1.1 Find I_1 and I_2 in the circuit in Fig. P2.11.

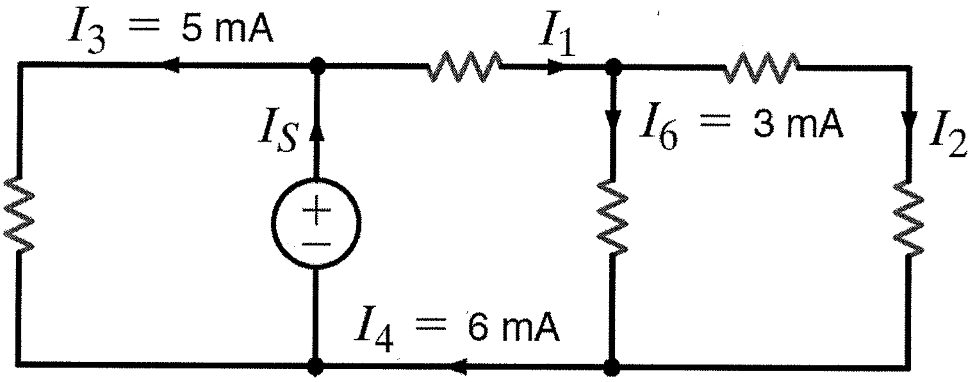
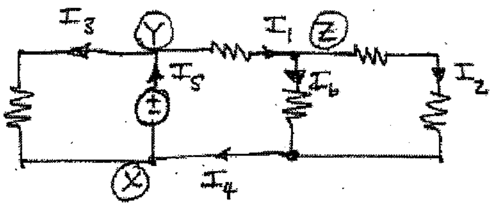


Figure P2.11

SOLUTION:

Find I_1 and I_2



$I_3 = 5mA \qquad I_6 = 3mA \qquad I_4 = 6mA$

KCL @ (X) : all currents enter

$I_3 - I_S + I_4 = 0$

$I_S = 5\times10^{-3} + 6\times10^{-3} \Rightarrow I_S = 11mA$

KCL @ (Y) : all currents enter

$-I_3 + I_S - I_1 = 0 \Rightarrow I_1 = I_S - I_3 = 11\times10^{-3} - 5\times10^{-3} \Rightarrow \boxed{I_1 = 6\,mA}$

KCL @ (Z) : all current enter

$I_1 - I_6 - I_2 = 0 \Rightarrow I_2 = I_1 - I_6 = 6\times10^{-3} - 3\times10^{-3} \Rightarrow \boxed{I_2 = 3\,mA}$

1.2 Find I_o and I_1 in the circuit in Fig. P2.12.

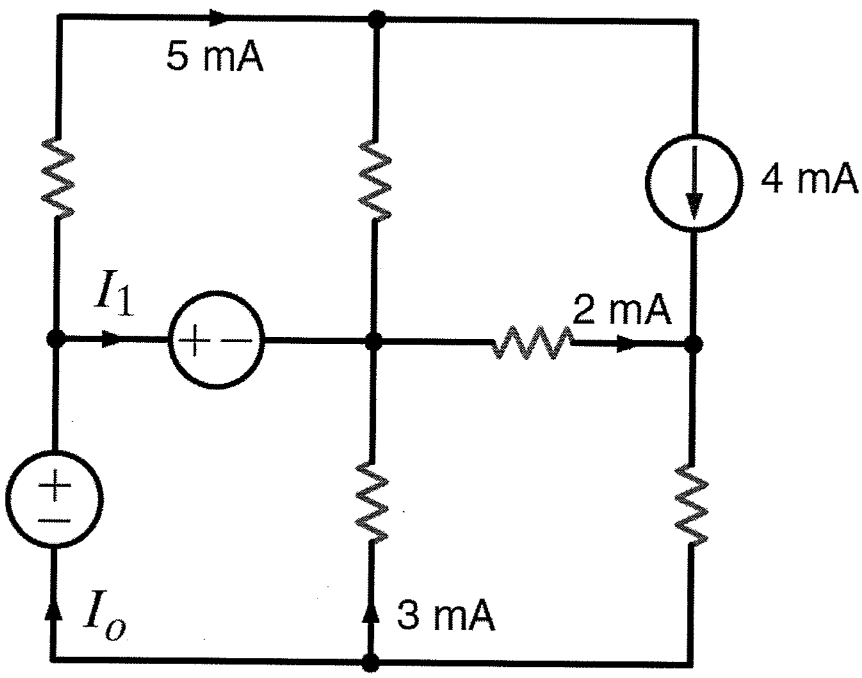
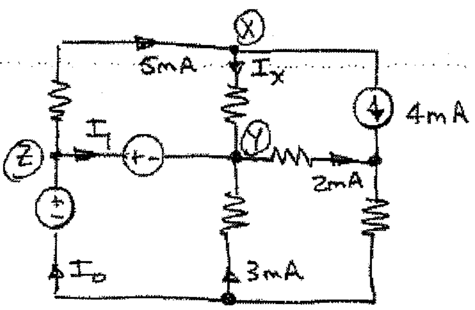


Figure P2.12

SOLUTION:

Find I_o and I_1



KCL @ Ⓧ: currents enter

$5 \times 10^{-3} - 4 \times 10^{-3} - I_x = 0 \Rightarrow I_x = 1\,\text{mA}$

KCL @ Ⓨ: current enter

$I_x - 2 \times 10^{-3} + 3 \times 10^{-3} + I_1 = 0 \Rightarrow \boxed{I_1 = -2\,\text{mA}}$

KCL @ Ⓩ: currents enter

$-5 \times 10^{-3} - I_1 + I_o = 0 \Rightarrow \boxed{I_o = 3\,\text{mA}}$

1.3 Find I_x in the circuit in Fig. P2.15.

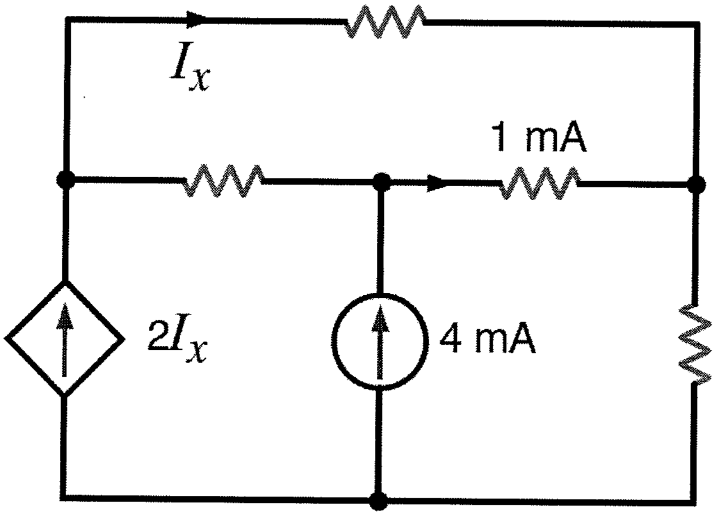
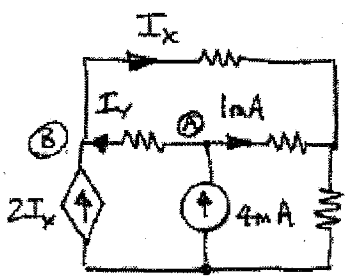


Figure P2.15

SOLUTION:

Find I_x.



