MAE140 Solution of Sample Quiz

Problem 1. Find voltage $v$ and current $i$. (15pt)

Because the two terminal of the $4\Omega$ resistor is shorted with a connecting wire, $v = 0$. We can also remove this element from the circuit because current in it and voltage across it are both zero. The remaining circuit is a current divider. Thus:

$$i = \frac{1/12}{1/4 + 1/4 + 1/12} \times 5 = \frac{1/12}{7/12} \times 5 = \frac{5}{7} = 0.7 \text{ A}$$
**Problem 2.** The element law for element N in the circuit below is \( v = 2i + 5 \). Compute the voltage across the 14 \( \Omega \) resistor.

There are many ways to solve this circuit. As the \( i-v \) characteristics of Element N is in Thevenin form, we can replace it with its Thevenin equivalent and proceed to solve the circuit.

A better way is to note that all circuit analysis techniques apply to all linear elements including element N in the above circuit. Treat \( i-v \) characteristics of element N similar to Ohm’s Law and proceed.

Considering the circuit, we note that \( N_{NV} = 3 - 1 - 1 = 1 \) while \( N_{MC} = 2 \). Thus, we proceed with node voltage method. Writing KCL for node \( V \), and noting \( i = 0.5v - 2.5 \), we get:

\[
+i + \frac{v - 0}{14} + \frac{v - 10}{2} = 0 \\
14(0.5v - 2.5) + v + 7v - 70 = 0 \\
7v - 35 - v + 7v - 70 = 0 \\
15v = 105 \\
v = 7 \text{ V} \\
i = 0.5v - 2.5 = 1 \text{ A}
\]
Problem 3. What is the best analysis method to find $i$ and $v$? B) Find $i$ and $v$.

Considering the circuit, we note that $N_{NV} = 5 - 1 - 1 = 3$ while $N_{MC} = 4 - 2 = 2$. Thus, we proceed with mesh-current method. We also note that by moving the 1-A current source on the outside, it will be located on a single mesh, simplifying mesh-current method. Writing KCLs, we get:

Mesh 1: \[ 2i_1 + 6(i_1 - i_2) + 4[i_1 - (-3)] + 6(i_1 - 1) = 0 \quad \rightarrow \quad 18i_1 - 6i_2 = 6 \]

Mesh 1: \[ +3 + 3[i_2 - (-3)] + 6(i_2 - i_1) = 0 \quad \rightarrow \quad -6i_1 - 3i_2 = -12 \]

From second equation, we have $i_2 = 4 - 2i_1$. Substituting in the first equations, we get

\[ 18i_1 - 6(4 - 2i_1) = 6 \quad \rightarrow \quad 30i_1 = 30 \]

$i_1 = 1$ A \quad $i_2 = 4 - 2 = 2$ A

$i$ and $v$ can now be found from mesh currents:

\[ i = i_2 - i_1 = 2 - 1 = 1 \text{ A} \]

\[ v = 4[i_1 - (-3)] = 4(1 + 3) = 16 \text{ V} \]