1 = 144,595$ W

$P_{5S} = \frac{V_2^2}{5S} = 129,587$ W

$P = (V_2 - V_3)^2 \; 11$ W

$$P_{5S} = \frac{V_2}{5S} = 129{,}587 \text{ W}$$

$$P_{3S} = \frac{(V_2 - V_3)^2}{3S} = 12 \text{ W}$$

3.16 Using nodal analysis, find current i_o in the circuit of Fig. 3.64.

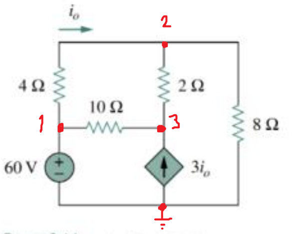


Figure 3.64 For Prob. 3.16.

$V_1 = 60$ V

(2) $\frac{V_2 - 60}{4} + \frac{V_2 - V_3}{2} + \frac{V_2}{8} = 0$

$7V_2 - 4V_3 = 120$

(3) $\frac{V_3 - 60}{10} + \frac{V_3 - V_2}{2} - 3i_0 = 0$

$i_0 = \frac{60 - V_2}{4}$

$5V_2 + 12V_3 = 1020$

$V_2 = \frac{1380}{26}$

$i_0 = \frac{60 - V_2}{4} = 1{,}731$ A

3.18 For the circuit in Fig. 3.66, find v_1 and v_2 using nodal analysis.

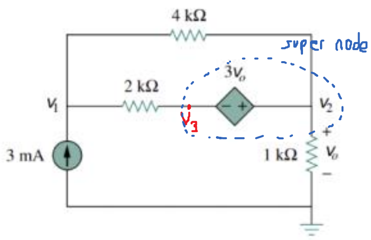


Figure 3.66 For Prob. 3.18.

(1) $\frac{V_1 - V_3}{2\,k\Omega} + \frac{V_1 - V_2}{4\,k\Omega} - 3\,mA = 0$

$3V_1 - V_2 - 2V_3 = 12$

(2-3) $\frac{V_3 - V_1}{2} + \frac{V_2 - V_1}{4} + V_2 = 0$

$-3V_1 + 5V_2 + 2V_3 = 0$

$V_2 = V_0$

$V_2 - V_3 = 3V_0$

$-2V_2 - V_3 = 0$

$V_1 = 1$ V

$V_2 = 3$ V

$V_3 = -6$ V

3.20 Obtain v_1 and v_2 in the circuit of Fig. 3.68.

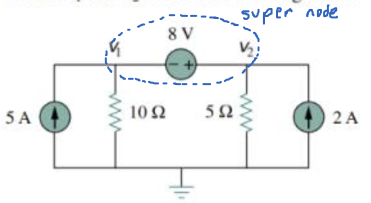


Figure 3.68 For Prob. 3.20.

$-5 + \frac{V_1}{10} + \frac{V_2}{5} - 2 = 0$

(1) $V_1 + 2V_2 = 70$

(2) $V_2 - 8 = V_1$

$V_1 = 18$ V

$V_2 = 26$ V

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*3.22 Use nodal analysis to determine voltages v_1, v_2, and v_3 in the circuit in Fig. 3.70.

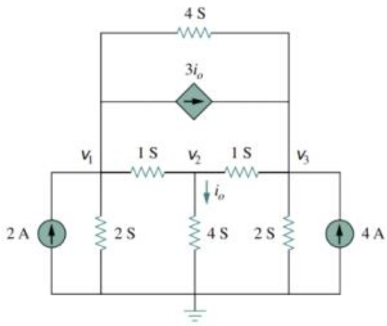


Figure 3.70 For Prob. 3.22.

* $\Omega = \frac{1}{S}$

(1) $-2 + 2V_1 + V_1 - V_2 + 4.(V_1 - V_3) + 3i_0 = 0$

(2) $V_2 - V_1 + 4V_2 + V_2 - V_3 = 0$

(3) $V_3 - V_2 + 2V_3 - 4 - 3i_0 + 4(V_3 - V_1) = 0$

$4V_2 = i_0$

$V_1 = 0{,}625$ V

$V_2 = 0{,}375$ V

$V_3 = 1{,}625$ V

3.24 Find the node voltages for the circuit in Fig. 3.72.

(1-2) $-1 + \frac{V_1 - V_3}{} + \frac{V_1}{} + \frac{V_2}{4} - 2V_0 = 0$

3.24 Find the node voltages for the circuit in Fig. 3.72.

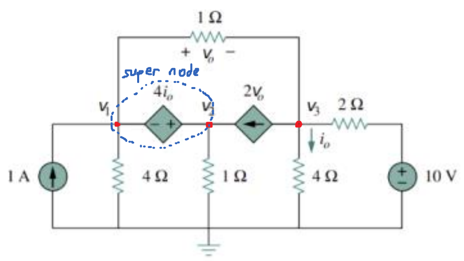


Figure 3.72 For Prob. 3.24.

