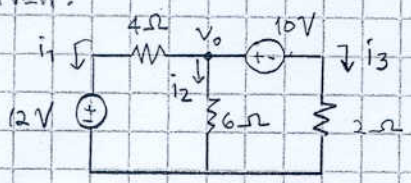
HW #2 SOLUTION
ECE 300
SPRING '07

3.6

Given:



USE nodal analysis to obtain V_o

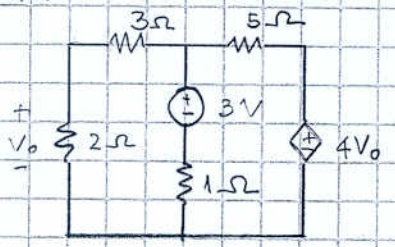
Solution:

$$i_1 + i_2 + i_3 = 0$$

$$\frac{V_o - 12}{4} + \frac{V_o}{6} + \frac{V_o - 10}{2} = 0 \longrightarrow V_o = \underline{8.727\ V}$$

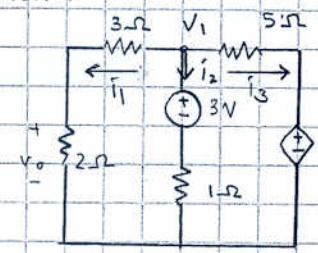
3.8

Given:



FIND V_o USING nodal analysis.

Solution:



$$i_1 + i_2 + i_3 = 0$$

$$\frac{V_1}{3+2} + \frac{V_1 - 3}{1} + \frac{V_1 - 4V_o}{5} = 0$$

Also, $\frac{V_o}{2} = \frac{V_1}{5} \Rightarrow V_o = \frac{2}{5} V_1$

So, $\frac{V_1}{5} + \frac{V_1 - 3}{1} + \frac{V_1 - \frac{8}{5} V_1}{5} = 0$

$$V_1 + 5V_1 - 15 + V_1 - \frac{8}{5} V_1 = 0$$

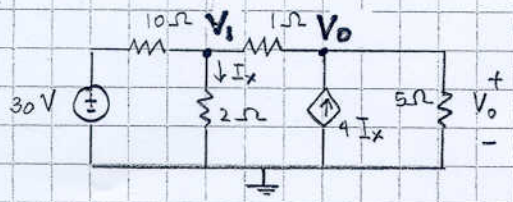
$$\frac{27}{5} V_1 = 15$$

$$V_1 = 2.778\ V$$

$$\Longrightarrow V_o = \underline{1.111\ V}$$

3.12

Given:



FIND V_o USING NODAL analysis

Solution:

At node 1: $\frac{V_1 - 30}{10} + \frac{V_1}{2} + \frac{V_1 - V_o}{1} = 0$

$$16V_1 - 10V_o = 30 \quad \text{—— ①}$$

At NODE 2: $\frac{V_o - V_1}{1} - 4I_x + \frac{V_o}{5} = 0$

$$-5V_1 + 6V_o - 20I_x = 0 \quad \text{—— ②}$$

$I_x = \frac{V_1}{2} \rightarrow$ ②: $-15V_1 + 6V_o = 0$

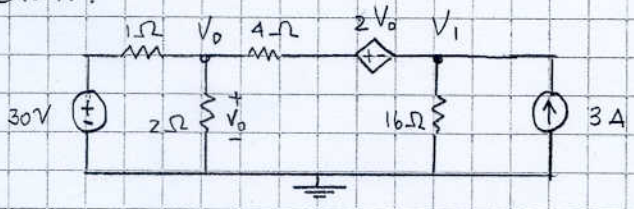
$$V_1 = 0.4V_o \quad \text{—— ③}$$

① & ③:

$16(0.4V_o) - 10V_o = 30 \longrightarrow$ $\underline{V_o = -8.333\ V}$

3.23

Given:



FIND V_o USING NODAL ANALYSIS

Solution:

At NODE 0: $\frac{V_o - 30}{1} + \frac{V_o}{2} + \frac{V_o - (2V_o + V_1)}{4} = 0$

$$1.25V_o - 0.25V_1 = 30 \quad \text{—— ①}$$

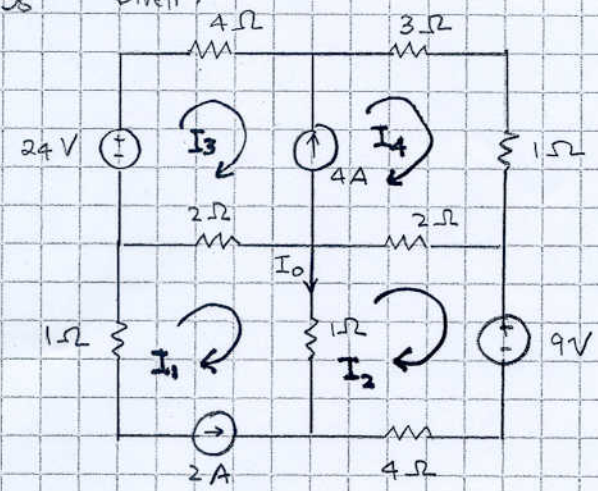
At NODE 1: $\frac{(2V_o + V_1) - V_o}{4} + \frac{V_1}{16} - 3 = 0$

$$5V_1 + 4V_o = 48 \quad \text{—— ②}$$

① & ②:

$\underline{V_o = 22.34\ V}$

3.38 Given :



FIND I_o USING MESH ANALYSIS

Solution :

Mesh 1 : $I_1 = -2A$ ——— ①

Mesh 2 : $1(I_2 - I_1) + 2(I_2 - I_4) + 9 + 4I_2 = 0$

$7I_2 - I_4 = -11$ ——— ②

SUPER MESH : $-24 + 4I_3 + 3I_4 + 1I_4 + 2(I_4 - I_2) + 2(I_3 - I_1) = 0$

$-2I_2 + 6I_3 + 6I_4 = 20$ ——— ③

Constraint Equation :

$-I_3 + I_4 = 4$

Solving the unknowns :

$$\begin{bmatrix} 7 & 0 & -1 \\ -2 & 6 & 6 \\ 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} I_2 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} -11 \\ 20 \\ 4 \end{bmatrix}$$

USING MATLAB, WE FOUND $I_2 = -0.55$

$I_3 = -4$

$I_4 = 7.15$

So, $I_o = I_1 - I_2 = -2 - (-0.55)$

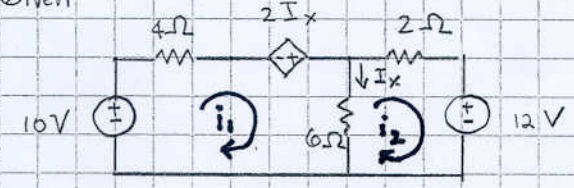
$I_o = -1.45A$

Checking the SUPER MESH (③) :

$1.1 - 24 + 42.9 \overset{\checkmark}{=} 20$

3.39

Given



FIND i_1 AND i_2

Solution :

Mesh 1 : $-10 + 4I_1 - 2I_x + 6(I_1 - I_2) = 0$

$-10 + 10I_1 - 2I_x - 6I_2 = 0$

$I_x = I_1 - I_2$:

$10 = -2I_1 + 2I_2 + 10I_1 - 6I_2$

$5 = 4I_1 - 2I_2$ ——— (1)

Mesh 2 : $12 + 8I_2 - 6I_1 = 0$

$6 = 3I_1 - 4I_2$ ——— (2)

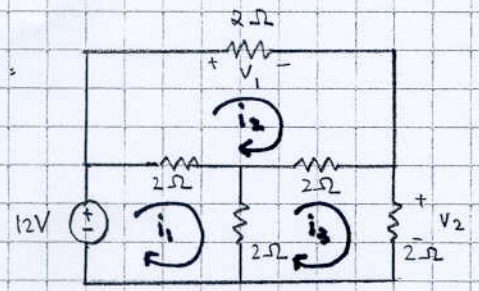
Solving (1) & (2) :

$I_1 = 0.8\,A$

$I_2 = -0.9\,A$

3.56

Given :



FIND V_1 & V_2

Loop 1 : $2(i_1 - i_2) + 2(i_1 - i_3) = 12$

$4i_1 - 2i_2 - 2i_3 = 12$

$2i_1 - i_2 - i_3 = 6$ ——— (1)

Loop 2 : $2(i_2 - i_1) + 2i_2 + 2(i_2 - i_3) = 0$

$-2i_1 + 6i_2 - 2i_3 = 0$

$-i_1 + 3i_2 - i_3 = 0$ ——— (2)

Loop 3 : $2(i_3 - i_1) + 2(i_3 - i_2) + 2i_3 = 0$

$-2i_1 - 2i_2 + 6i_3 = 0$

$-i_1 - i_2 + 3i_3 = 0$ ——— ③

FROM ①, ②, & ③ in MATRIX FORM :

$$\begin{bmatrix} 2 & -1 & -1 \\ -1 & 3 & -1 \\ -1 & -1 & 3 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 6 \\ 0 \\ 0 \end{bmatrix}$$