KCL @ Ⓐ: currents leaving

$-4\times10^{-3} + 10^{-3} + I_y = 0 \qquad I_y = 3\,\text{mA}$

KCL @ Ⓑ: currents entering

$I_y + 2I_x - I_x = 0 \qquad \boxed{I_x = -3\,\text{mA}}$

1.4 Find U_{fb} and U_{ec} in the circuit in Fig. P2.17.

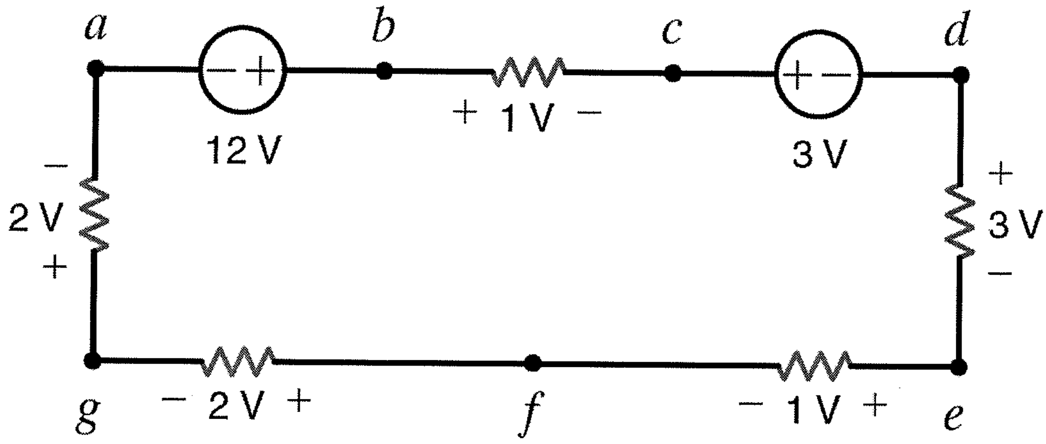
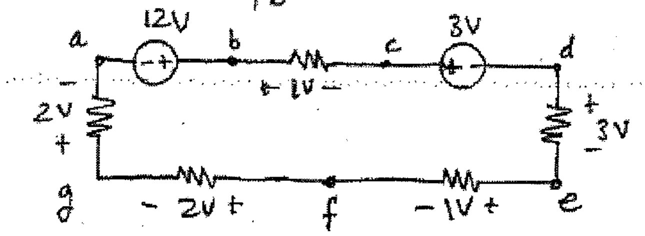


Figure P2.17

SOLUTION:

Find U_{fb} and U_{ec}



KVL along abfga:

$-12 + U_{bf} + 2 + 2 = 0$

$U_{bf} = 8\,V \Rightarrow \boxed{U_{fb} = -8\,V}$

KVL along cdec: $3 + 3 + U_{ec} = 0 \Rightarrow \boxed{U_{ec} = -6\,V}$

1.5 Find U_o in the circuit in Fig. P2.22.

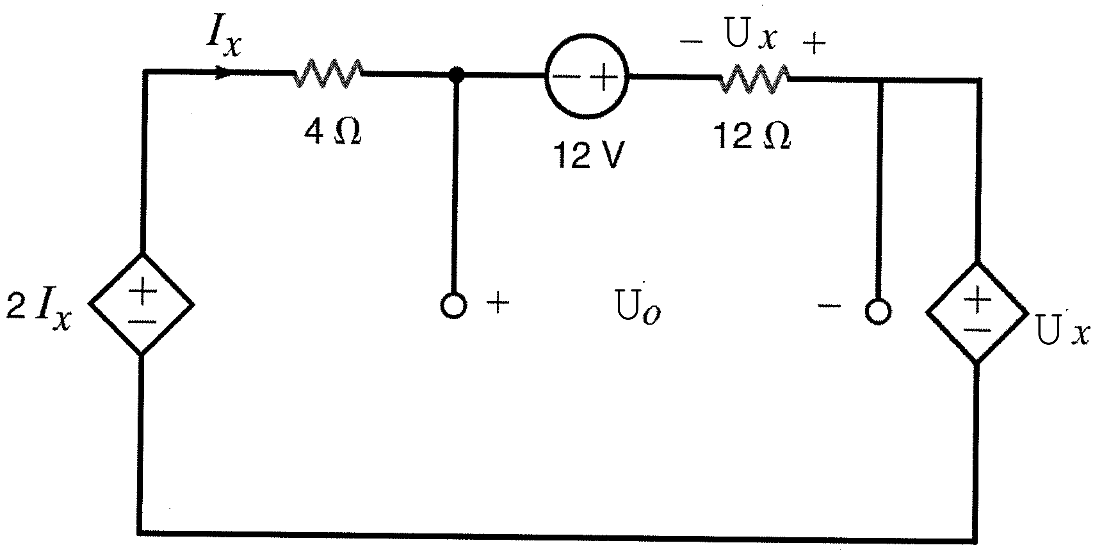
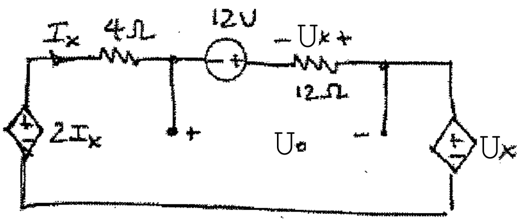


Figure P2.22

SOLUTION:

Find o



KVL :

$4I_x - 12 + 12I_x + U_x - 2I_x = 0$ (1)

$U_x = -12I_x$ (2)

Substitute (2) into (1): $4I_x + 12I_x - 12I_x - 2I_x = 12$

$2I_x = 12 \Rightarrow I_x = 6A$

$U_o = -12 + 12I_x = -12 + 12(6) \rightarrow \boxed{U_o = 60V}$

1.6 Find U_1 in the network in Fig. P2.26.

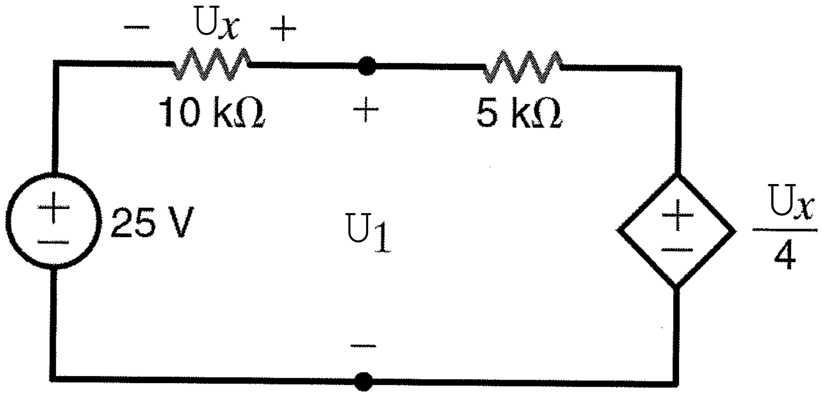
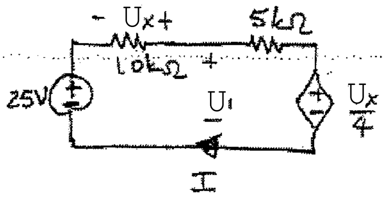


Figure P2.26

SOLUTION:

Find U_1.



