Homework Set #11

DUE Monday, April 3, 2017

For the circuit in Figure E4.11 determine the power supplied by each source using:

a) Nodal Analysis
b) Mesh Analysis

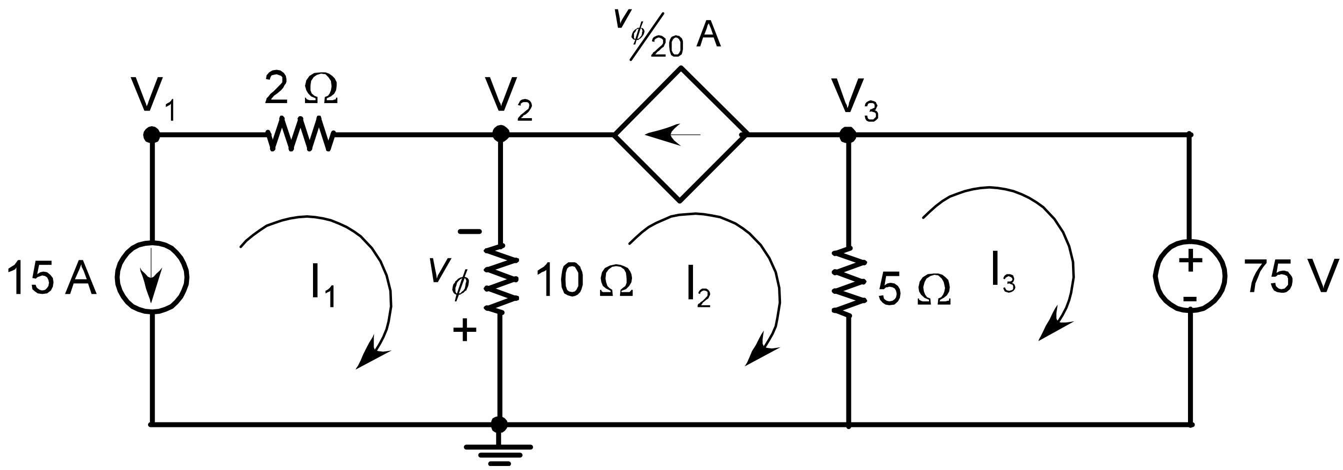


Figure E4.11

a)

By observation: $v_\phi = -V_2$

Node 1: $\frac{V_1 - V_2}{2} + 15 = 0$

Node 2: $\frac{V_2 - V_1}{2} + \frac{V_2}{10} - \frac{V_\phi}{20} = 0$ *gives* $\frac{V_2 - V_1}{2} + \frac{V_2}{10} + \frac{V_2}{20} = 0$

Node 3 $V_3 = 75$ V

The foregoing equations can be re-arranged as follows:

$$0.5V_1 - 0.50V_2 = -15$$
$$-0.5V_1 + 0.65V_2 = 0$$

In matrix form:

$$\begin{bmatrix} 0.5 & -0.5 \\ -0.5 & 0.65 \end{bmatrix} \text{X} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} -15 \\ 0 \end{bmatrix}$$

When ***inverted:***

$$\begin{bmatrix} 8.667 & 6.667 \\ 6.667 & 6.667 \end{bmatrix} \text{X} \begin{bmatrix} -15 \\ 0 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

These solve to: $V_1 = -130$ V, and $V_2 = -100$ V

Which leads to: $P_{15A} = +V_1 \times 15 = -130 \times 15 = -1950$ W,

$P_{75V} = -V_3 \times (-V_2/20 + V_3/5) = -75 \times (5 + 15) = -1500$ W

$P_{DEP} = +(V_3 - V_2)\text{x}(-V_2/20) = +(75 + 100)\text{x}(+100/20) = +875$ W

b)

By observation: $I_2 = -V_\phi/20$ $v_\phi = 10(I_2 - I_1)$ and $I_1 = -15$ A gives: $I_2 = -0.5(I_2 + 15)$