(1-2) $-1 + \frac{V_1 - V_3}{1} + \frac{V_1}{4} + \frac{V_2}{1} - 2V_0 = 0$

(3) $2V_0 + \frac{V_3 - V_1}{1} + \frac{V_3}{4} + \frac{V_3 - 10}{2} = 0$

$i_0 = \frac{V_3}{4}$

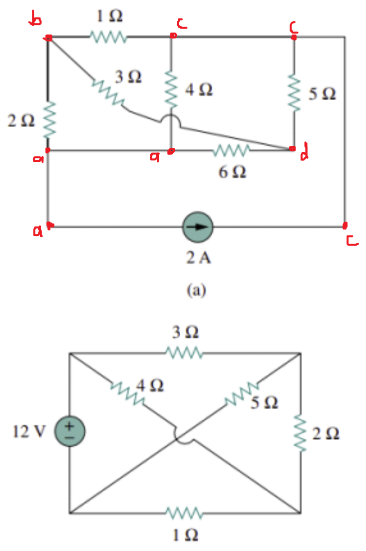
$V_2 - V_1 = 4i_0$

* $V_2 - V_1 = V_3$

* $V_3 - V_1 = -V_0$

$V_1 = 4,97$ V
$V_2 = 4,85$ V
$V_3 = -0,12$ V

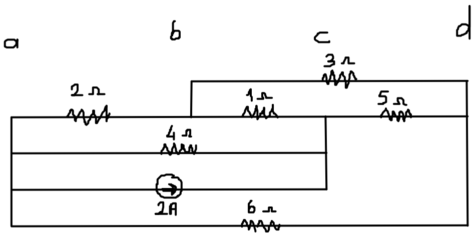
3.26 Which of the circuits in Fig. 3.74 is planar? For the planar circuit, redraw the circuits with no crossing branches.



(b)

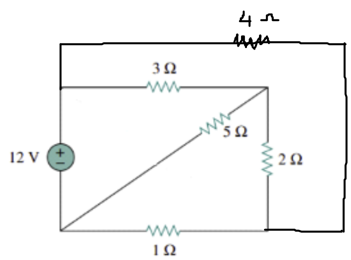
Figure 3.74 For Prob. 3.26.

a)



The (a) circuit is planar.

b]



The (b) circuit is planar

3.28 Rework Prob. 3.5 using mesh analysis.

Obtain v_o in the circuit of Fig. 3.54.

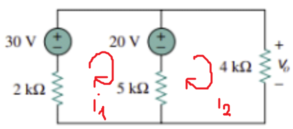


Figure 3.54 For Prob. 3.5.

(1) $2\,k\Omega \cdot i_1 - 30 + 20 + 5k\Omega(i_1 - i_2) = 0$

(2) $4\,k\Omega \cdot i_2 + 5k\Omega(i_2 - i_1) - 20 = 0$

$i_1 = i_2 = 0,005$ A

$V_0 = 4\,k\Omega \cdot 0,005\text{ A} = 20$ V

3.30 Solve Prob. 3.7 using mesh analysis.

~~Using nodal analysis,~~ find v_o in the circuit of Fig. 3.56.

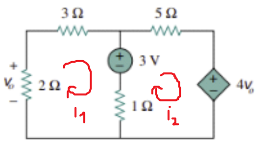


Figure 3.56 For Prob. 3.7.

(1) $2i_1 + 3i_1 + 3 + i_1 - i_2 = 0$

(2) $5i_2 + 4V_0 + i_2 - i_1 - 3 = 0$

$V_0 = -2i_1$

$i_1 = \frac{-5}{9}$ A

$i_2 = \frac{-1}{3}$ A

$V_0 = \frac{10}{9} = 1,1$ V

3.32 For the bridge network in Fig. 3.76, find i_o using mesh analysis.

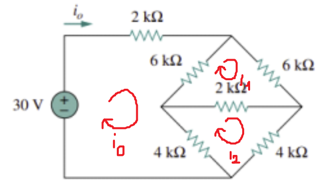


Figure 3.76 For Prob. 3.32.