KVL: $-25 + 10^4 I + 5\times10^3 I + U_x/4 = 0$ (1)

also: $U_x = -10^4 I$ (2)

Substitute (2) into (1):

$$-25 + I\left(10^4 + 5\times10^3 - 10^4/4\right) = 0$$

$$I = 2mA$$

$U_1 = 25 - 10^4 I \Rightarrow$ $\boxed{U_1 = 5V}$

1.7 If $U_o = 4$ V in the network in Fig. P2.30, find U_S.

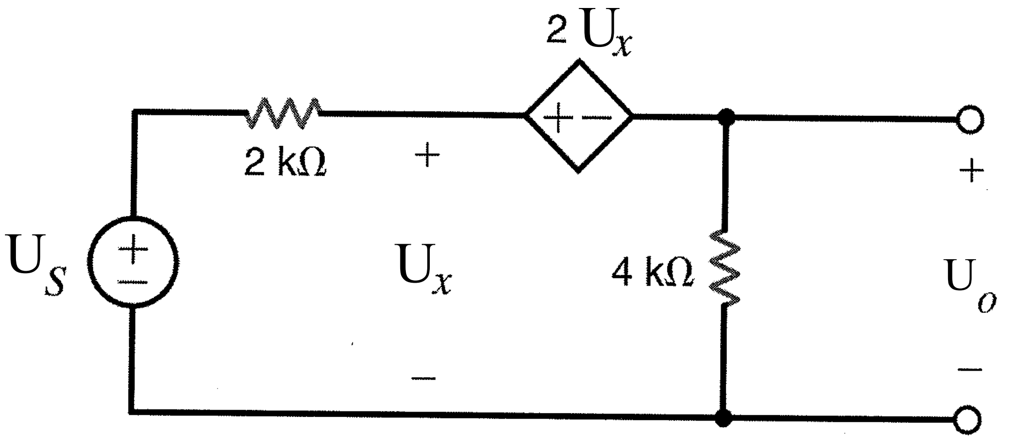
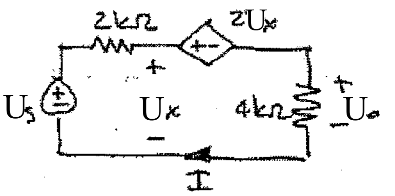


Figure P2.30

SOLUTION:

$U_o = 4V$, find U_S



KVL: $-U_S + 2\times10^3 I + 2U_x + 4\times10^3 I = 0$ (1)

also: $-U_x + 2U_x + V_o = 0 \Rightarrow U_x = -4V$ (2)

and $U_o = 4\times10^3 I \Rightarrow I = 1mA$ (3)

substitute (2) & (3) into (1): $I(6\times10^3) + 2U_x = U_S \Rightarrow \boxed{U_s = -2V}$

1.8 Find R_{AB} in the circuit in Fig. P2.49.

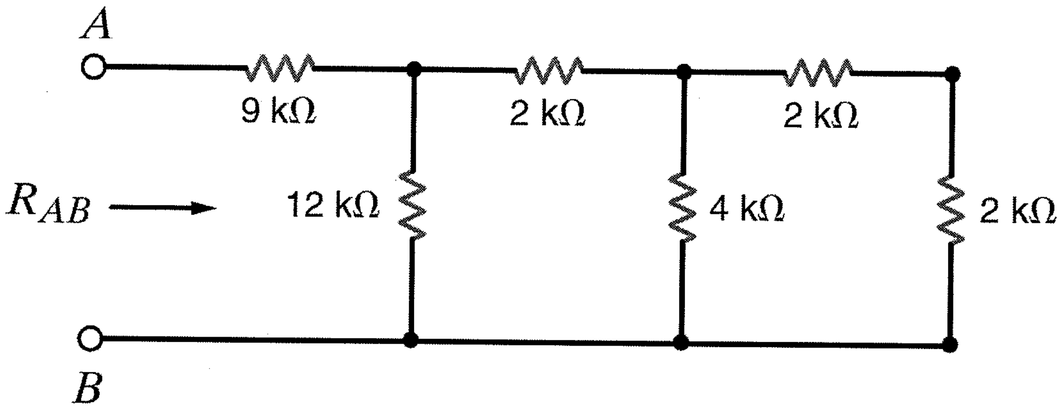
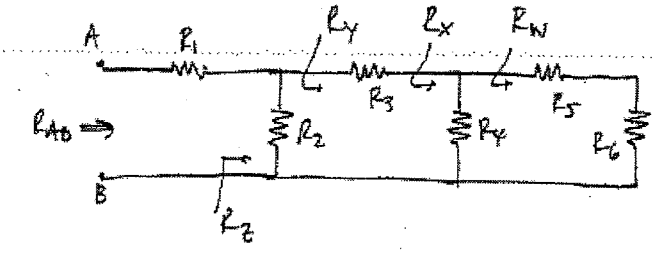


Figure P2.49

SOLUTION:

Find R_{AB}.



$R_1 = 9k\Omega \quad R_2 = 12k\Omega \quad R_3 = 2k\Omega$

$R_4 = 4k\Omega \quad R_5 = 2k\Omega \quad R_6 = 2k\Omega$

$R_W = R_5 + R_6 = 4k\Omega$

$R_X = R_4 // R_W = 2k\Omega$

$R_Y = R_3 + R_X = 4k\Omega \qquad R_Z = R_2 // R_Y = 3k\Omega$

$R_{AB} = R_1 + R_Z \Rightarrow \boxed{R_{AB} = 12k\Omega}$

1.9 Find I_1 and U_o in the circuit in Fig. P2.61.

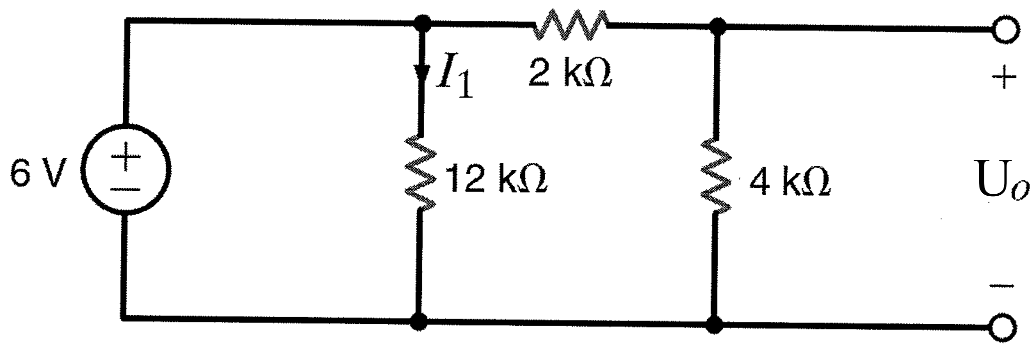
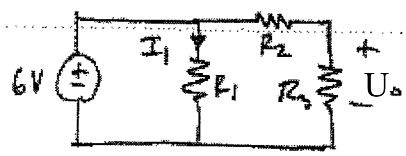


Figure P2.61

SOLUTION:

Find I_o & U_o



$R_1 = 12k\Omega$
$R_2 = 2k\Omega$
$R_3 = 4k\Omega$

$I_1 = \frac{6}{R_1} \Rightarrow I_1 = 0.5mA$

$U_o = 6\left[\frac{R_3}{R_2+R_3}\right] \Rightarrow \boxed{U_o = 4V}$

1.10 Find I_1 and U_o in the circuit in Fig. P2.62.

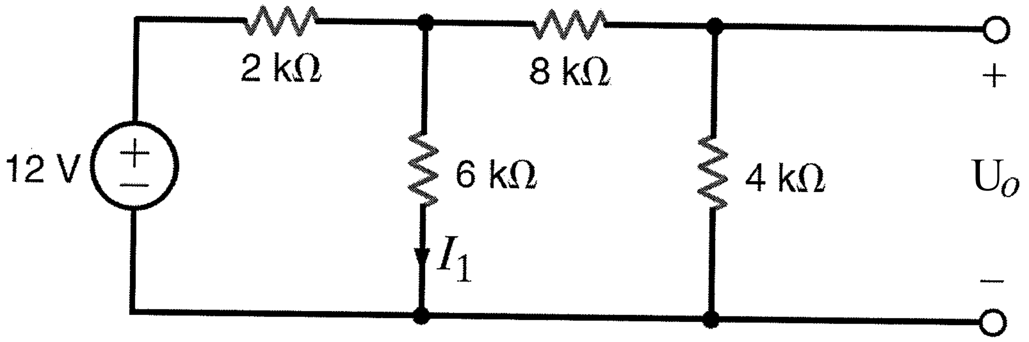
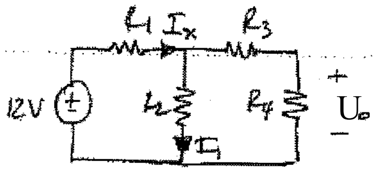


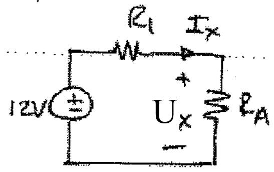
Figure P2.62

SOLUTION:

Find I_1 & U_o.



