2.110 Determine the value of V_o in the network in Fig. P2.110.

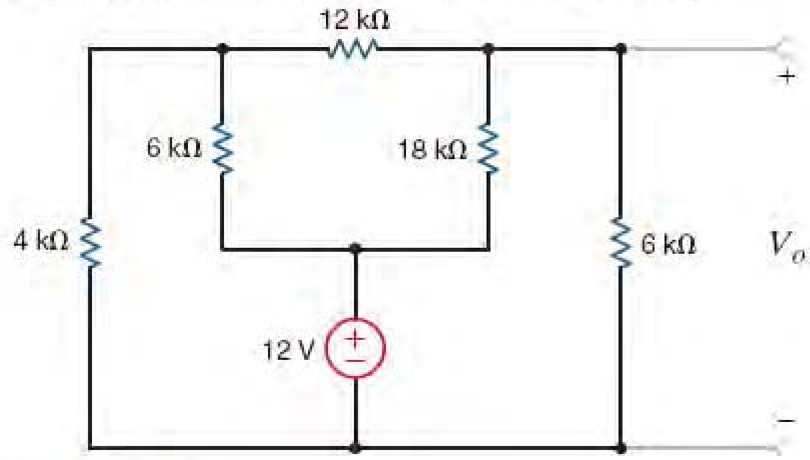
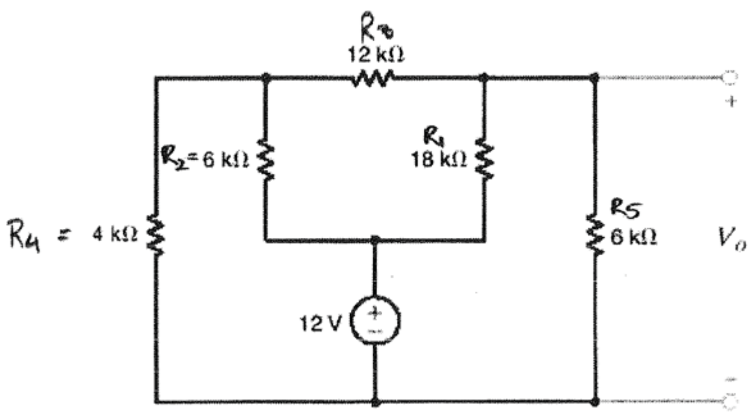


Figure P2.110

SOLUTION:

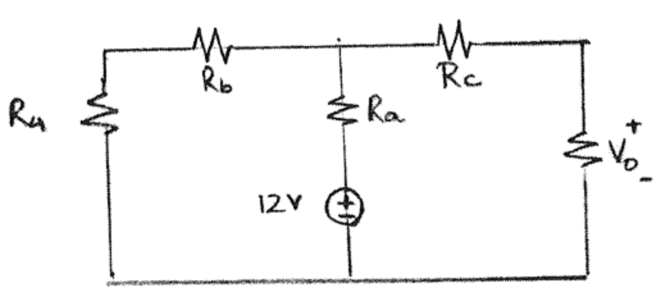


Using a delta to wye transformation:

$$R_a = \frac{R_1 R_2}{R_1+R_2+R_3} = \frac{18k(6k)}{18k+6k+12k} = 3k\,\Omega$$

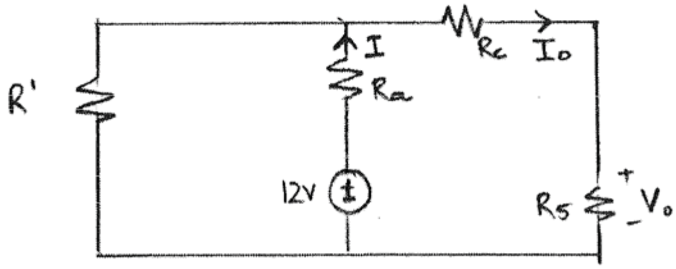
$$R_b = \frac{R_2 R_3}{R_1+R_2+R_3} = \frac{6k(12k)}{18k+6k+12k} = 2k\,\Omega$$

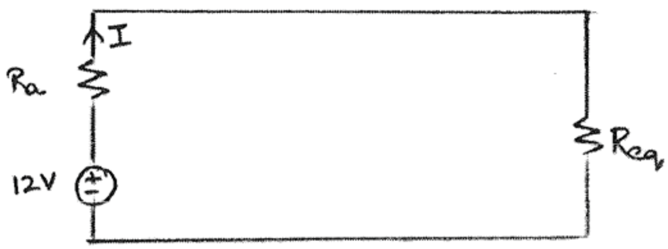
$$R_c = \frac{R_1 R_3}{R_1+R_2+R_3} = \frac{18k(12k)}{18k+6k+12k} = 6k\,\Omega$$



$$R' = R_4 + R_b = 4K + 2K$$

$$R' = 6K\,\Omega$$





$$R_{eq} = R' \parallel (R_c + R_5) = 6K \parallel (6K + 6K)$$

$$R_{eq} = 6K \parallel 12K = \frac{6K(12K)}{6K + 12K} = 4K\,\Omega$$

$$I = \frac{12}{R_a + R_{eq}} = \frac{12}{3K + 4k}$$

$$I = 1.714\,mA$$

Using current division:

$$I_o = \left(\frac{R'}{R' + R_c + R_5}\right)(I)$$

$$I_o = \left(\frac{6k}{6k+6k+6k}\right)(1.714m)$$

$$I_o = 0.571\,mA$$

$$V_o = I_o R_5 = (0.571m)(6k)$$

$$V_o = 3.43V$$

2.112 Find V_o in the network in Fig. P2.112.

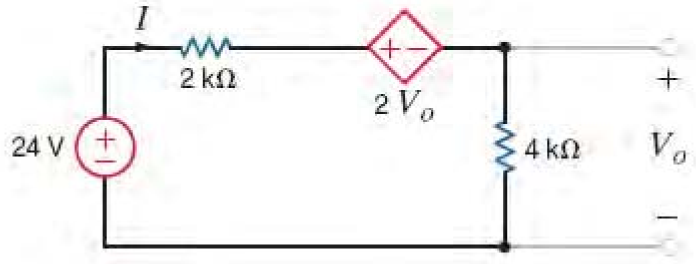


Figure P2.112

SOLUTION:

KVL:

$$24 = 2KI + 2V_o + V_o$$

$$I = \frac{24 - 3V_o}{2K}$$

$$V_o = I(4k) = \left(\frac{24 - 3V_o}{2K}\right)(4k)$$

$$V_o = 48 - 6V_o$$

$$7V_o = 48 - 6V_o$$

$$7V_o = 48$$

$$V_o = 6.86V$$

2.120 A typical transistor amplifier is shown in Fig. P2.120. Find the amplifier gain G (i.e., the ratio of the output voltage to the input voltage).

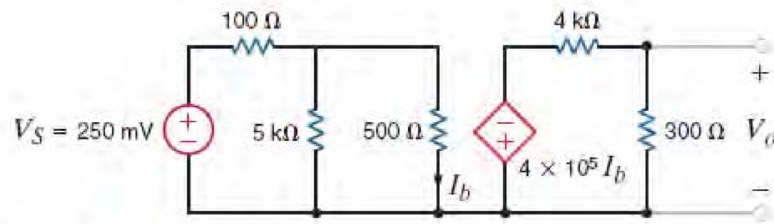
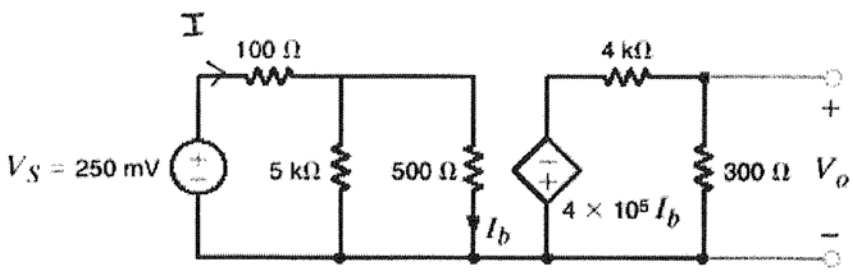


Figure P2.120

SOLUTION:



$$I = \frac{V_S}{(500 \| 5K) + 100} = \frac{250\,m}{454.55 + 100}$$

$$I = 0.451\,mA$$

$$I_b = \left(\frac{5K}{5K + 500}\right)(0.451m)$$

$$I_b = 0.41\,mA$$

$$V_o = \left(\frac{300}{4K + 300}\right)(-4 \times 10^5)(0.41\,mA)$$

$$V_o = -11.44\,V$$

$$G = \frac{V_o}{V_s} = \frac{-11.44}{250\,m}$$

$$G = -45.76$$

2.56 Find R_{AB} in the network in Fig. P2.56.

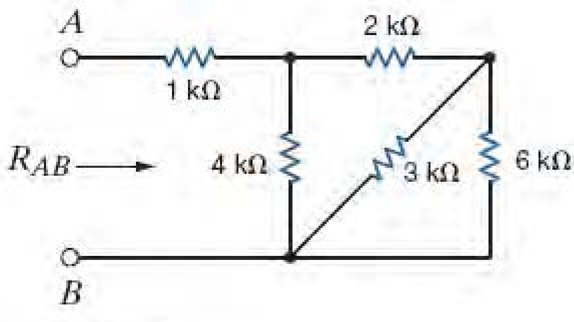
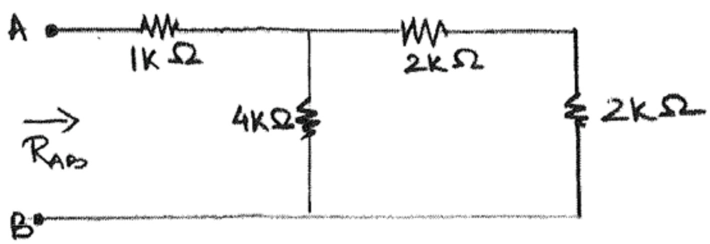


Figure P2.56

SOLUTION:

$3K \| 6K = 2k\Omega$



$R_{AB} = (4K \| 4K) + 1K$

$R_{AB} = 3K\Omega$

2.63 Find the equivalent resistance R_{eq} in the network in Fig. P2.63.

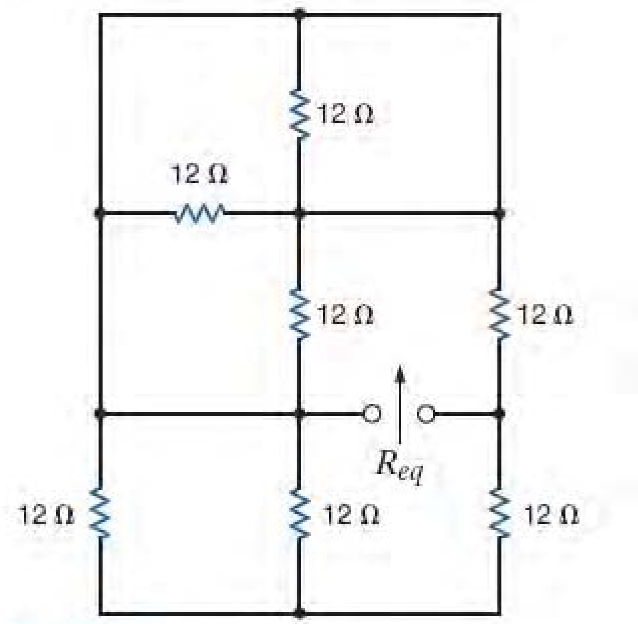
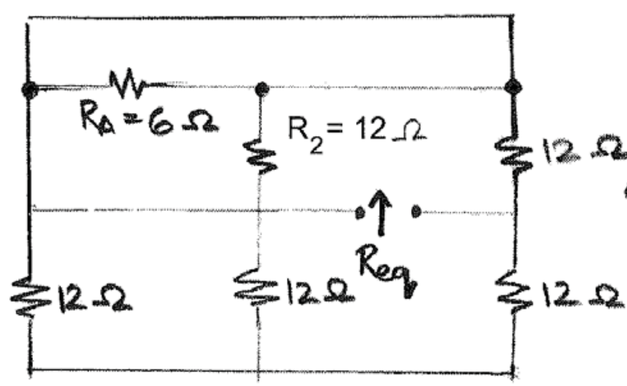


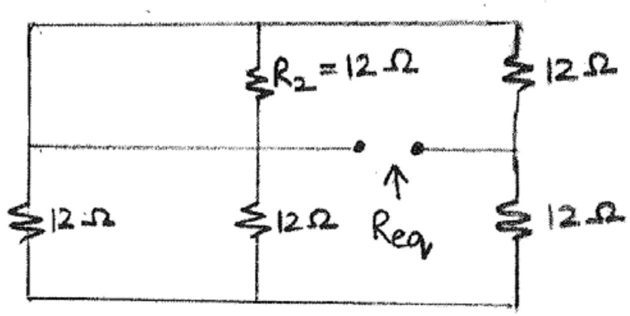
Figure P2.63

SOLUTION:

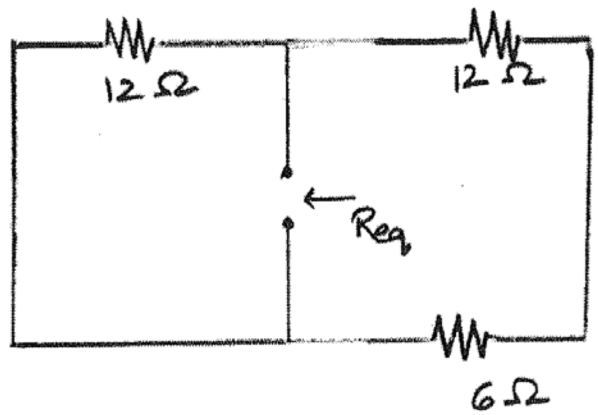
$R_A = R_1 \| R_3 = 6\,\Omega$



R_A is shorted.



R_2 is shorted.



$$R_{eq} = 12 \| 18$$

$$R_{eq} = 7.2\ \Omega$$

2.83 If $I_o = 2$ mA in the circuit in Fig. P2.83, find V_S.

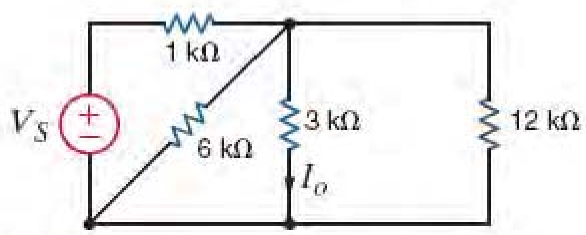
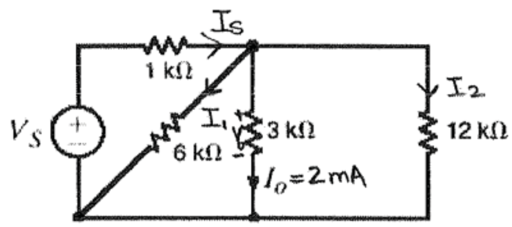


Figure P2.83

SOLUTION:



$V_O = I_o(3K) = 2m(3K) = 6V$

$I_1 = \frac{6}{6k} = 1mA$

$I_2 = \frac{6}{12k} = 0.5mA$

KCL:

$I_S = I_1 + I_o + I_2 = 1m + 2m + 0.5m$

$I_s = 3.5mA$

KVL:

$V_s = 1K\,I_s + V_o$

$V_s = 1K(3.5) + 6$

$V_s = 9.5\ V$

2.87 If $V_1 = 5$ V in the circuit in Fig. P2.87, find I_S.

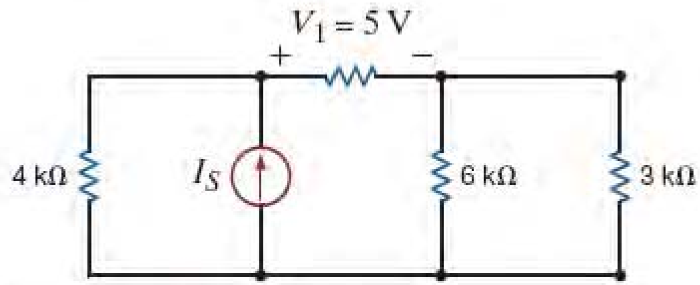
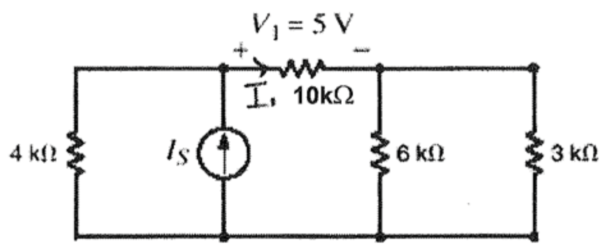
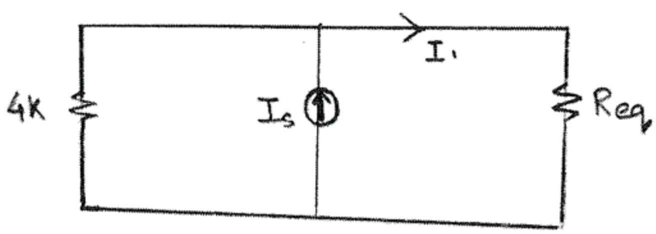


Figure P2.87

SOLUTION:



$$I_1 = \frac{V_1}{10k} = \frac{5}{10k} = \frac{1}{2}\,mA$$



$$R_{eq} = (6K \| 3K) + 10K$$

$$R_{eq} = 12K\,\Omega$$

$$I_1 = \left(\frac{4k}{4K + 12k}\right) I_s$$

$$I_s = \frac{I_1}{\left(\frac{4k}{4k+12k}\right)} = \frac{\frac{1}{2}m}{\left(\frac{4k}{4k + 12k}\right)}$$

$$I_s = 2mA$$

2.92 Find the value of I_A in the network in Fig. P2.92.

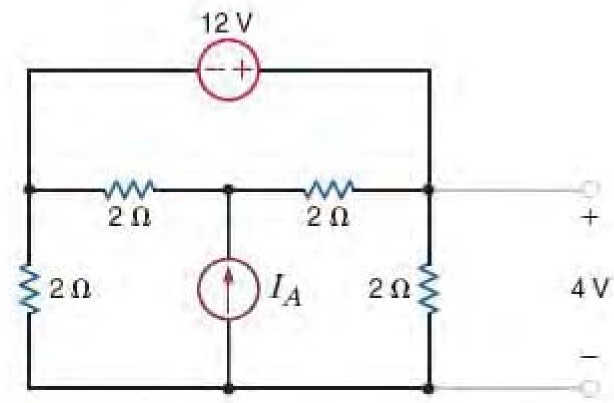
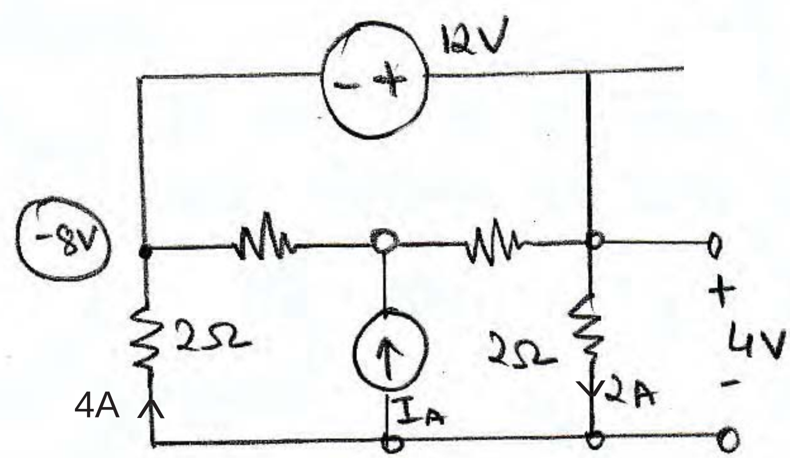


Figure P2.92

SOLUTION:



$$I_A = -2A$$

3.1 Find I_1 in the circuit in Fig. P3.1.

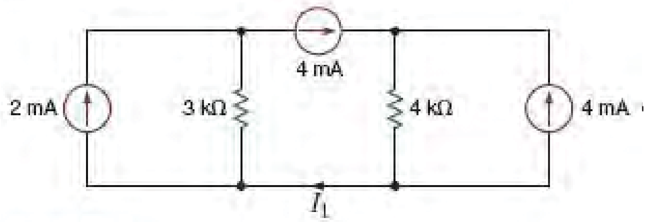


Figure P3.1

SOLUTION:

$I_1 = 4mA$

3.7 Find I_o in the circuit in Fig. P3.7 using nodal analysis.

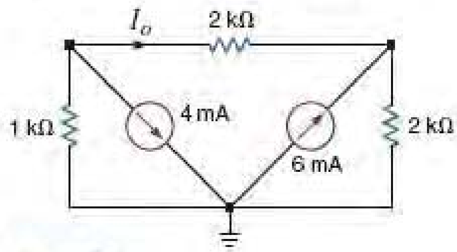


Figure P3.7

SOLUTION:

$$\begin{bmatrix} \frac{1}{k}+\frac{1}{2K} & -\frac{1}{2k} \\ -\frac{1}{2k} & \frac{1}{2K}+\frac{1}{2k} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} -\frac{4}{k} \\ \frac{6}{k} \end{bmatrix}$$