(0) $-30 + 2k\Omega \cdot i_o + 6k\Omega \cdot (i_o - i_1) + 4k\Omega (i_o - i_2) = 0$

(1) $6k\Omega (i_1 - i_o) + 6k\Omega \cdot i_1 + 2k\Omega \cdot (i_1 - i_2) = 0$

(2) $4k\Omega \cdot (i_2 - i_o) + 2k\Omega \cdot (i_2 - i_1) + 4k\Omega \, i_2 = 0$

$i_o = 4,286 \text{ mA}$

$i_1 = i_2 = 2,143 \text{ mA}$

3.34 Use mesh analysis to find v_{ab} and i_o in the circuit in Fig. 3.78.

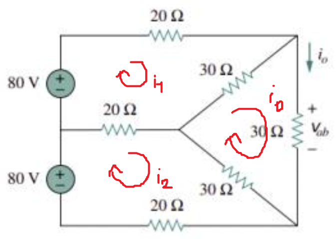


Figure 3.78 For Prob. 3.34.

(0) $30 \cdot (i_o - i_1) + 30 \cdot (i_o - i_2) + 30 i_o = 0$

(1) $-80 + 20 \cdot i_1 + 30 \cdot (i_1 - i_o) + 20 \cdot (i_1 - i_2) = 0$

(2) $-80 + 20 \cdot (i_2 - i_1) + 30 \cdot (i_2 - i_o) + 20 \cdot i_2 = 0$

$i_o = 1,778 \text{ A}$

$i_1 = i_2 = 2,667 \text{ A}$

$V_{ab} = 30 i_o = 53,33 \text{ V}$

3.36 Find current i in the circuit in Fig. 3.80.

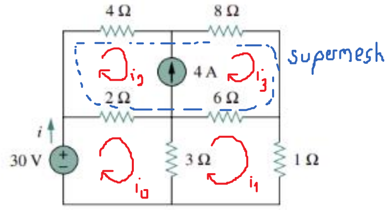


Figure 3.80 For Prob. 3.36.

* $i_3 - i_2 = 4$

(2−3) $2 \cdot (i_2 - i_o) + 4 i_2 + 8 i_3 + 6 \cdot (i_3 - i_1) = 0$

(1) $3 \cdot (i_1 - i_o) + 6 (i_1 - i_3) + i_1 = 0$

(0) $-30 + 2 \cdot (i_o - i_2) + 3 \cdot (i_o - i_1) = 0$

$i_o = i = 8,561 \text{ A}$

3.38 Use mesh analysis to find the current i_o in the circuit in Fig. 3.82.

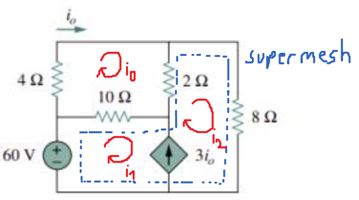


Figure 3.82 For Prob. 3.38.

(0) $16 i_o - 10 i_1 - 2 i_2 = 0$

(1-2) $-12 i_o + 10 i_1 + 10 i_2 = 60$

$i_2 - i_1 = 3 i_o$

$i_o = 1,731 \text{ A}$

3.40 Use mesh analysis to find i_1, i_2, and i_3 in the circuit of Fig. 3.84.

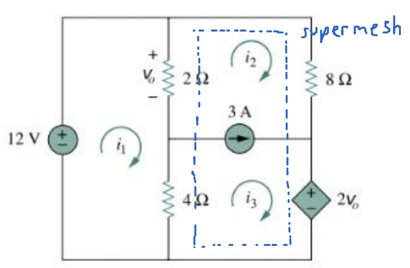


Figure 3.84 For Prob. 3.40.

(1) $6 i_1 - 2 i_2 - 4 i_3 = 12$

(2-3) $-6 i_1 + 10 i_2 + 4 i_3 + 2V_o = 0$

$V_o = 2 \cdot (i_1 - i_2)$

* $i_3 - i_2 = 3$

$i_1 = 3,5 \text{ A}$

$i_2 = -0.5 \text{ A}$

$i_3 = 2,5 \text{ A}$

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*3.42 In the circuit of Fig. 3.85, solve for i_1, i_2, and i_3.

