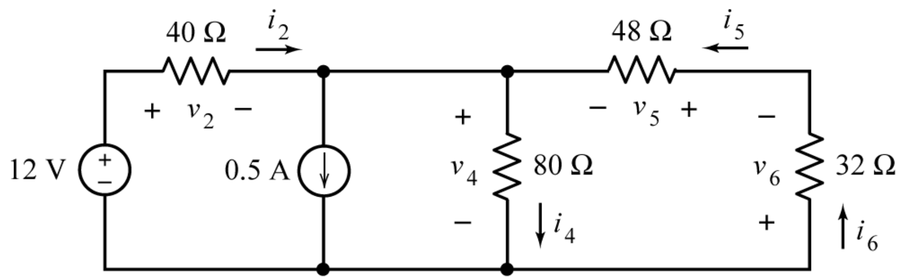
Solution:



Apply KCL to the node at which the current source and the 40 Ω, 48 Ω and 80 Ω resistors are connected together.

EQN 1: $i_2 + i_5 = 0.5 + i_4$

Apply KCL to the node at which the 48 Ω and 32 Ω resistors are connected together.

EQN 2: $i_5 = i_6$

Apply KVL to the loop consisting of the voltage source and the 40 Ω and 80 Ω resistors.

EQN 3: $12 = v_2 + v_4$

Apply KVL to the loop consisting of the 48 Ω, 32 Ω and 80 Ω resistors.

EQN 4: $v_4 + v_5 + v_6 = 0$

Apply Ohm's law to the resistors.

Ohm's law: $v_2 = 40\, i_2 ,\;\; v_4 = 80\, i_4 ,\;\; v_5 = 48\, i_5 ,\;\; v_6 = 32\, i_6$

Use the Ohm's law equations to eliminate the variables representing resistor voltages from the KVL equations.

EQN 5 (from EQN 3): $12 = 40\, i_2 + 80\, i_4$

EQN 6 (from EQN 4): $80\, i_4 + 48\, i_5 + 32\, i_6 = 0$

Use EQN 2 to eliminate i_6 from EQN 6.

EQN 7: $80\, i_4 + 48 i_5 + 32 i_5 = 0 \;\;\Rightarrow\;\; 80\, i_4 + 80\, i_5 = 0 \;\;\Rightarrow\;\; i_4 = -i_5$

Use EQN 7 to eliminate i_5 from EQN 1.

EQN 8: $$i_2 - i_4 = 0.5 + i_4 \quad \Rightarrow \quad i_2 = 0.5 + 2\,i_4$$

Use EQN 8 to eliminate i_4 from EQN 5. Solve the resulting equation to determine the value of $i_{2.}$

EQN 9: $$12 = 40\,i_2 + 80\left(\frac{i_2 - 0.5}{2}\right) = 80\,i_2 - 20 \quad \Rightarrow \quad i_2 = \frac{12+20}{80} = 0.4 \text{ A}$$

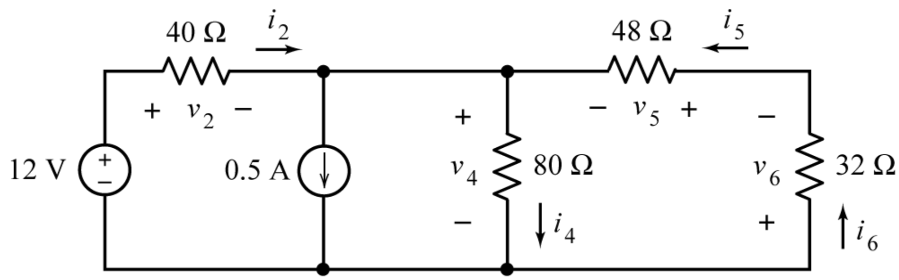
Determine the values of the rest of the resistor voltages and currents.