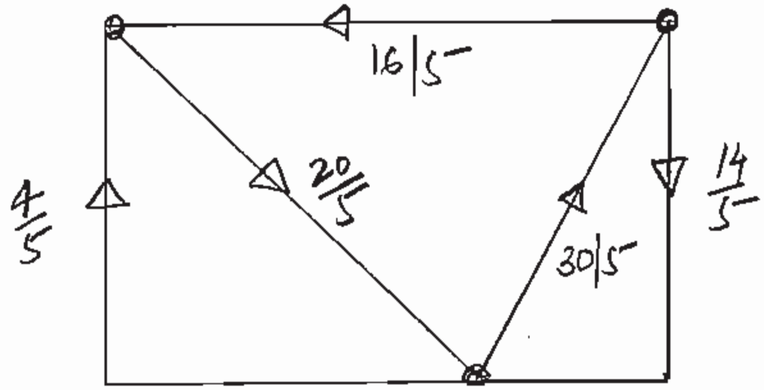
$$\Delta = \left(\frac{3}{2k}\right)\left(\frac{1}{k}\right) - \left(\frac{1}{4k^2}\right) = \frac{3}{2k^2} - \frac{1}{4k^2}$$

$$= \frac{6}{4K^2} - \frac{1}{4k^2} = \frac{5}{4k^2}$$

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \frac{4k^2}{5} \begin{bmatrix} \frac{1}{k} & \frac{1}{2k} \\ \frac{1}{2k} & 3/2k \end{bmatrix} \begin{bmatrix} -4/k \\ 6/k \end{bmatrix}$$

$$= \frac{4k^2}{5} \begin{bmatrix} -\frac{4}{k^2} + \frac{3}{k^2} \\ -\frac{2}{k^2} + \frac{9}{k^2} \end{bmatrix} = \frac{4}{5} \begin{bmatrix} -1 \\ 7 \end{bmatrix} = \begin{bmatrix} -\frac{4}{5} \\ 28/5 \end{bmatrix}$$

$$I_0 = \frac{1}{2k}\left(-\frac{4}{5} - \frac{28}{5}\right) = \frac{1}{2k}\left(\frac{-32}{5}\right) = \frac{-16}{5} mA$$



3.12 Find V_o in the network in Fig. P3.12 using nodal analysis.

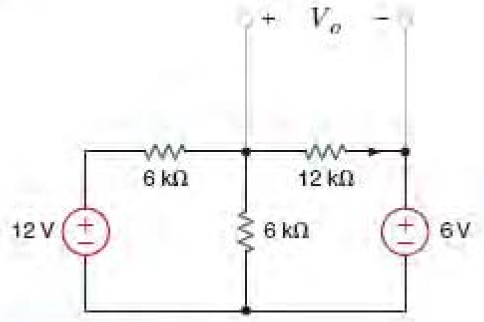
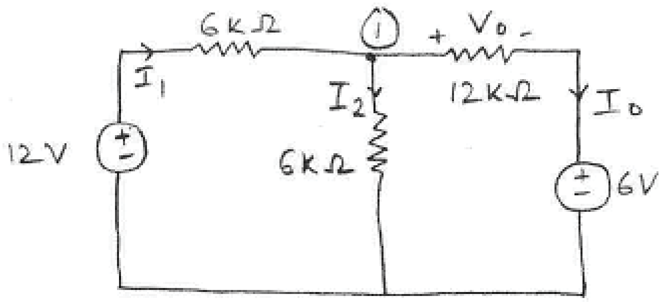


Figure P3.12

SOLUTION:



KCL at (1): $I_1 = I_2 + I_o$

$$\frac{12 - V_1}{6K} = \frac{V_1}{6K} + \frac{V_1 - 6}{12K}$$

$$24 - 2V_1 = 2V_1 + V_1 - 6$$

$$5V_1 = 30$$

$$V_1 = 6\ V$$

$$V_o = V_1 - 6$$

$$= 6 - 6$$

$$V_o = 0\ V$$

3.18 Find V_o in the circuit in Fig. P3.18 using nodal analysis.

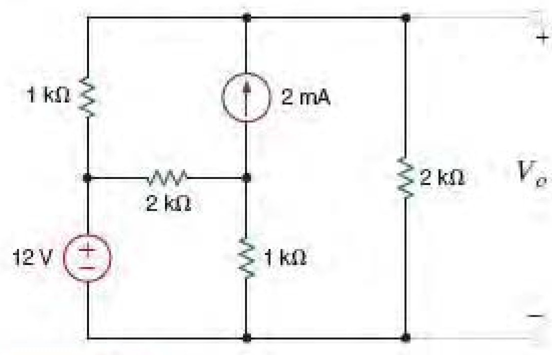
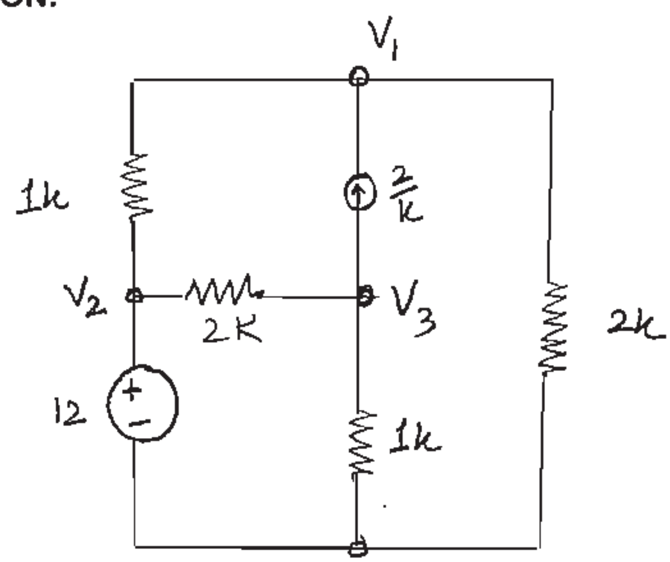


Figure P3.18

SOLUTION:

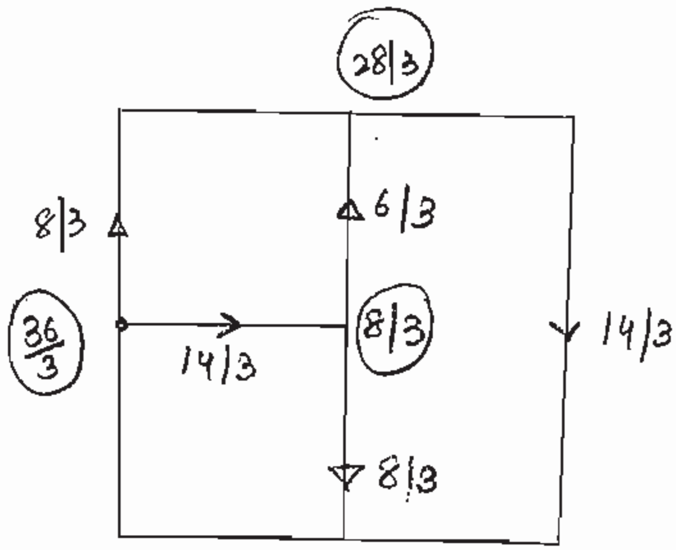


$$\frac{V_1 - 12}{1k} + \frac{V_1}{2k} = \frac{2}{k}$$

$$\frac{V_3 - 12}{2k} + \frac{V_3}{1k} = -2/k$$

$$\frac{V_1}{k} + \frac{V_1}{2k} = \frac{14}{k} \Rightarrow 3/2\, V_1 = 14 \quad V_1 = \frac{28}{3} V$$

$$\frac{V_3}{2k} + \frac{V_3}{1k} = \frac{4}{k} \Rightarrow 3/2\, V_3 = 4 \quad V_3 = \frac{8}{3} V$$


28/3
8/3
6/3
36/3
14/3
8/3
14/3
8/3

3.22 Find V_o in the network in Fig. P3.22 using nodal analysis.

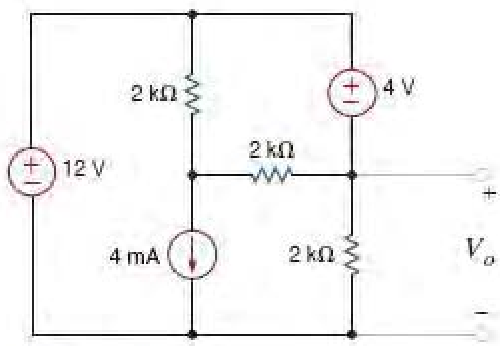


Figure P3.22

SOLUTION:

$V_D = 12 - 4 = 8V$

3.35 Find V_o in the circuit in Fig. P3.35 using nodal analysis.

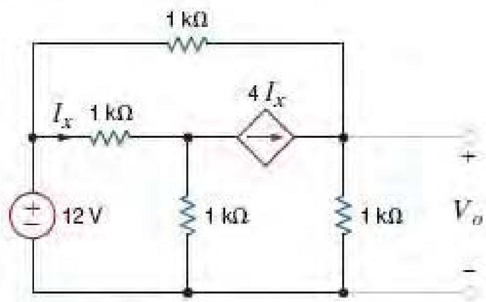


Figure P3.35

SOLUTION:

$$\frac{V_1 - 12}{k} + \frac{V_1}{k} + 4I_X = 0$$

$$\frac{V_0 - 12}{k} + \frac{V_0}{k} = 4I_X \qquad I_X = \frac{12 - V_1}{k}$$

$$V_1 - 12 + V_1 + 48 - 4V_1 = 0$$

$$V_0 - 12 + V_0 = 48 - 4V_1$$

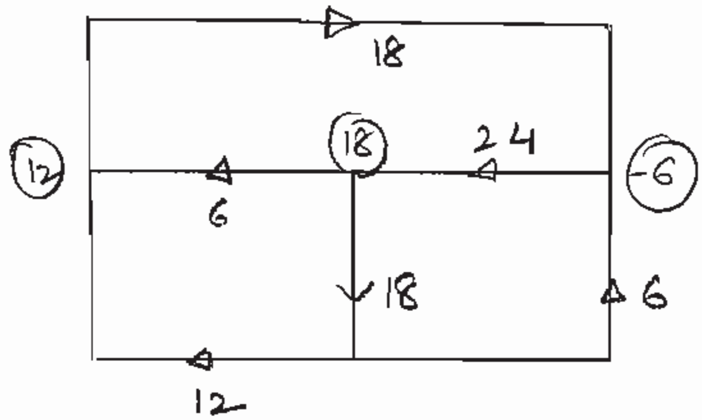
$$-2V_1 + 36 = 0$$

$$2V_0 + 4V_1 = 60$$

$$V_1 = 18V$$

$$2V_0 = 60 - 72 = -12$$

$$V_0 = -6V$$


18
12
18
24
-6
6
18
6
12

3.53 Find I_o in the network in Fig. P3.53 using mesh analysis.

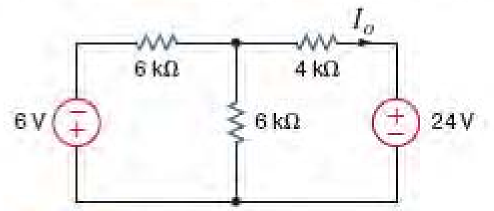
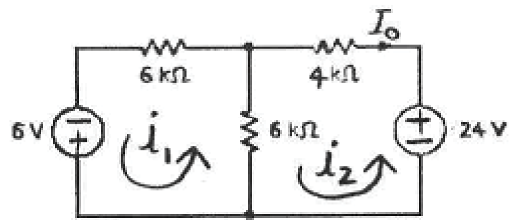


Figure P3.53

SOLUTION:



Let the loop current be I_1 & I_2 mA as indicated in the figure

<u>KVL for loop 1</u> :

$$6 = 6I_1 + 6(I_1 - I_2)$$

$$\Rightarrow 6 = 12I_1 - 6I_2 \quad \text{— (1)}$$

<u>KVL for the loop 2</u> :

$$24 = 4I_2 + 6(I_2 - I_1)$$

$$\Rightarrow 24 = -6I_1 + 10I_2 \quad \text{— (2)}$$

Solving equation (1) & (2) gives

$$I_2 = \frac{27}{7} \text{ mA}$$

$$\therefore \quad I_o = -I_2$$

$$I_o = -\frac{27}{7} \text{ mA} = -3.857 \text{ mA}$$

$$\boxed{I_o = -3.857 \text{ mA}}$$

3.58 Find V_o in the circuit in Fig. P3.58 using mesh analysis.

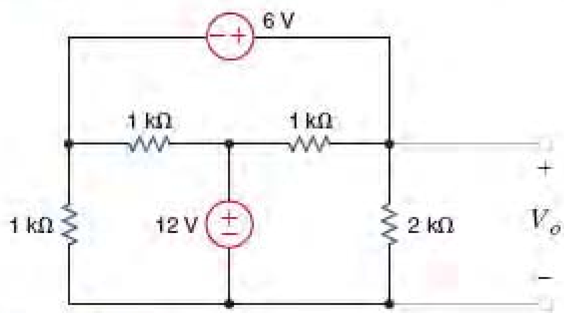
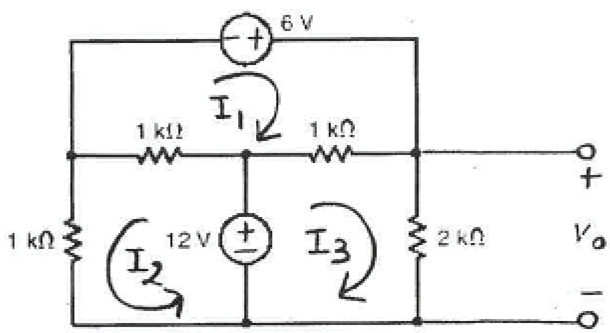


Figure P3.58

SOLUTION:



Let the mesh/loop currents be I_1, I_2 & I_3 as shown in the diagram

KVL in loop 1:

$$6 = (I_1)1 - I_3 + 1(I_1 + I_2)$$

$$\Rightarrow 6 = 2I_1 + I_2 - I_3 \quad \text{— (1)}$$

KVL in the loop 2:

$$12 = 2I_2 + I_1 \quad \text{— (2)}$$

3.70 Using loop analysis, find V_o in the network in Fig. P3.70.

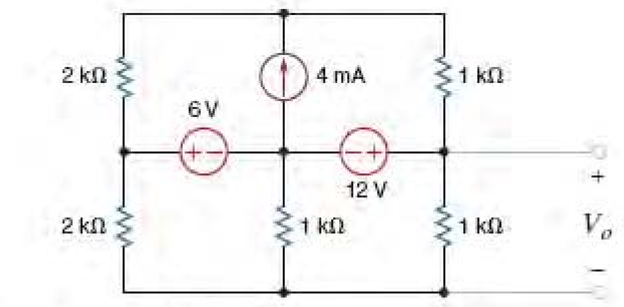
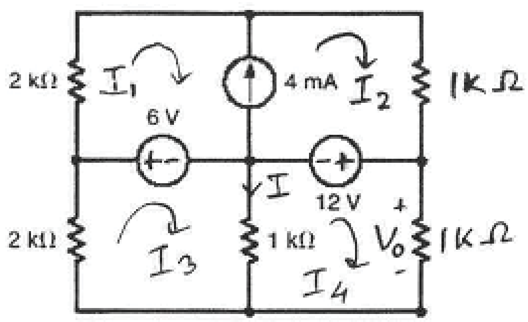


