ECE 2001
Fall 2019
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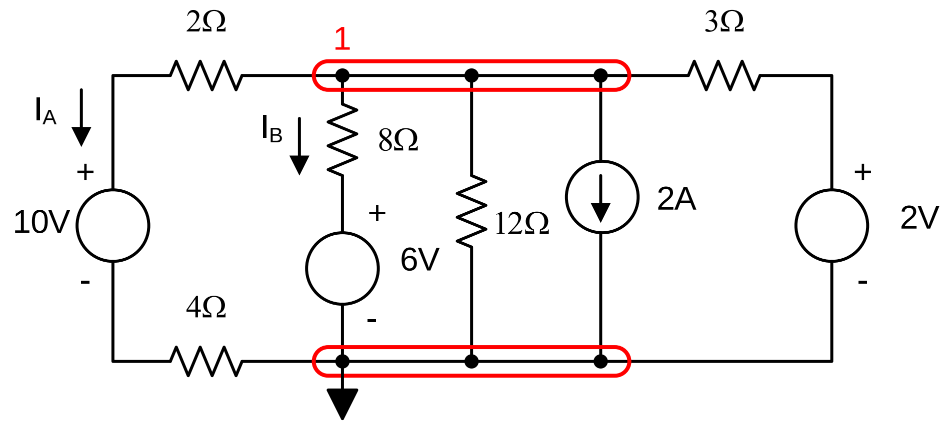
Homework Assignment 2 **SOLUTION**
Due: Friday, Sept. 13, 2019

1. (20) For the network below, find I_A, I_B, and the power for each of the sources.



Solution: NVM with V, A, Ω. Two essential nodes and no special cases.

1. $\frac{V_1-10}{6}+\frac{V_1-6}{8}+\frac{V_1}{12}+2+\frac{V_1-2}{3}=0$

1. $4V_1-40+3V_1-18+2V_1+48+8V_1-16=0$

1. $17V_1=26$

$V_1=1.53V$

$$I_A=\frac{V_1-10V}{6\Omega}=-1.412A$$

$$I_B=\frac{V_1-6V}{8\Omega}=-0.56A$$

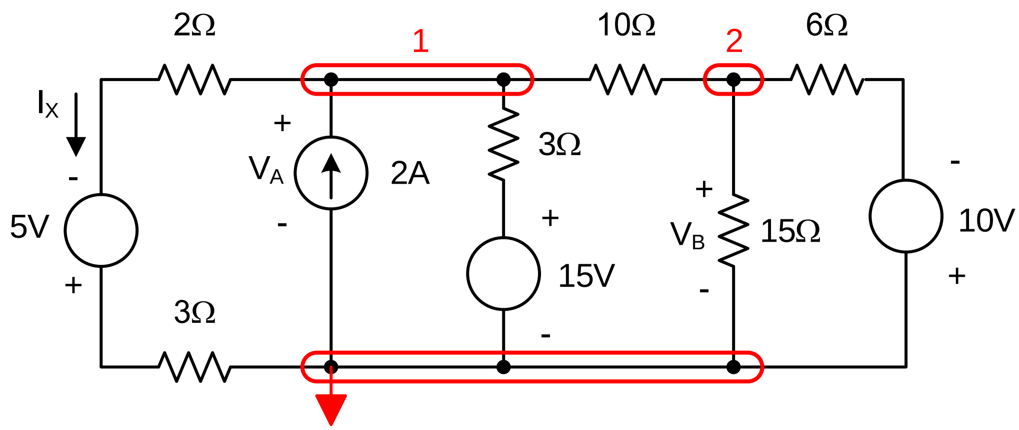
$P_{10V}=(-1.412A)(10V)=-14.12W$

$P_{6V}=(-0.56A)(6V)=-3.36W$

$P_{2A}=(2A)(1.53V)=3.06W$

$$P_{2V}=\left(\frac{1.53V-2V}{3\Omega}\right)(2V)=-0.313W$$

2. (20) Find V_A, V_B, I_X and the power for the 2A source, P_{2A}.



Solution: NVM with V, A, Ω. Three essential nodes and no special cases.