$$i_4 = \frac{i_2 - 0.5}{2} = \frac{0.4 - 0.5}{2} = -0.05 \text{ A}\,, \quad i_6 = i_5 = -i_4 = 0.05 \text{ A}\,,$$

$$v_2 = 40\,i_2 = 40(0.4) = 1.6 \text{ V}\,, \quad v_4 = 80\,i_4 = 80(-0.05) = -4 \text{ V}\,,$$

$$v_5 = 48\,i_5 = 48(0.05) = 2.4 \text{ V} \;\text{ and }\; v_6 = 32\,i_6 = 32(0.05) = 1.6 \text{ V}$$

MATLAB Solution:



Consecutive equations:

The above algebra shows that this circuit can be represented by these equations:

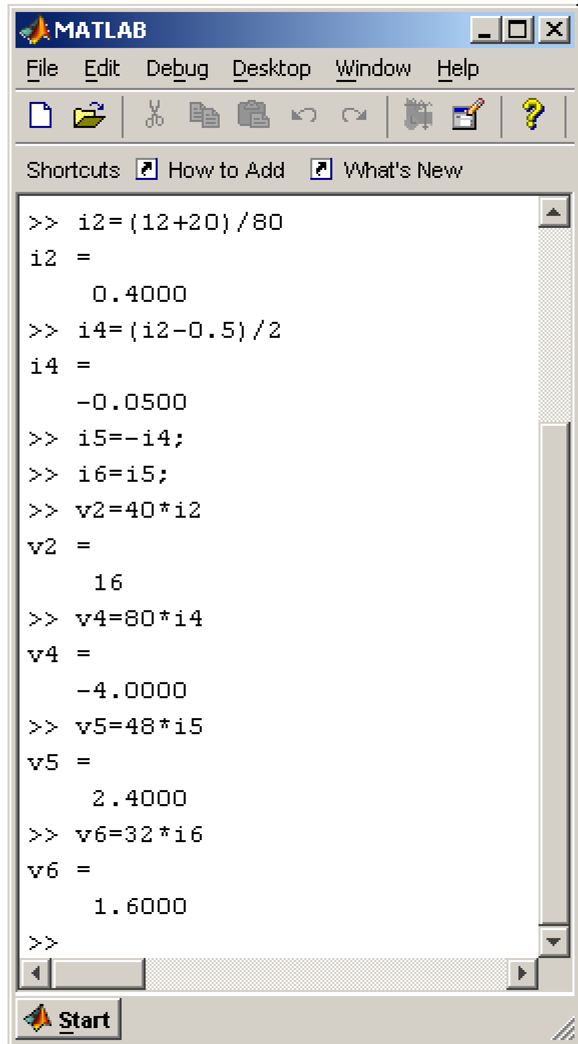
$$12 = 80\,i_2 - 20\,, \quad i_4 = \frac{i_2 - 0.5}{2}\,,$$

$$i_6 = i_5 = -i_4\,,$$

$$v_2 = 40\,i_2\,, \quad v_4 = 80\,i_4\,,$$

$$v_5 = 48\,i_5 \text{ and } \quad v_6 = 32\,i_6$$

These equations can be solved consecutively using MATLAB.



Simultaneous Equations

We can avoid some algebra if we are willing to solve simultaneous equations.

After applying Kirchhoff's laws and then using the Ohm's law equations to eliminate the variables representing resistor voltages we have

$$i_2 + i_5 = 0.5 + i_4, \quad i_5 = i_6, \quad 12 = 40\,i_2 + 80\,i_4$$

and

$$80\,i_4 + 48\,i_5 + 32\,i_6 = 0$$

This set of 4 simultaneous equations in i_2, i_4, i_5 and i_6 can be written as a single matrix equation.

$$\begin{bmatrix} 1 & -1 & 1 & 0 \\ 0 & 0 & 1 & -1 \\ 40 & 80 & 0 & 0 \\ 0 & 80 & 48 & 32 \end{bmatrix} \begin{bmatrix} i_2 \\ i_4 \\ i_5 \\ i_6 \end{bmatrix} = \begin{bmatrix} 0.5 \\ 0 \\ 12 \\ 0 \end{bmatrix}$$

This matrix equation can be solved using MATLAB.