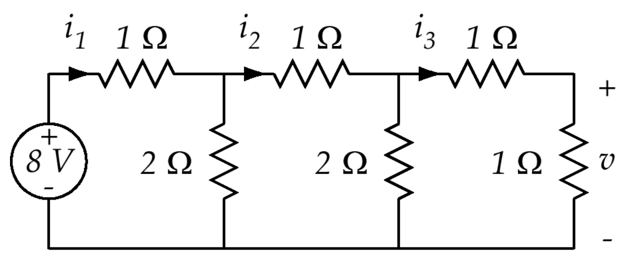
Inter American University of Puerto Rico
Bayamón Campus
School of Engineering
Department of Electrical Engineering

ELEN 3301 – Electric Circuits I

Problem Set 2 Solutions

Due Wednesday, September 1

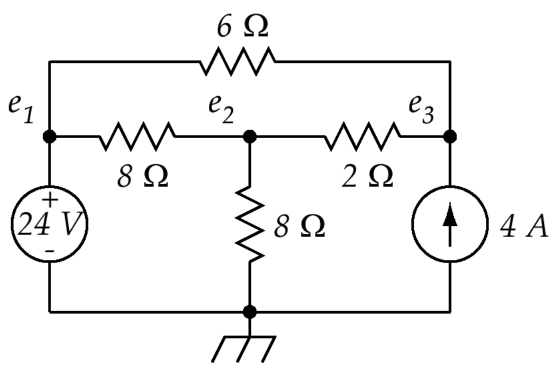
Problem 1: Find currents i_1, i_2, i_3 and voltage v in the following circuit:



Note that all the resistances from the voltage source can be combined to form a 2 Ω equivalent resistance. Thus, the total current leaving the voltage source $i_1 = 8V/2\Omega = 4A$. This current can flow down the first resistor or continue down the ladder. If we combine the resistors down the ladder, we see an equivalent resistance of 2 Ω. Thus, using current divider, the current will split evenly into 2 A down the 2 Ω resistor and $i_2 = 2A$ down the ladder. In the final section, the 2 A must again divide, and it is easy to see in this case that both legs have a 2 Ω resistance. Thus, the 2 A will again divide into 1 A down the 2 Ω resistor and $i_3 = 1A$. Using Ohm's law, $v = i_3 \cdot 1\Omega = 1V$.

Problem 2: Find node voltages e_1, e_2 and e_3 for the networks shown below using the node method (Note that the ground node has been chosen):

(A)



Node e_1: $e_1 = 24V$

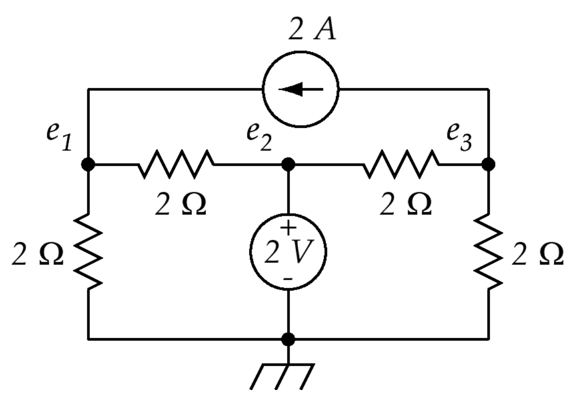
Node e_2: $\frac{e_3 - e_2}{2\Omega} = \frac{e_2}{8\Omega} + \frac{e_2 - 24V}{8\Omega}$

Node e_3: $4A = \frac{e_3 - e_2}{2\Omega} + \frac{e_3 - 24V}{6\Omega}$

Solving these two equations for e_2 and e_3 yields:

$e_2 = 24V$
$e_3 = 30V$

(B)



Node e_1: $2 = \frac{e_1 - 2V}{2\Omega} + \frac{e_1}{2\Omega}$

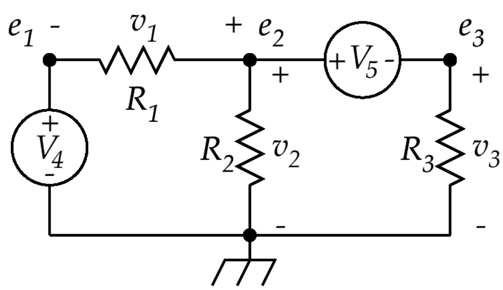
Node e_2: $e_2 = 2V$

Node e_3: $\frac{2V - e_3}{2\Omega} + \frac{-e_3}{2\Omega} = 2A$

Solving these two equations for e_1 and e_3 yields:

$$e_1 = 3V$$
$$e_3 = -1V$$

Problem 3: Find voltages v_1, v_2 and v_3 in the following circuit using the node method:



Node e_1: $e_1 = V_4$

Nodes e_2 and e_3 are joined by a voltage source; we must treat them together as a supernode where $e_3 = e_2 - V_5$:

$$\text{Supernode } \{e_2{,}e_3\}\text{: } \frac{e_2 - V_4}{R_1} + \frac{e_2}{R_2} + \frac{e_2 - V_5}{R_3} = 0$$

Solving this equation for e_2 yields:

$$e_2 = \frac{R_2 R_3}{R_1 R_2 + R_1 R_3 + R_2 R_3} V_4 + \frac{R_1 R_2}{R_1 R_2 + R_1 R_3 + R_2 R_3} V_5$$

Finally,

$$\begin{aligned}
v_2 = e_2 &= \frac{R_2 R_3}{R_1 R_2 + R_1 R_3 + R_2 R_3} V_4 + \frac{R_1 R_2}{R_1 R_2 + R_1 R_3 + R_2 R_3} V_5 \\
v_1 = e_2 - V_4 &= \frac{R_1 R_2}{R_1 R_2 + R_1 R_3 + R_2 R_3} V_5 - \frac{R_1 R_2 + R_1 R_3}{R_1 R_2 + R_1 R_3 + R_2 R_3} V_4 \\
v_3 = e_2 - V_5 &= \frac{R_2 R_3}{R_1 R_2 + R_1 R_3 + R_2 R_3} V_4 - \frac{R_1 R_3 + R_2 R_3}{R_1 R_2 + R_1 R_3 + R_2 R_3} V_5
\end{aligned}$$