⇒



$I_x = \frac{12}{R_1+R_x} = 2mA$

$U_x = 12\left[\frac{R_A}{R_A+R_1}\right] = 8V$

$R_1 = 2k\Omega$ $R_2 = 6k\Omega$

$R_3 = 8k\Omega$ $R_4 = 4k\Omega$

$R_A = R_2 \,//\, (R_3+R_4)$

$R_A = 4k\Omega$

By current division: $I_1 = I_x\left[\frac{R_4+R_3}{R_2+R_4+R_3}\right] \Rightarrow I_1 = 1.33\ mA$

By voltage division: $U_o = U_x\left[\frac{R_4}{R_4+R_3}\right] \Rightarrow$ $\boxed{U_o = 2.67V}$

1.11 Find U_o in the network in Fig. P2.111.

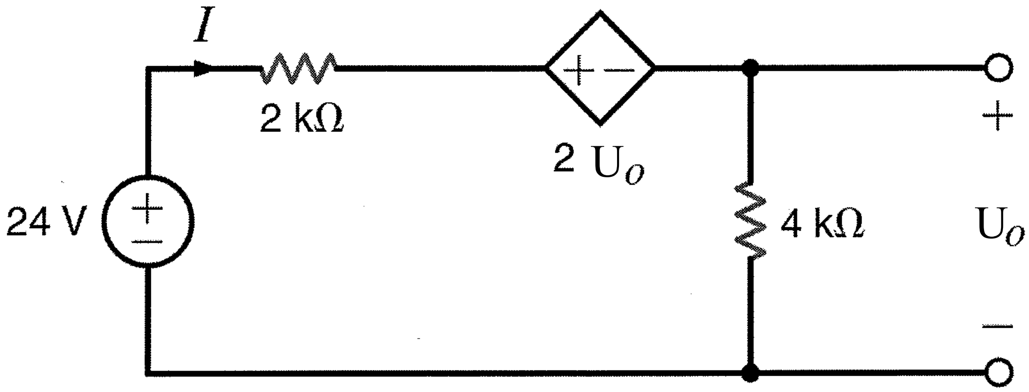
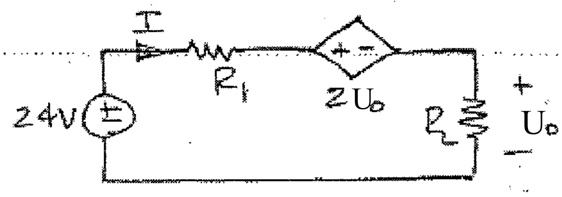


Figure P2.111

SOLUTION:

Find U_o.



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

$$24 = R_1 I + 2U_o + R_2 I$$

$$U_o = R_2 I = 4I$$

$$24 = I(14) \Rightarrow I = \frac{12}{7}$$

$$\boxed{U_o = 6.86\text{ V}}$$

1.12 A typical transistor amplifier is shown in Fig. P2.117. Find the amplifier gain G (i.e., the ratio of the output voltage to the input voltage).

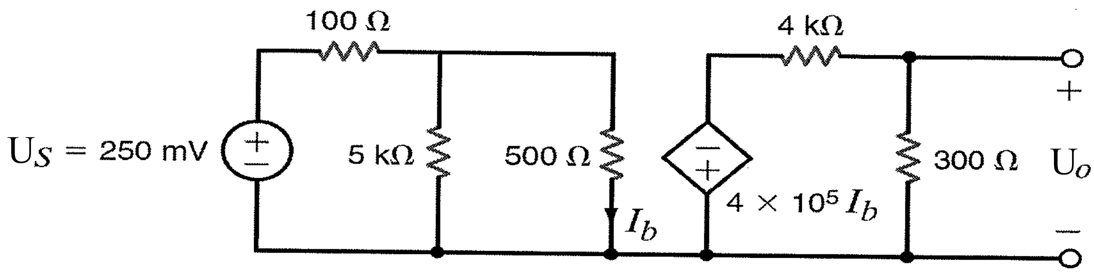
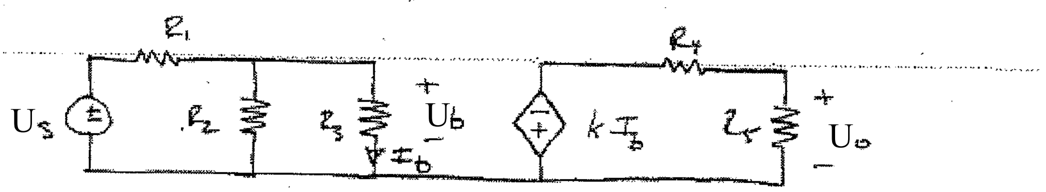


Figure P2.117

SOLUTION:

Find $G = U_o / U_S$



$U_S = \frac{1}{4}$ V $\quad R_1 = 100\,\Omega \quad R_2 = 5\,k\Omega \quad R_3 = 500\,\Omega$

$k = 4 \times 10^5 \quad R_4 = 4\,k\Omega \quad R_5 = 300\,\Omega$

$$U_b = U_S \left[\frac{R_2 /\!/ R_3}{R_1 + (R_2 /\!/ R_3)} \right] = 0.205\ V$$

$$I_b = U_b / R_3 = 410\,\mu A$$

$$U_o = -kI_b \left[\frac{R_5}{R_4 + R_5} \right] \Rightarrow U_o = -11.4\ V$$

$$G = \frac{U_o}{U_S} \qquad \boxed{G = -45.8}$$

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

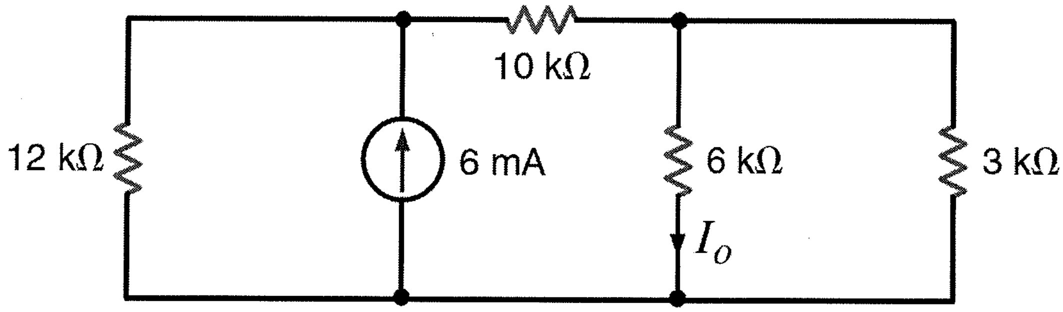
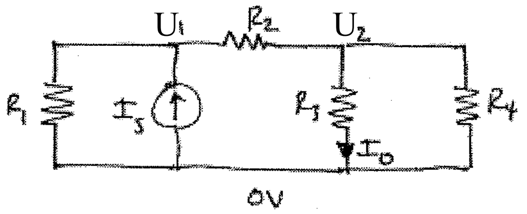


Figure P3.1

SOLUTION:

I_o via nodal.



