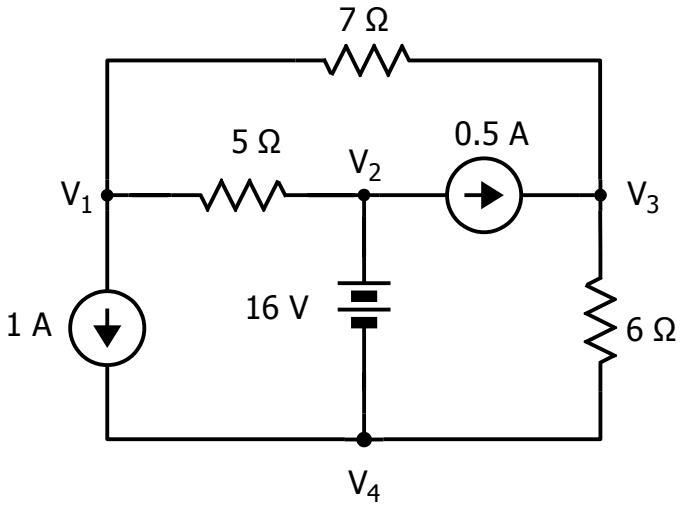
EE3 Fall 2020
Homework Problem 2

Find the current through the battery, two ways:

– with V_4 as the reference node

– with V_2 as the reference node



CHOOSING V_4 TO BE THE REFERENCE NODE,

$V_2 = 16$ V

$$\frac{V_1-16}{5}+1+\frac{V_1-V_3}{7}=0$$

$$\frac{V_3-V_1}{7}-0.5+\frac{V_3}{6}=0$$

$$7V_1-(16)(7)+35+5V_1-5V_3=0$$

$$6V_3-6V_1-21+7V_3=0$$

$$12V_1-5V_3=77$$

$$-6V_1+13V_3=21$$

$$\begin{bmatrix}12 & -5\\ -6 & 13\end{bmatrix}\begin{bmatrix}V_1\\ V_3\end{bmatrix}=\begin{bmatrix}77\\ 21\end{bmatrix}$$

$V_1 = 8.78$ V; $V_3 = 5.67$ V

KCL at the top of the battery (currents assumed to be leaving unless known otherwise):

$$\frac{V_2-V_1}{5}+0.5+I_B=0$$

$$I_B=\frac{V_1-V_2}{5}-0.5=\frac{8.78-16}{5}-0.5=-1.94\text{ A}$$

CHOOSING V_2 TO BE THE REFERENCE NODE,

$V_4 = -16$ V

$$\frac{V_1-0}{5}+1+\frac{V_1-V_3}{7}=0$$

$$\frac{V_3-V_1}{7}-0.5+\frac{V_3-(-16)}{6}=0$$

$$7V_1+35+5V_1-5V_3=0$$

$$6V_3-6V_1-21+7V_3-7\cdot(-16)=0$$

$$12V_1-5V_3=-35$$

$$-6V_1+13V_3=-91$$

$$\begin{bmatrix}12 & -5\\ -6 & 13\end{bmatrix}\begin{bmatrix}V_1\\ V_3\end{bmatrix}=\begin{bmatrix}-35\\ -91\end{bmatrix}$$

$V_1 = -7.22$ V; $V_3 = -10.33$ V

KCL at the top of the battery (currents assumed to be leaving unless known otherwise):

$$\frac{0-V_1}{5}+0.5+I_B=0$$

$$I_B=\frac{V_1-0}{5}-0.5=\frac{-7.22}{5}-0.5=-1.94\text{ A}$$