(a) $i_o = 4 \text{ A}$

Figure 3.84 For Prob. 3.40.

*3.42 In the circuit of Fig. 3.85, solve for i_1, i_2, and i_3.

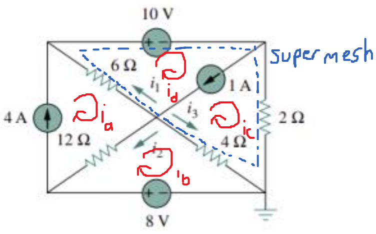

Figure 3.85 For Prob. 3.42.

(a) $i_a = 4\ A$

(b) $16 i_b - 12 \cdot 4 - 4 \cdot i_c = 8$

(c-d) $-6 \cdot 4 - 4 i_b + 6 i_c + 6 i_d = -10$

* $i_d - i_c = 1$

$i_b = 4\ A$ $\quad i_1 = i_d - i_a = -1\ A$

$i_c = 2\ A$ $\Rightarrow$ $i_2 = i_a - i_b = 0$

$i_d = 3\ A$ $\quad i_3 = i_b - i_c = 2\ A$

3.44 Find i_1, i_2, and i_3 in the circuit in Fig. 3.87.

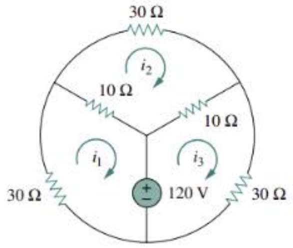

Figure 3.87 For Prob. 3.44.

(1) $40 i_1 - 10 i_2 = -120$

(2) $-10 i_1 + 50 i_2 - 10 i_3 = 0$

(3) $40 i_3 - 10 i_2 = 120$

$i_1 = -3\ A$

$i_2 = 0$

$i_3 = 3\ A$

3.46 Calculate the power dissipated in each resistor in the circuit in Fig. 3.88.

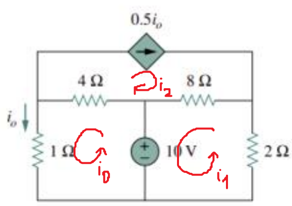

Figure 3.88 For Prob. 3.46.

$i_2 = 0{,}5 i_0$

(0) $5 i_0 - 10 + 4 i_2 = 0$

$i_0 = \frac{10}{7}\ A$

(1) $10 i_1 + 10 + 8 i_2 = 0$

$i_1 = \frac{-11}{7}$, $i_2 = \frac{5}{7}$

$P_{1\Omega} = i_0^2 \cdot R_{1\Omega} = 2{,}041\ W$

$P_{4\Omega} = (i_2 + i_0)^2 \cdot R_{4\Omega} = 18{,}37\ W$

$P_{8\Omega} = (i_1 + i_2)^2 \cdot R_{8\Omega} = 5{,}878\ W$

$P_{2\Omega} = i_1 \cdot R_{2\Omega} = 4{,}939\ W$

3.48 Find the mesh currents i_1, i_2, and i_3 in the network of Fig. 3.90.

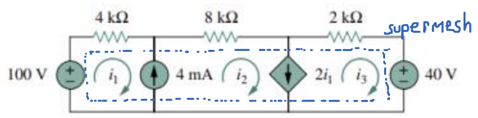

Figure 3.90 For Prob. 3.48.

(1-2-3) $-100 + 4k\Omega \cdot i_1 + 8k\Omega \cdot i_2 + 2k\Omega \cdot i_3 + 40 = 0$

* $i_2 - i_1 = 4\ mA$

* $i_2 - i_3 = 2 i_1$

$i_1 = 2\ mA$

$i_2 = 6\ mA$

$i_3 = 2\ mA$

3.50 Find v_o and i_o in the circuit of Fig. 3.92.

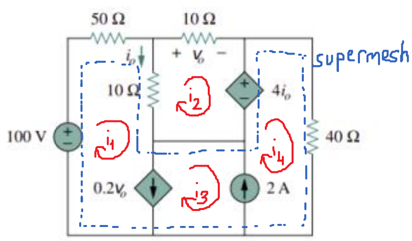

Figure 3.92 For Prob. 3.50.