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

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

@U_1: $\frac{U_1}{R_1} - I_S + \frac{U_1 - U_2}{R_2} = 0$

@U_2: $\frac{U_2 - U_1}{R_2} + \frac{U_2}{R_3} + \frac{U_2}{R_4} = 0$

$\$$: $I_o = U_2 / R_3$

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

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

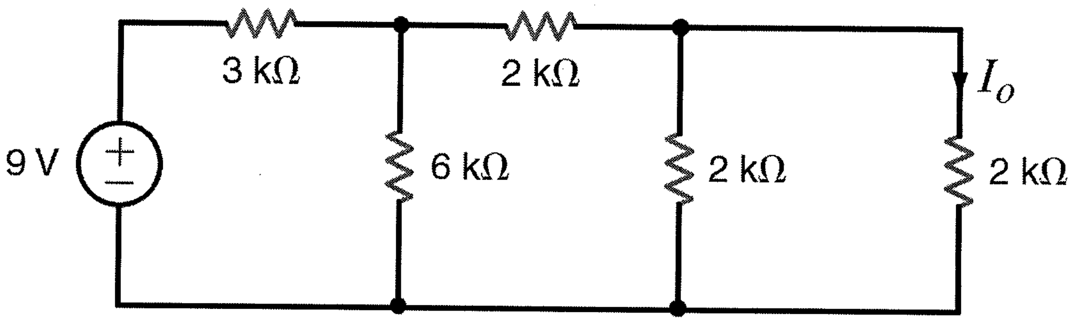
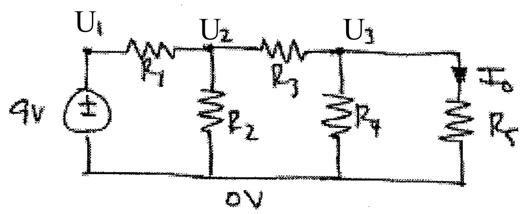


Figure P3.5

SOLUTION:

Find I_o by nodal.



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

@ U_1: $U_1 = 9V$

@ U_2: $\frac{U_2 - U_1}{R_1} + \frac{U_2}{R_2} + \frac{U_2 - U_3}{R_3} = 0$

@ U_3: $\frac{U_3 - U_2}{R_3} + \frac{U_3}{R_4} + \frac{U_3}{R_5} = 0$

and $I_o = U_3 / R_5$

$\boxed{I_o = 0.6 mA}$

1.15 Find I_o in the network in Fig. P3.6 using nodal analysis.

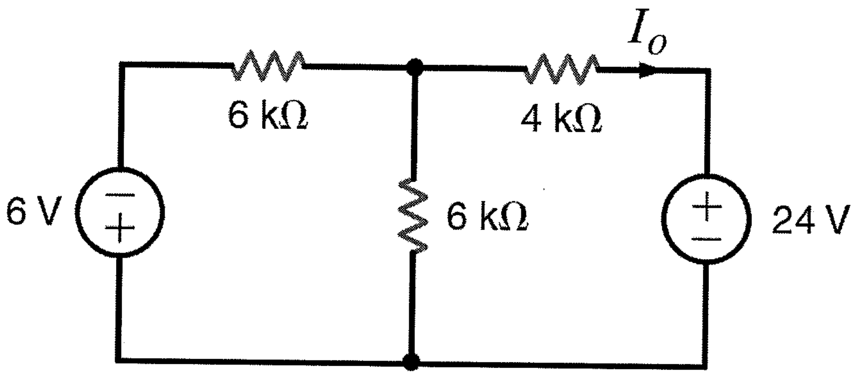
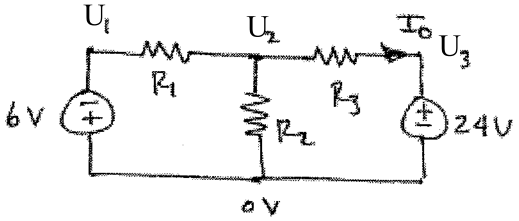


Figure P3.6

SOLUTION:

Find I_o by nodal.



$R_1 = R_2 = 6\,k\Omega \quad R_3 = 4\,k\Omega$

@ U_1: $U_1 = -6V$

@ U_2: $\frac{U_2 - U_1}{R_1} + \frac{U_2}{R_2} + \frac{U_2 - U_3}{R_3} = 0$

@ U_3: $U_3 = 24V$

and $I_o = (U_2 - U_3)/R_3$

$U_2 = 8.57\ V$

$\boxed{I_o = -3.86\,mA}$

1.16 Find U_o in the circuit in Fig. P3.8 using nodal analysis.

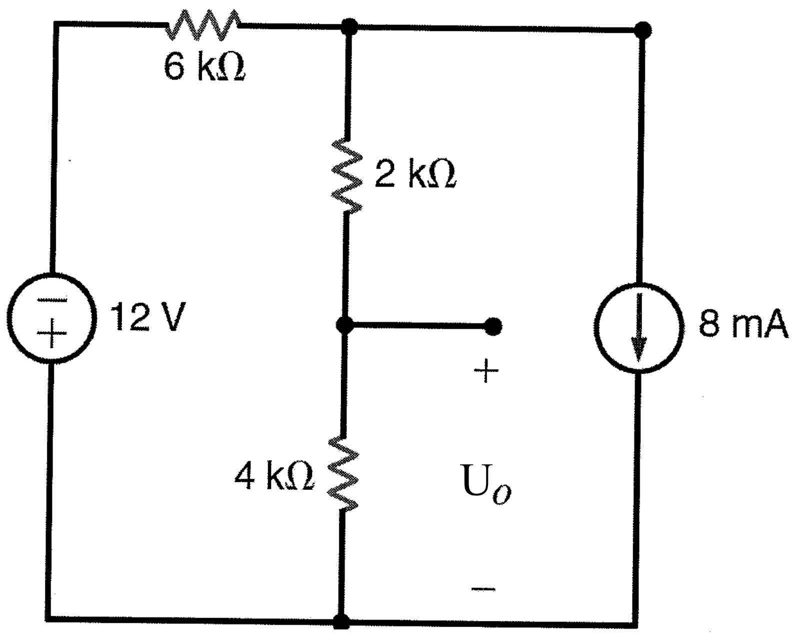
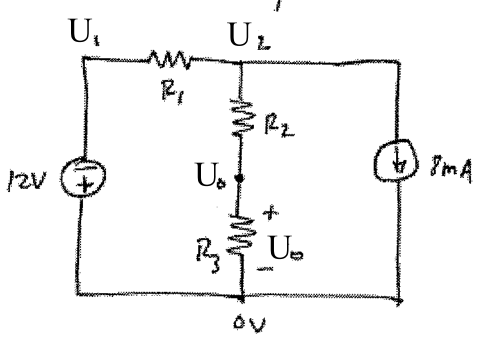


Figure P3.8

SOLUTION:

Find U_o by nodal.