Solves to: $I_2 = -5$ A

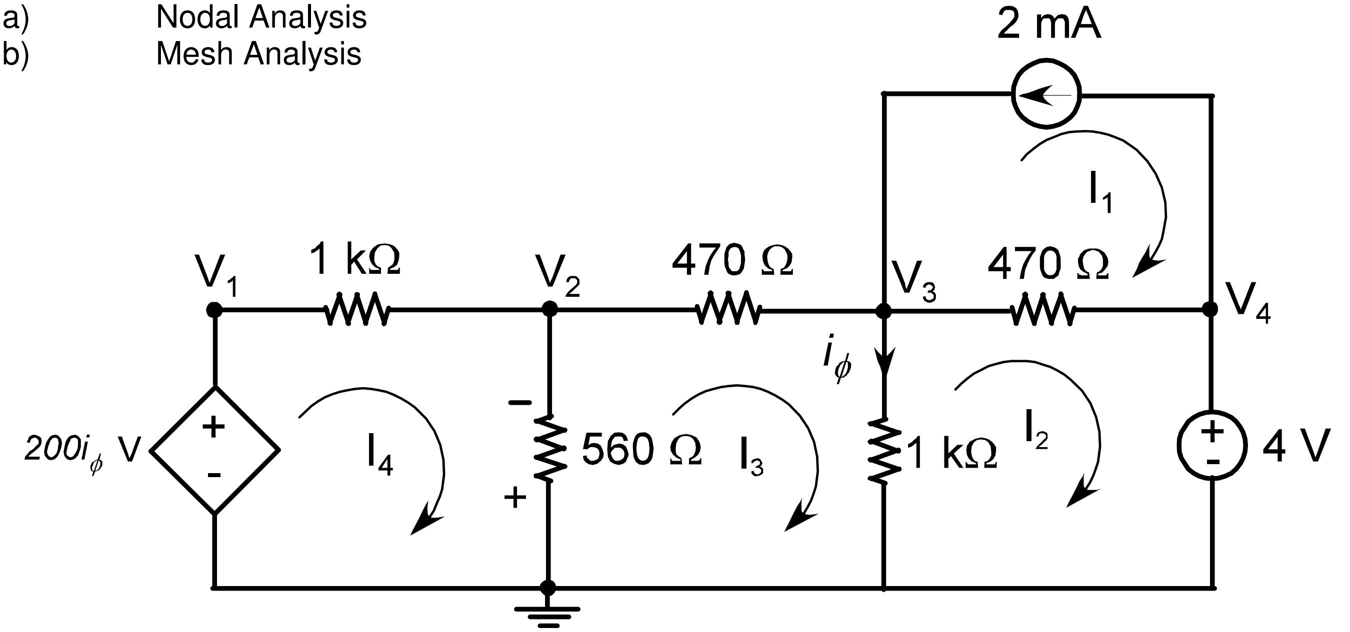
Mesh 3: $75 + 5(I_3 - I_2) = 0$ gives: $5(I_3 + 5) = -75$ Solves to: $I_3 = -20$ A

2. And just when you thought it was safe!!

For the circuit in Figure E4.12 determine the power supplied by each source using:

a) Nodal Analysis

b) Mesh Analysis



a)

By observation: $i_\phi = 0.001V_3$ and $V_1 = 200 \times 0.001V_3 = 0.2V_3$ and $V_4 = 4$ V

Node 2: $\frac{V_2 - 0.2V_3}{1000} + \frac{V_2}{560} + \frac{V_2 - V_3}{470} = 0 \quad gives \quad 4.913V_2 - 2.328V_3 = 0$

Node 3: $0.002 + \frac{V_3}{1000} + \frac{V_3 - V_2}{470} + \frac{V_3 - 4}{470} = 0 \quad gives \quad -2.128V_2 + 5.255V_3 = 10.511$

These solve to: $V_2 = 1.173$ V, and $V_3 = 2.475$ V

b)

Observation: $i_\phi = (I_3 - I_2)$ and $I_1 = -0.002$ A

Mesh 2: $4 + 1000(I_2 - I_3) + 470(I_2 + 0.002) = 0$ gives: $1470I_2 - 1000I_3 = -4.94$

Mesh 3: $1000(I_3 - I_2) + 560(I_3 - I_4) + 470\, I_3 = 0$ gives: $-1000I_2 + 2030I_3 - 560I_4 = 0$

Mesh 4: $-200(I_3 - I_2) + 1000I_4 + 560(I_4 - I_3) = 0$ gives: $200I_2 - 760I_3 + 1560I_4 = 0$

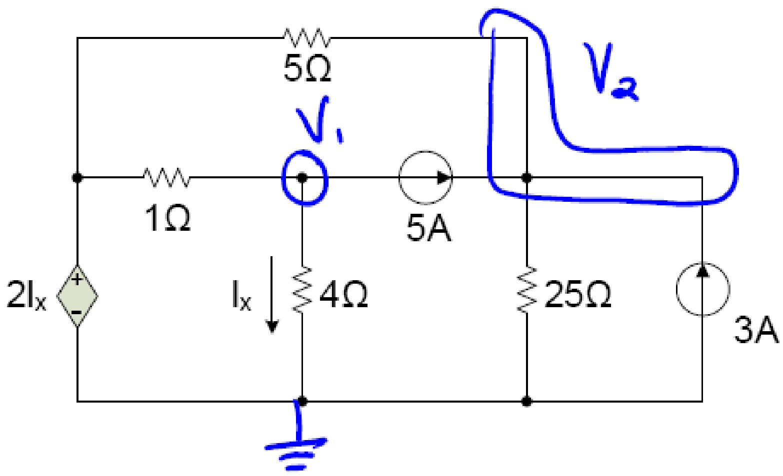
Solves to: $I_1 = -2$ mA, $I_2 = -5.25$ mA, $I_3 = -2.77$ mA and $I_4 = -0.677$ mA

Which leads to: $P_{2mA} = +(V_4 - V_3) \times 0.002 = 1.525 \times 2 = 3.05$ mW,

$P_{4V} = +V_4 \times I_2 = 4 \times -5.25 = -21$ mW

$P_{DEP} = -0.2(I_3 - I_2) \times I_4 = -0.2(-2.77 + 5.25) \times (-0.677) = 0.336$ mW

3. Given the following circuit *(Note: this is an old exam problem)*
Label the circuit with all the node voltages including the reference node
a. Use the node-voltage method to solve for the unknown node-voltages
b. Compute the value of Ix.



KCL V_1) $\dfrac{V_1 - 2I_x}{1} + \dfrac{V_1}{4} + 5 = 0$

KCL V_2) $\dfrac{V_2 - 2I_x}{5} - 5 + \dfrac{V_2}{25} - 3 = 0$

constraint) $I_x = \dfrac{V_1}{4}$

$V_1 = -6.667\,V$

$V_2 = 30.56\,V$

$I_x = -1.667\,A$