We found $i_1 = 6\,A$

$i_2 = 3\,A$

$i_3 = 3\,A$

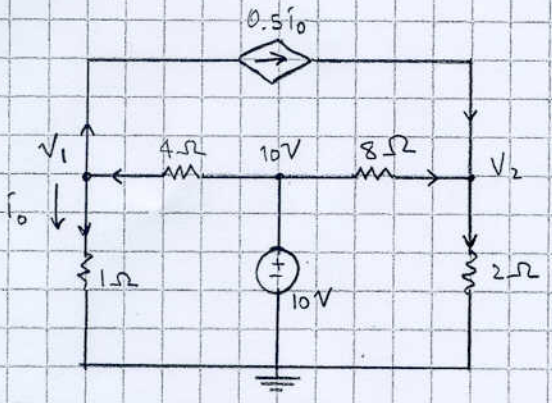
Thus,

$V_1 = 2i_2 = \underline{\underline{6\,V}}$

$V_2 = 2i_3 = \underline{\underline{6\,V}}$

#3.60

Given :



Calculate the power dissipated in each resistor.

$i_o = \frac{V_1}{1}$

Solution :

At node 1 : $\frac{V_1}{1} + 0.5\frac{V_1}{1} - \frac{V_1 - 10}{4} = 0 \longrightarrow V_1 = \frac{10}{7}$

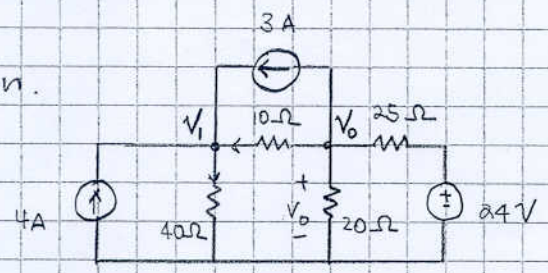
At node 2 : $\frac{V_2}{2} - \frac{10 - V_2}{8} - 0.5\frac{V_1}{1} = 0 \longrightarrow V_2 = \frac{22}{7}$

$P_{1\Omega} = (V_1)^2/1 = \underline{\underline{2.041\ \text{Watts}}}$ $\quad P_{4\Omega} = \frac{(10 - V_1)^2}{4} = \underline{\underline{18.38\ \text{Watts}}}$

$P_{2\Omega} = (V_2)^2/2 = \underline{\underline{4.939\ \text{Watts}}}$ $\quad P_{8\Omega} = \frac{(10 - V_2)^2}{8} = \underline{\underline{5.88\ \text{Watts}}}$

3.68

Given.



FIND V_o

Solution:

At NODE 1 : $\frac{V_1}{40} - \frac{V_o - V_1}{10} - 4 - 3 = 0$

$$\frac{V_1}{40} - \frac{V_o - V_1}{10} = 7$$

$$V_1 - 4(V_o - V_1) = 280$$

$$-4V_o + 5V_1 = 280 \quad \text{——— (1)}$$

At NODE 0 : $\frac{V_o}{20} + \frac{V_o - 24}{25} + \frac{V_o - V_1}{10} + 3 = 0$

$$5V_o + 4(V_o - 24) + 10(V_o - V_1) = -300$$

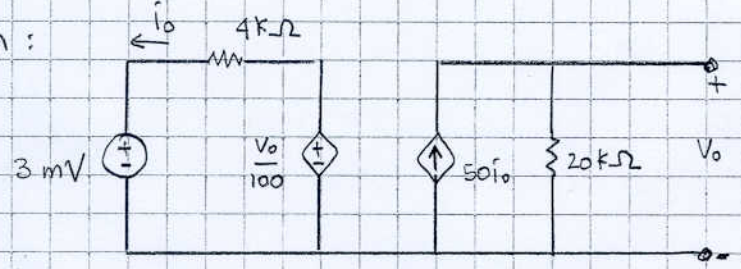
$$19V_o - 10V_1 = -204 \quad \text{——— (2)}$$

SOLVE (1) & (2):

$$V_o = 32.36\ V$$

$$V_1 = 81.89\ V$$

3.84 Given:



Calculate V_o & i_o

Solution:

FROM output loop : $V_o = 50 i_o \times 20 \times 10^3 = 10^6 i_o$ ——— (1)

FROM input Loop : $3 \times 10^{-3} + 4 \times 10^3 i_o - \frac{V_o}{100} = 0$ ——— (2)

Solving (1) & (2) we get $i_o = 0.5\ mA$ AND $V_o = 0.5\ V$