$R_1 = 6\,k\Omega \quad R_2 = 2\,k\Omega \quad R_3 = 4\,k\Omega$

$U_1 = -12\,V$

@ U_2: $\frac{U_2 - U_1}{R_1} + \frac{U_2 - U_o}{R_2} + 8\times10^{-3} = 0$

@ U_o: $\frac{U_2 - U_o}{R_2} = \frac{U_o}{R_3}$

$\boxed{U_o = -20V}$

1.17 Use nodal analysis to find U_o in the circuit in Fig. P3.9.

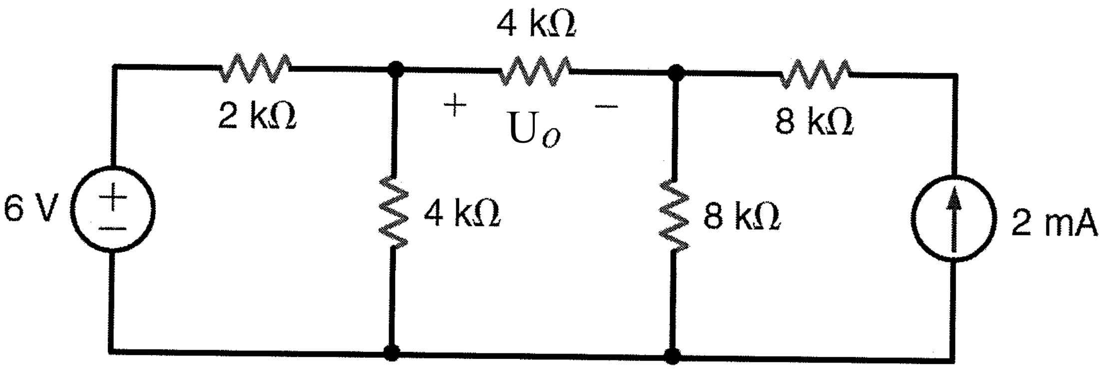
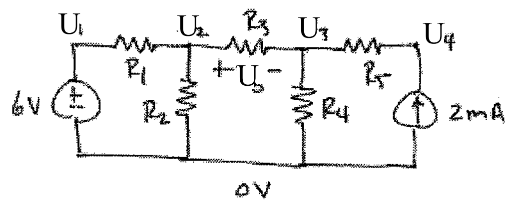


Figure P3.9

SOLUTION:

Find U_o by nodal.



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

$R_4 = R_5 = 8k\Omega$

$U_1 = 6V$

@ U_2: $\frac{U_2 - U_1}{R_1} + \frac{U_2}{R_2} + \frac{U_2 - U_3}{R_3} = 0$

@ U_3: $\frac{U_3 - U_2}{R_3} + \frac{U_3}{R_4} + \frac{U_3 - U_4}{R_5} = 0$

@ U_4: $\frac{U_4 - U_3}{R_5} = 2 \times 10^{-3}$

and $U_o = U_2 - U_3$

$U_2 = 5.2V, \; U_3 = 8.8V$ $\boxed{U_o = -3.6V}$

1.18 Use nodal analysis to find U_o in the circuit in Fig. P3.13.

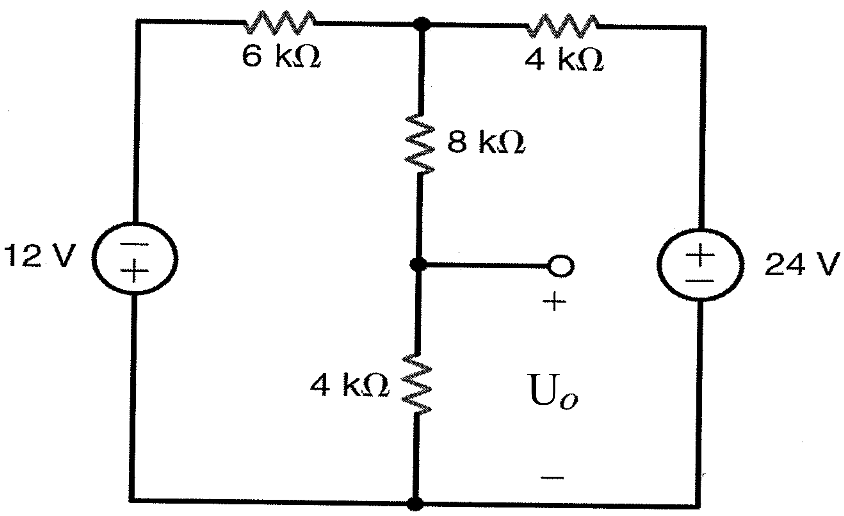
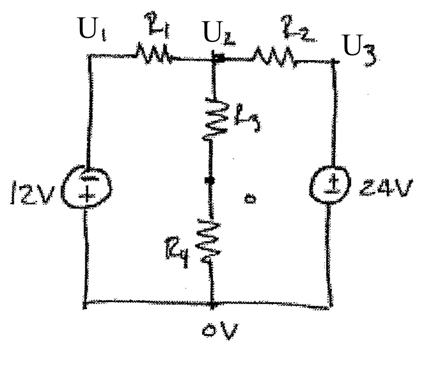


Figure P3.13

SOLUTION:

Find U_o by nodal.



$U_1 = -12V \qquad U_3 = 24V$

@ U_2: $\frac{U_2 - U_1}{R_1} + \frac{U_2 - U_3}{R_2} + \frac{U_2 - U_o}{R_3} = 0$

@ U_3: $\frac{U_o - U_2}{R_3} + \frac{U_o}{R_4} = 0$

$\boxed{U_o = 2.67V}$

$R_1 = 6k\Omega \quad R_2 = R_4 = 4\,k\Omega$

$R_3 = 8\,k\Omega$

1.19 Find U_o in the network in Fig. P3.32 using nodal analysis.

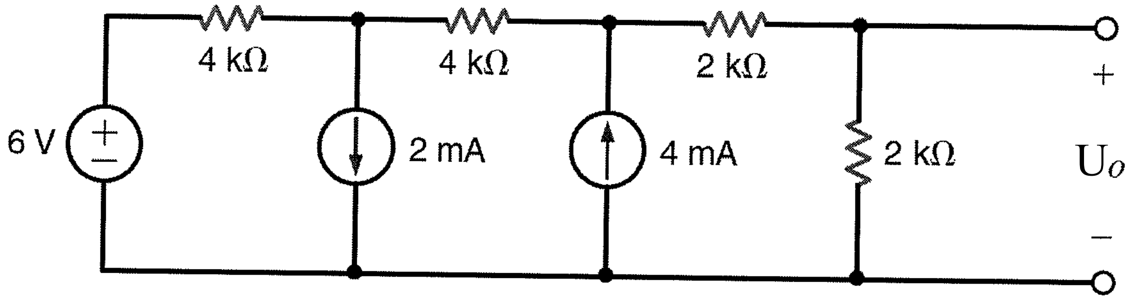
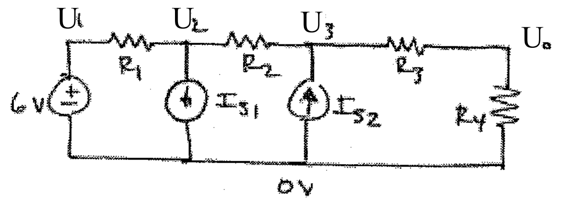


Figure P3.32

SOLUTION:

Find U_o by nodal.



$R_1 = R_2 = 4\,k\Omega \qquad R_3 = R_4 = 2\,k\Omega$

$I_{S1} = 2\,mA \qquad I_{S2} = 4\,mA$

$U_1 = 6V$

@U_2: $\dfrac{U_2 - U_1}{R_1} + \dfrac{U_2 - U_3}{R_2} + I_{S1} = 0$

@U_3: $\dfrac{U_3 - U_2}{R_2} + \dfrac{U_3 - U_o}{R_3} = I_{S2}$

@U_o: $\dfrac{U_o - U_3}{R_3} + \dfrac{U_o}{R_4} = 0$

$\boxed{U_o = 5V}$

1.20 Use mesh equations to find U_o in the circuit in Fig. P3.62.

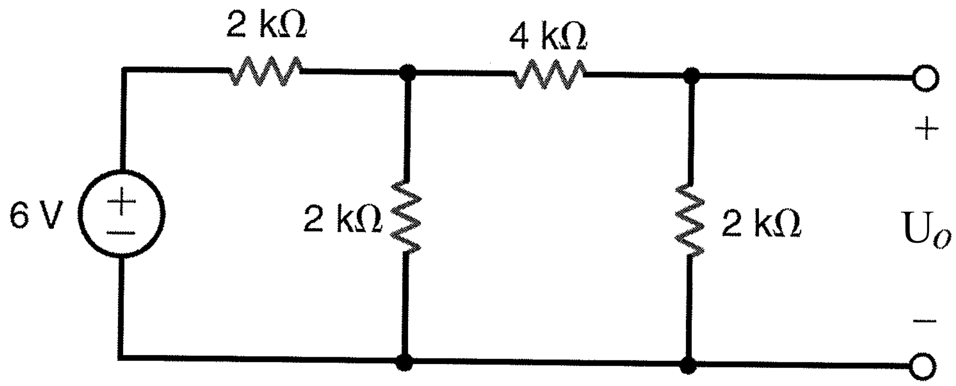
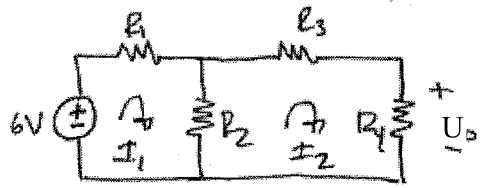


Figure P3.62

SOLUTION:

Use mesh analysis to find U_o.



