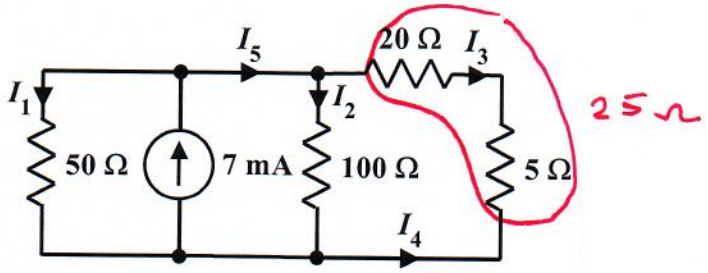
EE/EET 2240

**Homework Problem #009**




25 Ω

a. Use the current divider equation to determine $I_1$.

b. Use the current divider equation to determine $I_2$.

c. Use the current divider equation to determine $I_3$.

$$I_3 = \frac{\frac{1}{25\,\Omega}}{\frac{1}{50\,\Omega} + \frac{1}{100\,\Omega} + \frac{1}{25\,\Omega}} \quad 7\,mA = \frac{4}{7}\,7\,mA$$

$$= 4\,mA$$

d. Determine the value of $I_4$.

e. Determine the value of $I_5$.

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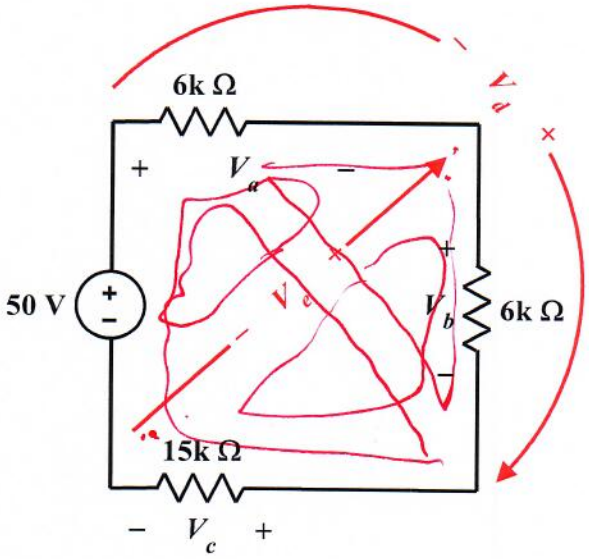
# Homework Problem #008




$V_e = V_b + V_c$

$V_e = -V_a + 50$

a. Use the voltage divider equation to determine $V_a$.

$V_a = \frac{6k\Omega}{6k\Omega + 6k\Omega + 15k\Omega} \cdot 50V = \frac{2}{5} 50\,V$

$= \frac{100}{5} V$

b. Use the voltage divider equation to determine $V_b$.

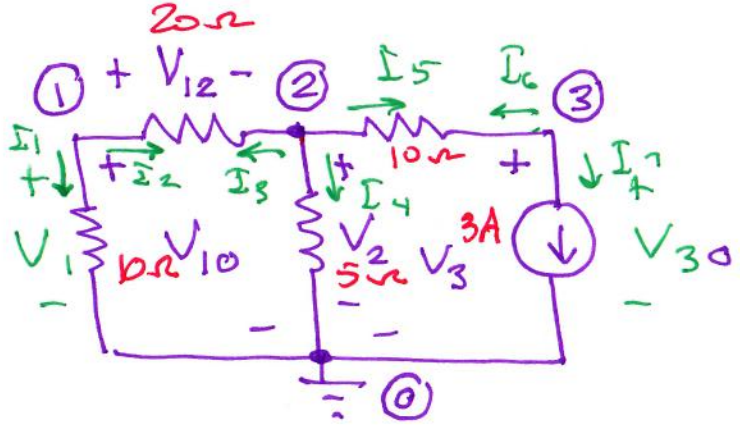
c. Use the voltage divider equation to determine $V_c$.

d. Determine the value of $V_d$.

e. Determine the value of $V_e$.