Figure P3.70

SOLUTION:



KCL : $I + I_4 = I_3$

$I = I_3 - I_4$

KVL : $6 = 2KI_1 + 1KI_2 + 12$

$\boxed{2KI_1 + 1KI_2 = -6}$

KVL: $12 = 6 + 2kI_3 + 1kI_4$

$\boxed{2KI_3 + 1KI_4 = 6}$

KVL : $2KI_3 + 6 + kI = 0$

$2kI_3 + 1k(I_3 - I_4) = -6$

$\boxed{3KI_3 - 1KI_4 = -6}$

$2kI_3 + 1kI_4 = 6$
$3KI_3 - 1KI_4 = -6$

$I_3 = 0A$
$I_4 = 6mA$

$V_o = 1k(I_4) = 6V$

3.78 Use loop analysis to find V_o in the network in Fig. P3.78.

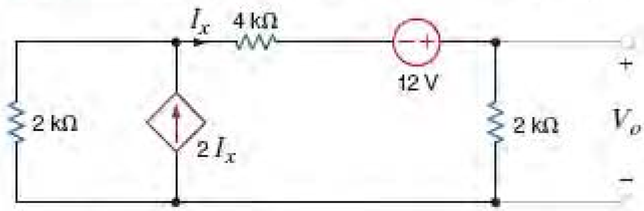
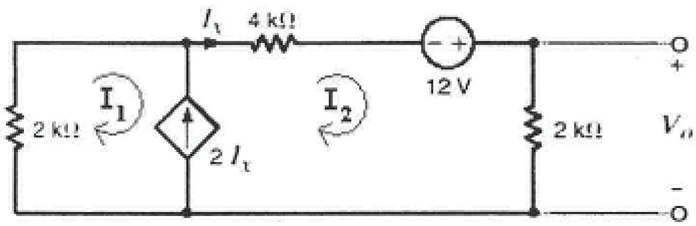


Figure P3.78

SOLUTION:



KCL: $I_1 + 2I_x = I_x$

$I_1 = -I_x$ and $I_2 = I_x$

KVL: $12 = 2kI_1 + 4kI_2 + 2kI_2$

$2kI_1 + 6kI_2 = 12$

$2k(-I_x) + 6k(I_x) = 12$

$4kI_x = 12$

$I_x = 3mA$

$V_0 = 2kI_x = 2k(3m)$

$V_0 = 6V$

3.86. Use mesh analysis to find V_o in the circuit in Fig. P3.86.

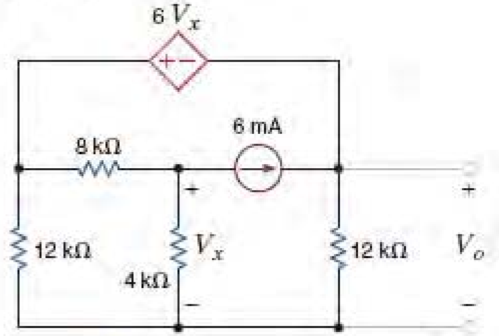
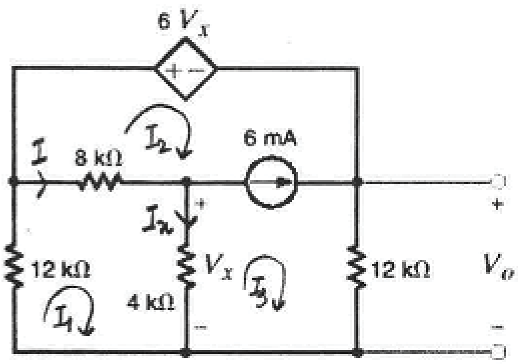


Figure P3.86

SOLUTION:



KCL: $I_1 = I + I_2$

$I = I_1 - I_2$

KCL: $I = 6m + I_x$

$I_x = I_1 - I_2 - 6m$

KVL lower left loop:

$12k\,I_1 + 8k\,I + 4k\,I_x = 0$

$12k\,I_1 + 8k(I_1 - I_2) + 4k(I_1 - I_2 - 6m) = 0$

$$\boxed{24k\,I_1 - 12k\,I_2 = 24}$$

KVL outer loop: $12k\,I_1 + 6V_x + 12k\,I_3 = 0$

$$V_x = 4k\,I_x = 4k(I_1 - I_2 - 6m)$$

$$V_x = 4k\,I_1 - 4k\,I_2 - 24$$

$$12k\,I_1 + 6[4k\,I_1 - 4k\,I_2 - 24] + 12k\,I_3 = 0$$

$$36k\,I_1 - 24k\,I_2 + 12k\,I_3 = 144$$

KCL: $I_x + I_3 = I_1$

$$I_3 = I_1 - [I_1 - I_2 - 6m]$$

$$I_3 = I_2 + 6m$$

$$36k\,I_1 - 24k\,I_2 + 12k(I_2 + 6m) = 144$$

$$\boxed{36k\,I_1 - 12k\,I_2 = 72}$$

$$24k\,I_1 - 12k\,I_2 = 24$$

$$36k\,I_1 - 12k\,I_2 = 72$$

$$I_1 = 4mA$$

$$I_2 = 6mA$$

$$I_3 = 6m + 6m$$

$$I_3 = 12mA$$

$$V_o = 12k(I_3) = 12k(12m)$$

$$V_o = 144V$$