1. $\frac{V_1+5}{5} - 2 + \frac{V_1-15}{3} + \frac{V_1-V_2}{10} = 0$

2. $\frac{V_2-V_1}{10} + \frac{V_2}{15} + \frac{V_2+10}{6} = 0$

1. $6V_1 + 30 - 60 + 10V_1 - 150 + 3V_1 - 3V_2 = 0$

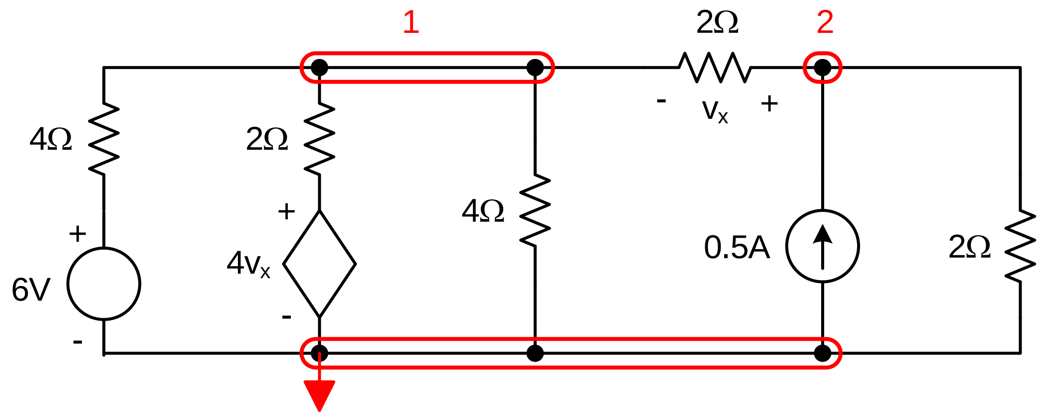
2. $3V_2 - 3V_1 + 2V_2 + 5V_2 + 50 = 0$

$\begin{bmatrix} 19 & -3 \\ -3 & 10 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 180 \\ -50 \end{bmatrix}$ $\quad V_1 = 9.12V = V_A \quad V_2 = -2.26V = V_B$

$$I_X = \frac{V_1 + 5V}{5\Omega} = 2.82A$$

$P_{2A} = -(2A)(9.12V) = -18.24W$

3. (20) Find V_x and the power for the dependent source.



Solution: NVM with V, A, Ω. Three essential nodes and no special cases.

1. $\frac{V_1-6}{4}+\frac{V_1-4V_x}{2}+\frac{V_1}{4}+\frac{V_1-V_2}{2}=0$

2. $\frac{V_2-V_1}{2}-0.5+\frac{V_2}{2}=0$

DS. $V_x=V_2-V_1$

1DS. $\frac{V_1-6}{4}+\frac{V_1+4V_1-4V_1}{2}+\frac{V_1}{4}+\frac{V_1-V_2}{2}=0$

1DS. $V_1-6+2V_1+8V_1-8V_2+V_1+2V_1-2V_2=0$

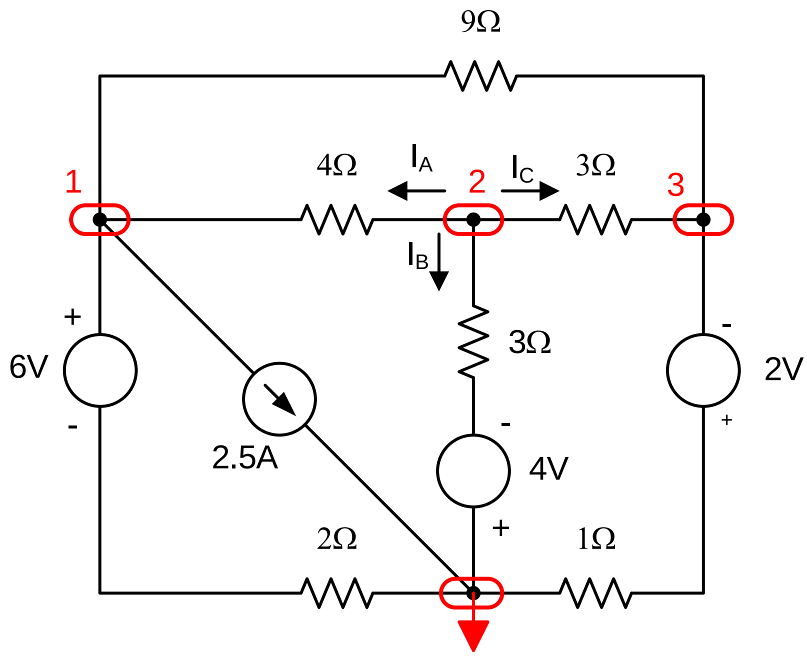
2. $V_2-V_1-1+V_2=0$

$\begin{bmatrix}-1 & 2\\ 14 & -10\end{bmatrix}\begin{bmatrix}V_1\\ V_2\end{bmatrix}=\begin{bmatrix}1\\ 6\end{bmatrix}$ $\quad V_1=1.222V \quad V_2=1.111V$

$V_x=V_2-V_1=-0.111V$

$P_{4V_x}=\left(\frac{1.222V-(-0.444V)}{2\Omega}\right)(-0.444V)=-0.370W$

4. Find I_A, I_B, and I_C, and show that they satisfy Kirchhoff's Current Law.



Solution. NVM using V, A, Ω. Four essential nodes and no special cases.