$R_1 = R_2 = R_4 = 2k\Omega \quad R_3 = 4k\Omega$

$6 = I_1 R_1 + (I_1 - I_2) R_2$

$0 = -R_2 I_1 + I_2 (R_2 + R_3 + R_4)$

$U_o = I_2 R_4$

$I_2 = 429 \mu A$ $\boxed{U_o = 858 \text{ mV}}$

1.21 Use mesh analysis to find U_o in the circuit in Fig. P3.65.

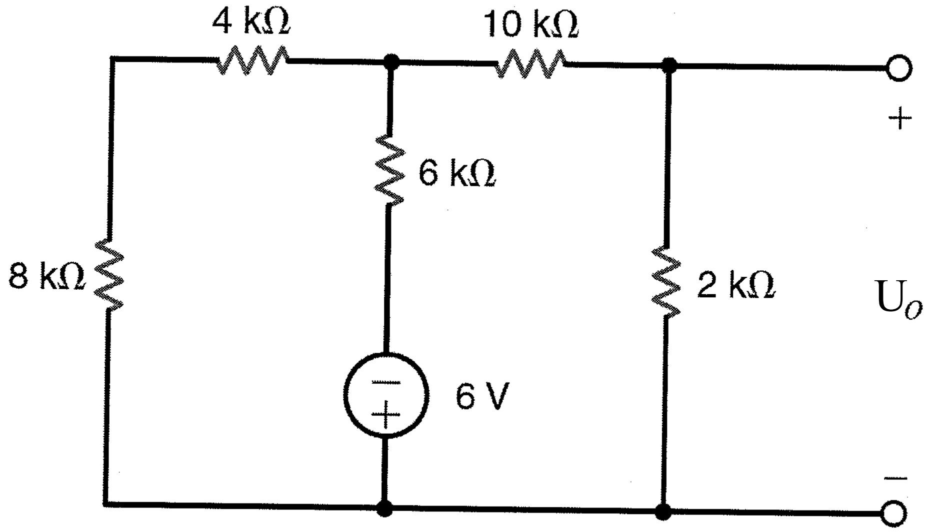
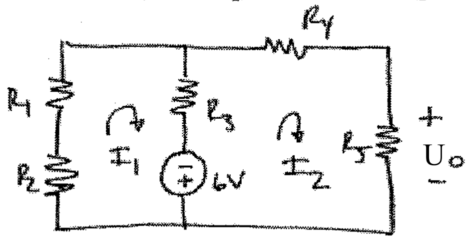


Figure P3.65

SOLUTION:

Find U_o via mesh



$R_1 = 4k\Omega \quad R_2 = 8k\Omega \quad R_3 = 6k\Omega$

$R_4 = 10k\Omega \quad R_5 = 2k\Omega$

$U_o = I_2 R_5$

$$I_1 R_1 + I_1 R_2 + (I_1 - I_2) R_3 = 6$$

$$I_2 R_4 + I_2 R_5 + (I_2 - I_1) R_3 = -6$$

$I_2 = -250 \mu A$ $\boxed{U_o = -0.5\,V}$

1.22 Use loop analysis to find U_o in the circuit in Fig. P3.67.

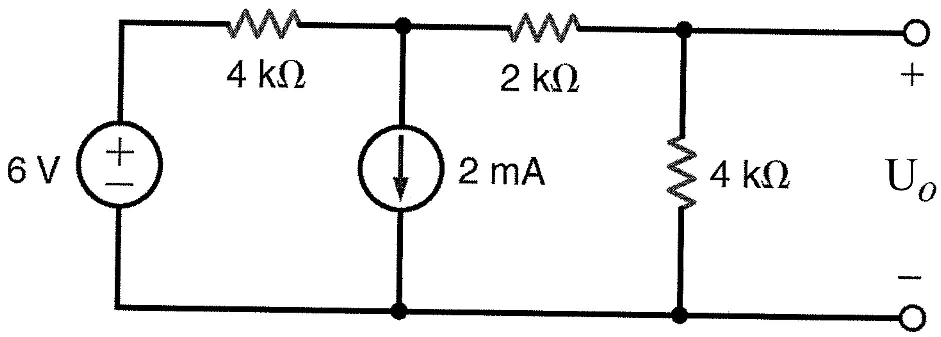
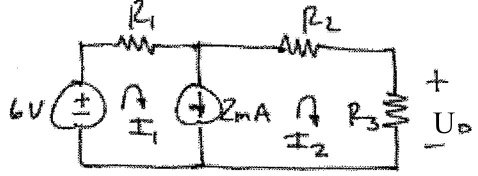


Figure P3.67

SOLUTION:

Find Uo using loop analysis.



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

$2mA = I_1 - I_2$

$6 = I_1 R_1 + I_2 R_2 + I_2 R_3$

$U_o = I_2 R_3$

$I_2 = -200\mu A$

$\boxed{U_o = -0.8V}$

1.23 Find I_o in the network in Fig. P3.69 using mesh analysis.

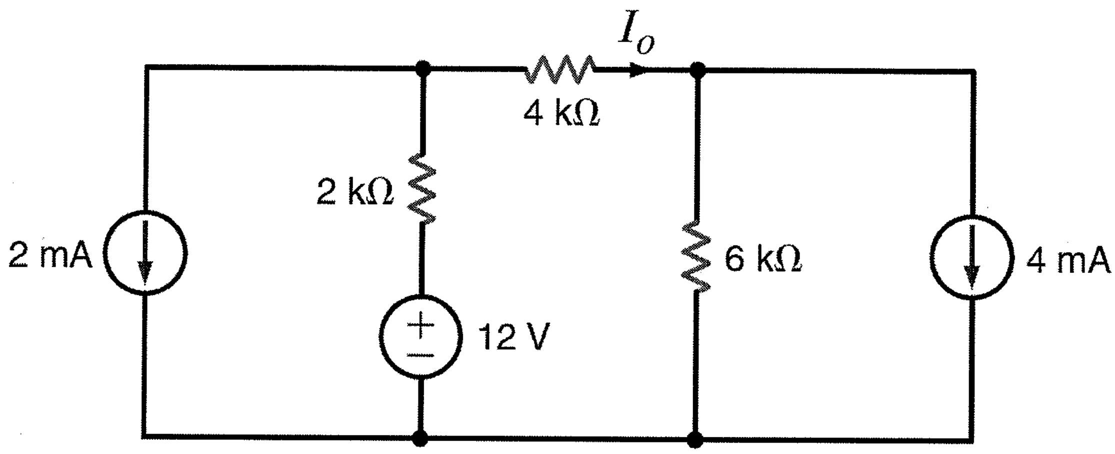
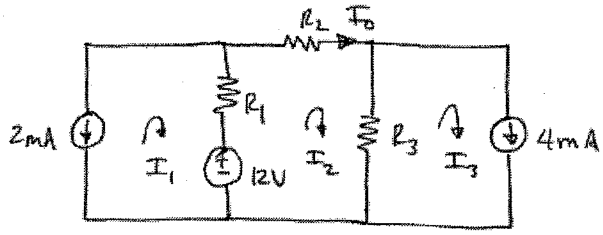


Figure P3.69

SOLUTION:

Use mesh analysis to find I_o.