$V_e = -\frac{100}{5} V + 50\,V = \frac{350}{5} V$

# Nodal Analysis




Write a KCL equation for each node other than the reference node.

$$I_1 + I_2 = 0 \qquad \text{(KCL)}$$

$$I_3 + I_4 + I_5 = 0 \qquad \text{(KCL)}$$

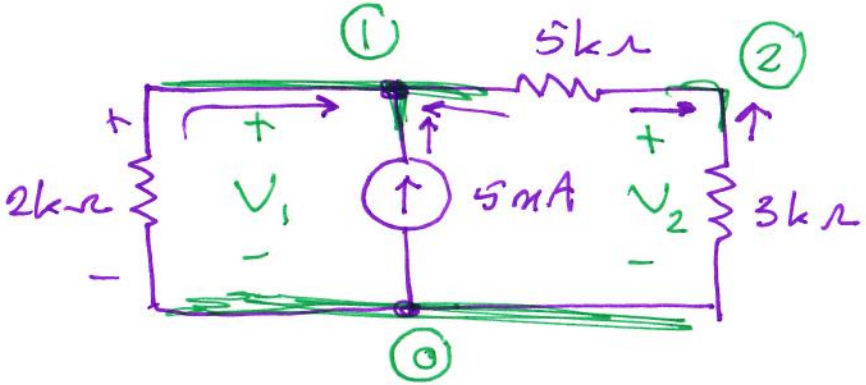
$$I_6 + I_7 = 0 \qquad \text{(KCL)}$$

Eq. 1: $\frac{V_1}{10\Omega} + \frac{V_1 - V_2}{20\Omega} = 0$

Eq. 2: $\frac{V_2 - V_1}{20\Omega} + \frac{V_2}{5\Omega} + \frac{V_2 - V_3}{10\Omega} = 0$

Eq. 3: $\frac{V_3 - V_2}{10\Omega} + 3 = 0$

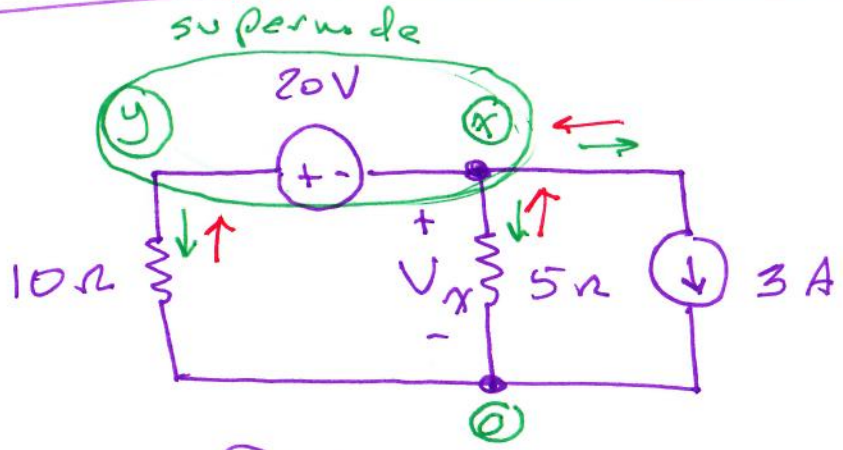
$$\begin{array}{c} \\ \text{Eq. 1} \\ \text{Eq. 2} \\ \text{Eq. 3} \end{array} \begin{bmatrix} V_1 & V_2 & V_3 \\ \hline 3/20 & -1/20 & 0 \\ -1/20 & 7/20 & -1/10 \\ 0 & -1/10 & 1/10 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ -3 \end{bmatrix}$$




$$-\frac{V_1}{2000\Omega} + \frac{5}{1000} + \frac{V_2 - V_1}{5000} = 0 \qquad \text{(KCL at node 1)}$$

$$\frac{V_1 - V_2}{5000} - \frac{V_2}{3000} = 0 \qquad \text{(KCL at node 2)}$$

$$\begin{bmatrix} -7/10000 & 1/5000 \\ 1/5000 & -2/15000 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} -5/1000 \\ 0 \end{bmatrix}$$

