Spring 2008

EECS70A / CSE 70A Network Analysis I
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Homework # 3 solution

Chapter 3, Solution 1.

Let V_x be the voltage at the node between 1-kΩ and 4-kΩ resistors.

$$\frac{9-V_x}{1k}+\frac{6-V_x}{4k}=\frac{V_k}{2k} \longrightarrow V_x=6$$

$$I_x=\frac{V_x}{2k}=\underline{3\ \text{mA}}$$

Chapter 3, Solution 3.

Applying KCL to the upper node,

$$10 = \frac{v_0}{10}+\frac{v_o}{20}+\frac{v_o}{30}+2+\frac{v_0}{60} \longrightarrow v_0 = \underline{\mathbf{40\ V}}$$

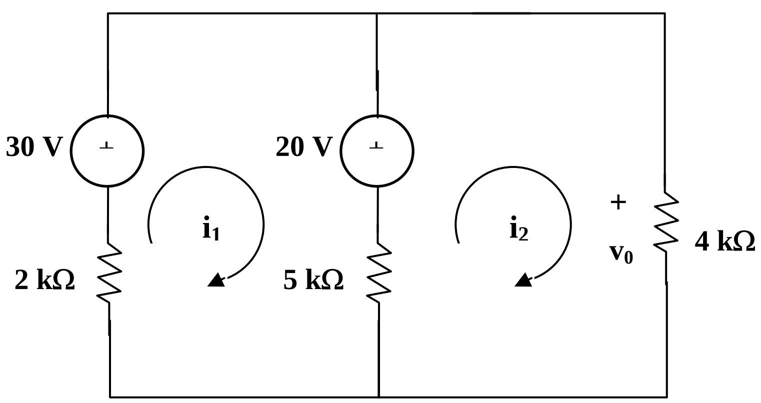
$i_1 = \frac{v_0}{10} =$ **<u>4 A</u>** , $i_2 = \frac{v_0}{20} =$ **<u>2 A</u>**, $i_3 = \frac{v_0}{30} =$ **<u>1.3333 A</u>**, $i_4 = \frac{v_0}{60} =$ **<u>666.7 mA</u>**

Chapter 3, Solution 6.

$i_1 + i_2 + i_3 = 0$ $$\frac{v_2-12}{4}+\frac{v_0}{6}+\frac{v_0-10}{2}=0$$

or $v_0 =$ **<u>8.727 V</u>**

Chapter 3, Solution 35.



Assume that i_1 and i_2 are in mA. We apply mesh analysis. For mesh 1,

$$-30 + 20 + 7i_1 - 5i_2 = 0 \quad \text{or} \quad 7i_1 - 5i_2 = 10 \qquad (1)$$

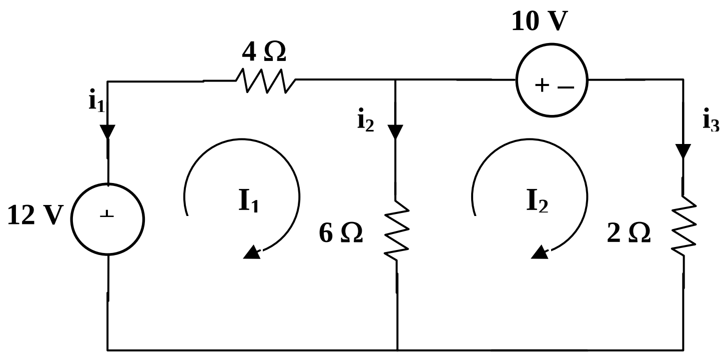
For mesh 2,

$$-20 + 9i_2 - 5i_1 = 0 \quad \text{or} \quad -5i_1 + 9i_2 = 20 \qquad (2)$$

Solving (1) and (2), we obtain, $i_2 = 5$.

$$v_0 = 4i_2 = \underline{\textbf{20 volts}}.$$

Chapter 3, Solution 36.



Applying mesh analysis gives,

$$12 = 10I_1 - 6I_2$$
$$-10 = -6I_1 + 8I_2$$

or

$$\begin{bmatrix} 6 \\ -5 \end{bmatrix} = \begin{bmatrix} 5 & -3 \\ -3 & 4 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$$\Delta = \begin{vmatrix} 5 & -3 \\ -3 & 4 \end{vmatrix} = 11, \quad \Delta_1 = \begin{vmatrix} 6 & -3 \\ -5 & 4 \end{vmatrix} = 9, \quad \Delta_2 = \begin{vmatrix} 5 & 6 \\ -3 & -5 \end{vmatrix} = -7$$

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{9}{11}, \quad I_2 = \frac{\Delta_2}{\Delta} = \frac{-7}{11}$$

$$i_1 = -I_1 = -9/11 = -0.8181 \text{ A}, \quad i_2 = I_1 - I_2 = 10/11 = 1.4545 \text{ A}.$$

$$v_o = 6i_2 = 6x1.4545 = \underline{\textbf{8.727 V}}.$$

Chapter 3, Solution 68.

$$\begin{bmatrix} 0.125 & -0.1 \\ -0.1 & 0.19 \end{bmatrix} \text{V} = \begin{bmatrix} +4+3 \\ -3+24/25 \end{bmatrix} = \begin{bmatrix} 7 \\ -2.04 \end{bmatrix}$$

Using MATLAB, we get,

```
>> Y=[0.125,-0.1;-0.1,0.19]
Y =
    0.1250   -0.1000
   -0.1000    0.1900

>> I=[7,-2.04]'
I =
    7.0000
   -2.0400

>> V=inv(Y)*I
V =
   81.8909
   32.3636
```

Thus, V_o = **32.36 V**.