* $i_0 = i_1 - i_2$

* $V_0 = 10 i_2$

(2) $20 i_2 - 10 i_1 + 4 i_0 = 0$

(1-3-4) $-100 + 50 i_1 + 10(i_1 - i_2) - 4 i_0 + 40 i_4 = 0$

* $i_1 - i_3 = 0{,}2 V_0$

* $i_3 - i_4 = 2$

$i_1 = 2{,}824\ A$

$i_2 = 1{,}059\ A$

$i_3 = 0{,}706\ A$

$i_4 = -1{,}294\ A$

$i_0 = i_1 - i_2 = 1{,}765\ A$

$V_0 = 10 i_2 = 10{,}59\ V$

3.50 Find v_o and i_o in the circuit of Fig. 3.92.

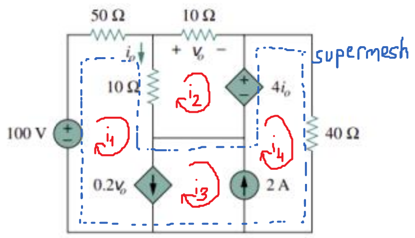

Figure 3.92 For Prob. 3.50.

* $i_0 = i_1 - i_2$
* $V_0 = 10 i_2$

(2) $20 i_2 - 10 i_1 + 4 i_0 = 0$

(1-3-4) $-100 + 50 i_1 + 10(i_1 - i_2) - 4 i_0 + 40 i_4 = 0$

* $i_1 - i_3 = 0{,}2 V_0$
* $i_3 - i_4 = 2$

$i_1 = 2{,}824$ A
$i_2 = 1{,}059$ A
$i_3 = 0{,}706$ A
$i_4 = -1{,}294$ A

$i_0 = i_1 - i_2 = 1{,}765$ A

$V_0 = 10 i_2 = 10{,}59$ V

3.52 By inspection, write the node-voltage equations for the circuit in Fig. 3.94 and obtain the node voltages.

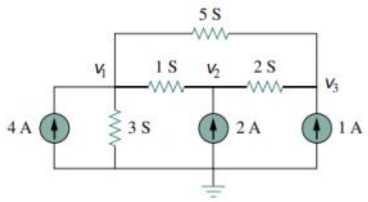

Figure 3.94 For Prob. 3.52.

* $G \cdot V = i$

$G_{11} = 8, \quad G_{12} = -1, \quad G_{13} = -5$

$G_{21} = -1, \quad G_{22} = 3, \quad G_{23} = -2$

$G_{31} = -5, \quad G_{32} = -2, \quad G_{33} = 7$

$i_1 = 4$ A, $i_2 = 2$ A, $i_3 = 1$ A

$$\begin{bmatrix} 8 & -1 & -5 \\ -1 & 3 & -2 \\ -5 & -2 & 7 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 4 \\ 2 \\ 1 \end{bmatrix}$$

Then we write the above equation as augmented matrix.
After bringing our matrix to row echolon form, we find v1, v2, v3.
Since these stages are only processes, direct results are written.

$V_1 = \frac{7}{2} = 3{,}5$ V $\quad V_2 = \frac{151}{34} = 4{,}441$ V $\quad V_3 = \frac{133}{34} = 3{,}912$ V

3.54 Write the node-voltage equations of the circuit in Fig. 3.96 by inspection.

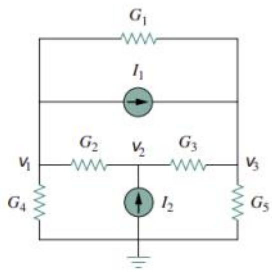

Figure 3.96 For Prob. 3.54.

* $G \cdot V = I$

$G_{11} = G_1 + G_2 + G_4 \quad G_{12} = -G_2 \quad G_{13} = -G_1$

$G_{21} = -G_2 \quad G_{22} = G_2 + G_3 \quad G_{23} = -G_3$

$G_{31} = -G_1 \quad G_{32} = -G_3 \quad G_{33} = G_1 + G_3 + G_5$

$i_1 = -I_1 \quad i_2 = I_2 \quad i_3 = I_1$

$$\begin{bmatrix} G_1 + G_2 + G_4 & -G_2 & -G_1 \\ -G_2 & G_2 + G_3 & -G_3 \\ -G_1 & -G_3 & G_1 + G_3 + G_5 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} -I_1 \\ I_2 \\ I_1 \end{bmatrix}$$

3.56 By inspection, write the mesh-current equations for the circuit in Fig. 3.98.

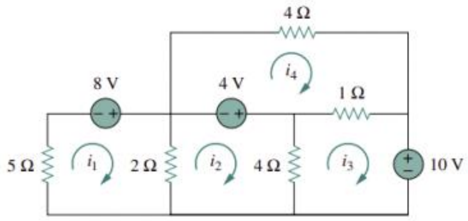

Figure 3.98 For Prob. 3.56.