1. $\frac{V_1-6}{2}+2.5+\frac{V_1-V_2}{4}+\frac{V_1-V_3}{9}=0$
2. $\frac{V_2-V_1}{4}+\frac{V_2+4}{3}+\frac{V_2-V_3}{3}=0$
3. $\frac{V_3-V_2}{3}+\frac{V_3-V_1}{9}+\frac{V_3+2}{1}=0$

1. $18V_1-108+90+9V_1-9V_2+4V_1-4V_3=0$
2. $3V_2-3V_1+4V_2+16+4V_2-4V_3=0$
3. $3V_3-3V_2+V_3-V_1+9V_3+18=0$

$$\begin{bmatrix} 31 & -9 & -4 \\ -3 & 11 & -4 \\ -1 & -3 & 13 \end{bmatrix}\begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}=\begin{bmatrix} 18 \\ -16 \\ -18 \end{bmatrix} \qquad \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}=\begin{bmatrix} -0.3189V \\ -2.2421V \\ -1.9265V \end{bmatrix}$$

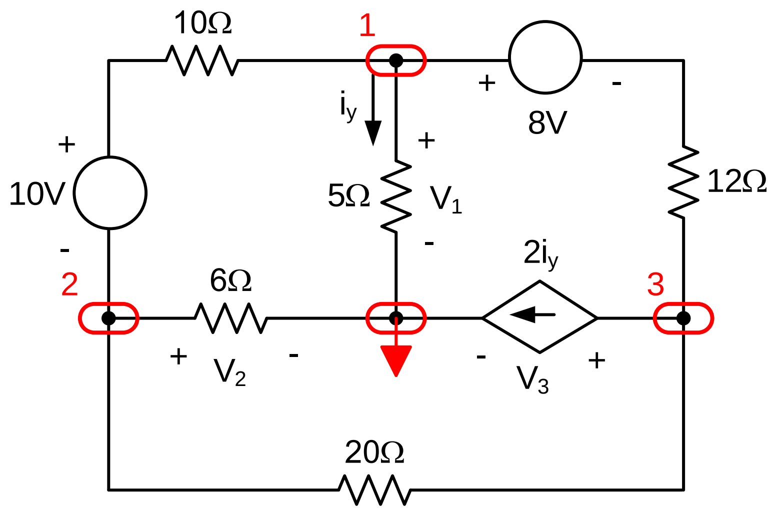
$$I_A=\frac{V_2-V_1}{4\Omega}=-0.4808A$$

$$I_B=\frac{V_2+4V}{3\Omega}=0.5860A$$

$$I_C=\frac{V_2-V_3}{3\Omega}=-0.1052A$$

$$I_A+I_B+I_B=0$$

5. For the circuit shown, find V_1, V_2, V_3, i_y, and the power for the dependent source.



Solution. NVM using V, A, Ω. Four essential nodes, no special cases.

1. $\frac{V_1-10-V_2}{10}+\frac{V_1}{5}+\frac{V_1-8-V_3}{12}=0$

2. $\frac{V_2+10-V_1}{10}+\frac{V_2}{6}++\frac{V_2-V_3}{20}=0$

3. $\frac{V_3+8-V_1}{12}+2i_y+\frac{V_3-V_2}{20}=0$

DS. $i_y=\frac{V_1}{5}$

3DS. $\frac{V_3+8-V_1}{12}+\frac{V_1}{3}+\frac{V_3-V_2}{20}=0$

1. $6V_1-60-6V_2+12V_1+5V_1-40-5V_3=0$
2. $6V_2+60-6V_1+10V_2+3V_2-3V_3=0$
3DS. $5V_3+40-5V_1+24V_1+3V_3-3V_2=0$

$$\begin{bmatrix}23 & -6 & -5\\ -6 & 19 & -3\\ 19 & -3 & 8\end{bmatrix}\begin{bmatrix}V_1\\ V_2\\ V_3\end{bmatrix}=\begin{bmatrix}100\\ -60\\ -40\end{bmatrix} \qquad \begin{bmatrix}V_1\\ V_2\\ V_3\end{bmatrix}=\begin{bmatrix}1.186V\\ -4.27V\\ -9.42V\end{bmatrix}$$

$$i_y=\frac{V_1}{5\Omega}=0.2372A$$
$$P_{2iy}=2i_yV_3=-4.52W$$