Alternatively, using nodal analysis we get the same answer.

Node 1: $-4+\frac{V_1}{40}+\frac{V_1-V_0}{10}-3=0$

Node 2: $\frac{V_0}{20}+\frac{V_0-V_1}{10}+3+\frac{V_0-24}{25}=0$

Chapter 4, Solution 33.

(a) R_{Th} = 10||40 = 400/50 = **8 ohms**

V_{Th} = (40/(40 + 10))20 = **16 V**

(b) R_{Th} = 30||60 = 1800/90 = **<u>20 ohms</u>**

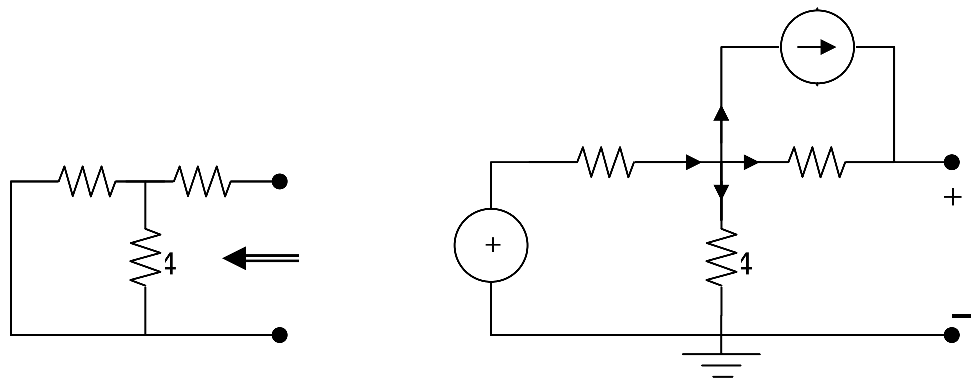
$$2 + (30 - v1)/60 = v_1/30, \quad \text{and} \quad v_1 = V_{Th}$$

$$120 + 30 - v_1 = 2v_1, \quad \text{or} \quad v_1 = 50\text{ V}$$

$$V_{Th} = \underline{\mathbf{50\ V}}$$

Chapter 4, Solution 34.

To find R_{Th}, consider the circuit in Fig. (a).



$$R_{Th} = 20 + 10||40 = 20 + 400/50 = \underline{\mathbf{28\ ohms}}$$

To find V_{Th}, consider the circuit in Fig. (b).

At node 1, $(40 - v_1)/10 = 3 + [(v_1 - v_2)/20] + v_1/40, \quad 40 = 7v_1 - 2v_2$ (1)

At node 2, $3 + (v1 - v2)/20 = 0, \quad \text{or} \quad v1 = v2 - 60$ (2)

Solving (1) and (2), $v_1 = 32$ V, $v_2 = 92$ V, and $V_{Th} = v_2 =$ **<u>92 V</u>**

Chapter 4, Solution 84.

Let the equivalent circuit of the battery terminated by a load be as shown below.

For open circuit,

$$R_L = \infty, \quad \longrightarrow \quad V_{Th} = V_{oc} = V_L = \underline{10.8\text{ V}}$$

When R_L = 4 ohm, V_L=10.5,

$$I_L = \frac{V_L}{R_L} = 10.8/4 = 2.7$$

But $V_{Th} = V_L + I_L R_{Th} \quad \longrightarrow \quad R_{Th} = \frac{V_{Th} - V_L}{I_L} = \frac{12 - 10.8}{2.7} = \underline{0.4444\Omega}$

Chapter 4, Solution 85.

(a) Consider the equivalent circuit terminated with R as shown below.

$$V_{ab} = \frac{R}{R + R_{Th}} V_{Th} \quad \longrightarrow \quad 6 = \frac{10}{10 + R_{Th}} V_{Th} \quad \text{or} \quad 60 + 6R_{Th} = 10V_{Th} \qquad (1)$$

where RTh is in k-ohm.

Similarly,

$$12 = \frac{30}{30 + R_{Th}} V_{Th} \quad \longrightarrow \quad 360 + 12R_{Th} = 30V_{Th} \qquad (2)$$

Solving (1) and (2) leads to

$$\underline{V_{Th} = 24 \text{ V}, \ R_{Th} = 30k\Omega}$$

(b) $V_{ab} = \frac{20}{20 + 30}(24) = \underline{9.6 \text{ V}}$