* $R \cdot i = V$

$R_{11} = 7 \quad R_{12} = -2 \quad R_{13} = 0 \quad R_{14} = 0$

$R_{21} = -2 \quad R_{22} = 6 \quad R_{23} = -4 \quad R_{24} = 0$

$R_{31} = 0 \quad R_{32} = -4 \quad R_{33} = 5 \quad R_{34} = -1$

$R_{41} = 0 \quad R_{42} = 0 \quad R_{43} = -1 \quad R_{44} = 5$

$V_1 = 8$ V $\quad V_2 = 4$ V $\quad V_3 = -10$ V $\quad V_4 = -4$ V

$$\begin{bmatrix} 7 & -2 & 0 & 0 \\ -2 & 6 & -4 & 0 \\ 0 & -4 & 5 & -1 \\ 0 & 0 & -1 & 5 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix} = \begin{bmatrix} 8 \\ 4 \\ -10 \\ -4 \end{bmatrix}$$

Then we write the above equation as augmented matrix.
After bringing our matrix to row echolon form, we find i1, i2, i3 and i4.
Since these stages are only processes, direct results are written.

$i_1 = \frac{17}{22}\,A, \quad i_2 = \frac{-57}{44}\,A, \quad i_3 = \frac{-293}{88}\,A, \quad i_4 = \frac{-129}{88}\,A$

3.58 By inspection, obtain the mesh-current equations for the circuit in Fig. 3.100.

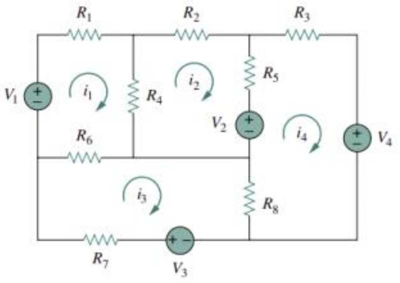

Figure 3.100 For Prob. 3.58.

* $R \cdot i = V$

$R_{11} = R_1 + R_4 + R_6 \qquad R_{12} = -R_4 \qquad R_{13} = -R_6 \qquad R_{14} = 0$

$R_{21} = -R_4 \qquad R_{22} = R_2 + R_4 + R_5 \qquad R_{23} = 0 \qquad R_{24} = -R_5$

$R_{31} = -R_6 \qquad R_{32} = 0 \qquad R_{33} = R_6 + R_7 \qquad R_{34} = -R_8$

$R_{41} = 0 \qquad R_{42} = -R_5 \qquad R_{43} = -R_8 \qquad R_{44} = R_3 + R_5 + R_8$

$V_1' = V_1 \qquad V_2' = -V_2 \qquad V_3' = V_3 \qquad V_4' = V_2 - V_4$

$$\begin{bmatrix} R_1+R_4+R_6 & -R_4 & -R_6 & 0 \\ -R_4 & R_2+R_4+R_5 & 0 & -R_5 \\ -R_6 & 0 & R_6+R_7 & -R_8 \\ 0 & -R_5 & -R_8 & R_3+R_5+R_8 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix} = \begin{bmatrix} V_1 \\ -V_2 \\ V_3 \\ V_2-V_4 \end{bmatrix}$$

3.66 Calculate v_o and i_o in the circuit of Fig. 3.102.

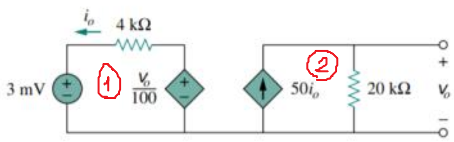

Figure 3.102 For Prob. 3.66.

(2) $50 i_0 \cdot 20\,k\Omega = V_0$

(1) $3\,mV - \frac{V_0}{100} + 4\,k\Omega \cdot i_0 = 0$

$$3 \cdot 10^{-3} - \frac{50 \cdot i_0 \cdot 20 \cdot 10^3}{100} + 4 \cdot 10^3 \cdot i_0 = 0$$

$$i_0 = \frac{3 \cdot 10^{-3}}{6 \cdot 10^3} = 0{,}5 \cdot 10^{-6}\,A = 0{,}5\,\mu A$$

$$V_0 = 50 \cdot i_0 \cdot 20\,k\Omega = 0{,}5\,V$$