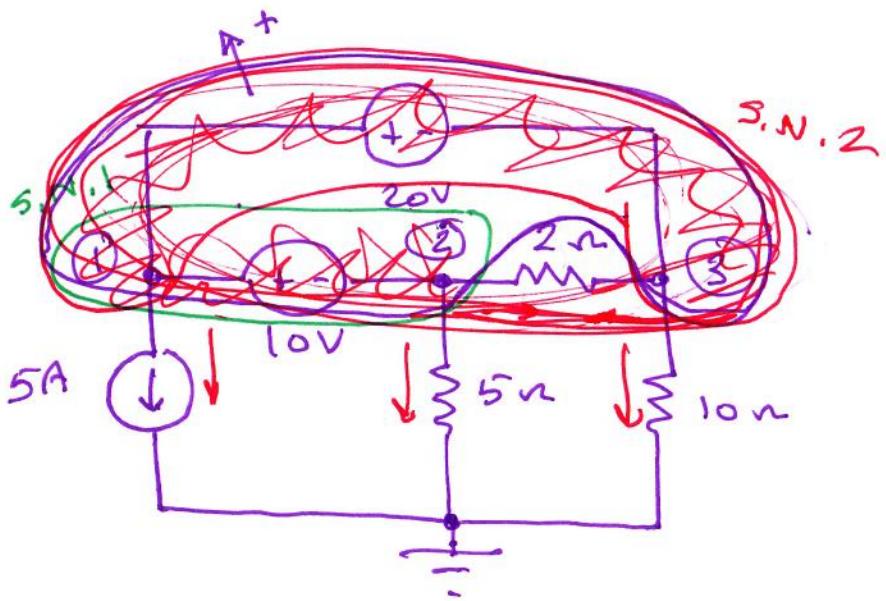



Find $V_x$ using nodal analysis.

$V_y - V_x = 20$ (constraint equation)

$\frac{V_y}{10} + \frac{V_x}{5} + 3 = 0$ (KCL for the Supernode)

$+\left(-\frac{V_y}{10}\right) + \left(-\frac{V_x}{5}\right) - 3 = 0$



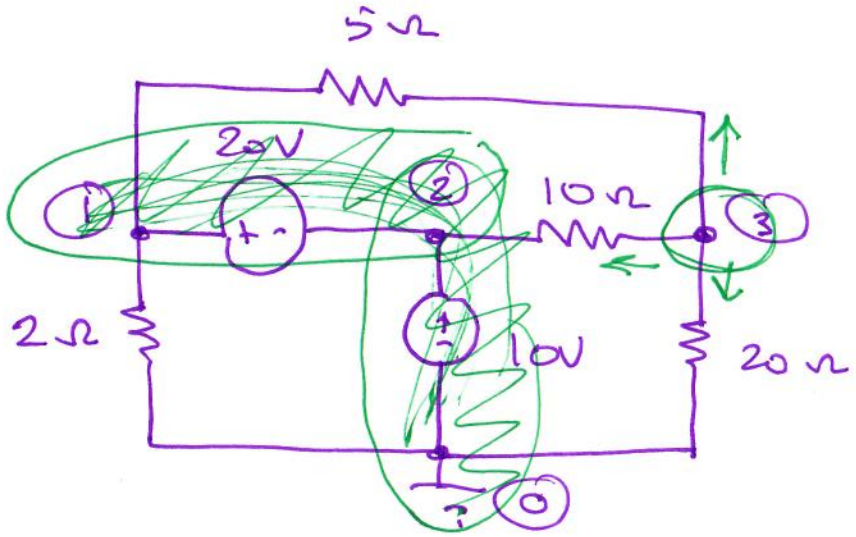

$$V_1 - V_2 = 10 \qquad \text{(constraint)}$$

$$V_1 - V_3 = 20 \qquad \text{(constraint)}$$

$$5 + \frac{V_2}{5} + \frac{V_3}{10} = 0 \qquad \text{(KCL for supernode)}$$

$$\begin{bmatrix} 1 & -1 & 0 \\ 1 & 0 & -1 \\ 0 & 1/5 & 1/10 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 10 \\ 20 \\ -5 \end{bmatrix}$$

Never write a KCL equation for the ref node or any supernode involving the ref. node.




$V_1 - V_2 = 20$ (constraint)

$V_2 = 10$ (constraint)

$\frac{V_3 - V_1}{5\Omega} + \frac{V_3 - V_2}{10\Omega} + \frac{V_3}{20\Omega} = 0$ (KCL at node 3)

$$\begin{bmatrix} 1 & -1 & 0 \\ 0 & 1 & 0 \\ -1/5 & -1/10 & 7/20 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 20 \\ 10 \\ 0 \end{bmatrix}$$