$R_1 = 2k\Omega \quad R_2 = 4k\Omega \quad R_3 = 6k\Omega$

$I_o = I_2$

$I_1 = -2mA$

$I_3 = 4mA$

$12 = (I_2 - I_1)R_1 + I_2R_2 + (I_2 - I_3)R_3 \rightarrow I_2 = 2.67mA$

$\boxed{I_o = 2.67mA}$

1.24 Find U_o in the circuit in Fig. P3.84 using mesh analysis.

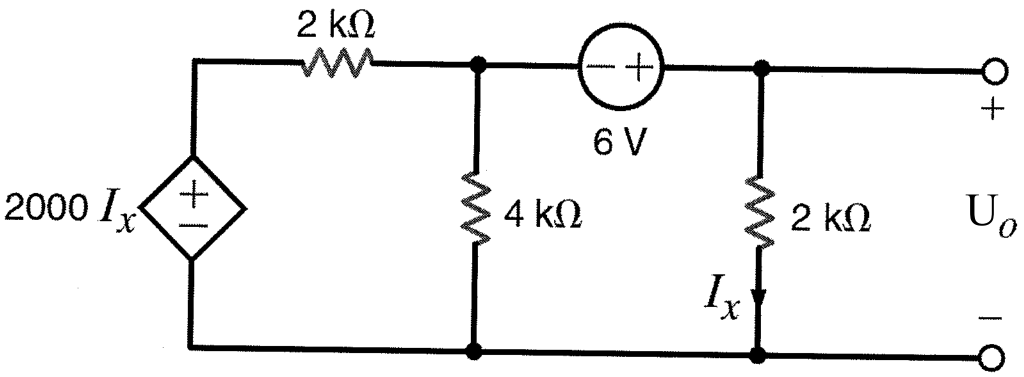
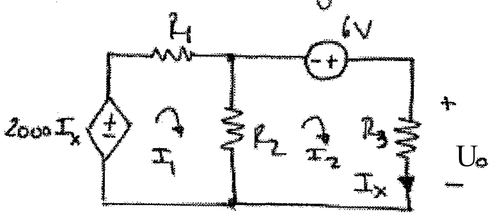


Figure P3.84

SOLUTION:

Find U_o using mesh analysis.



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

$I_x = I_2$ $U_o = R_3 I_2$

$$2000\, I_x = I_1 R_1 + (I_1 - I_2) R_2$$

$$6 = I_2 R_3 + (I_2 - I_1) R_2$$

$I_2 = 3\,mA$ $\boxed{U_o = 6\,V}$

1.25 Find U_o in the circuit in Fig. 3PFE-1.

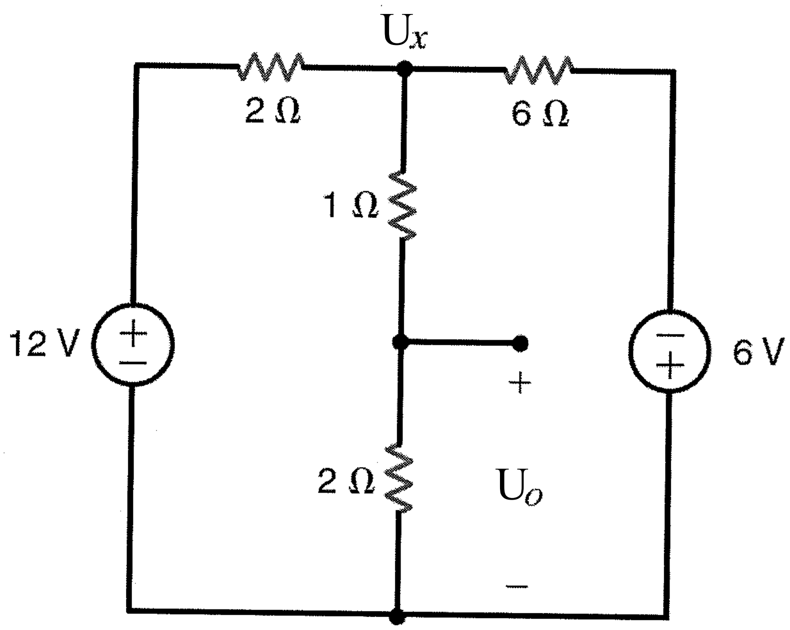
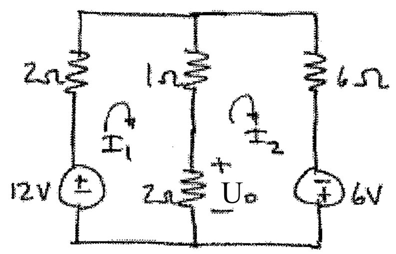


Figure 3PFE-1

SOLUTION

Find U_o.



$$12 = 2I_1 + (I_1 - I_2) + 2(I_1 - I_2)$$

$$6 = 2(I_2 - I_1) + (I_2 - I_1) + 6I_2$$

$$U_o = 2(I_1 - I_2)$$

Results: $I_1 = 3.5\,A$, $I_2 = 1.83\,A$

$$\boxed{U_o = 3.33\ V}$$

1.26 Determine the voltage U_o in the circuit in Fig. 3PFE-4.

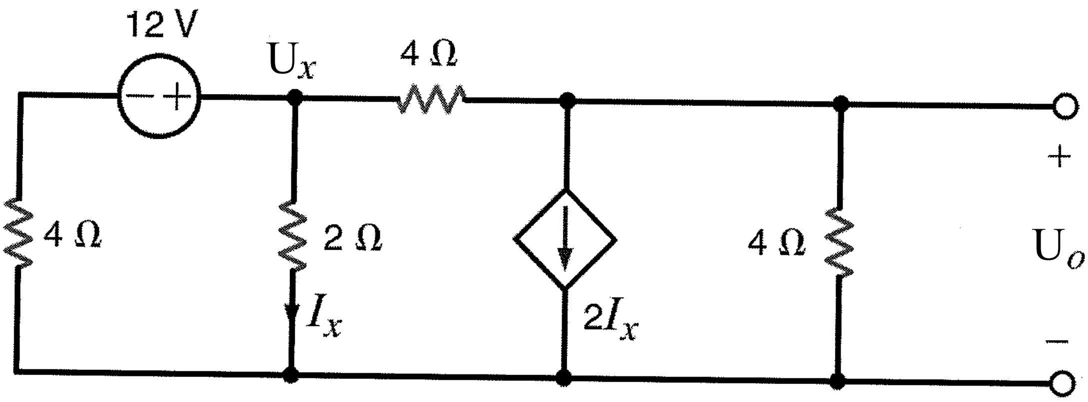
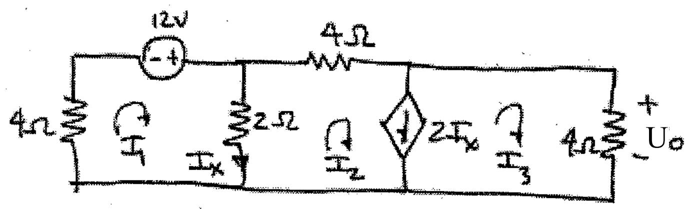


Figure 3PFE-4

SOLUTION

Find U_o.



$I_x = I_1 - I_2$

$U_o = 4I_3$

$2I_x = I_2 - I_3$

$12 = 4I_1 + 2(I_1 - I_2)$

$4I_1 + 4I_2 + 4I_3 = 12$

Results: $I_3 = -0.818\text{ A}$

$\boxed{U_o = -3.27\text{ V}}$