EE 100/42 Spring 2009
Solutions to Homework 2

P 2.9 Combining the resistances shown in Figure P 2.9b, we have

$$\begin{aligned} R_{eq} &= 1 + \frac{1}{1+\frac{1}{R_{eq}}} + 1 = 2 + \frac{R_{eq}}{1+R_{eq}} \\ R_{eq}(1+R_{eq}) &= 2(1+R_{eq}) + R_{eq} \\ (R_{eq})^2 &= 2R_{eq} - 2 = 0 \\ R_{eq} &= 2.732\ \Omega \end{aligned}$$

($R_{eq} = -0.732\ \Omega$ is another root, but is not physically reasonable)

P 2.10 The 12 Ω and 6 Ω resistors are in parallel having an equivalent resistance of 4 Ω. Similarly, the 18 Ω and 9 Ω resistors are in parallel and have an equivalent resistance of 6 Ω. Finally, the two parallel combinations are in series and we have:

$$R_{ab} = 4 + 6 = 10\ \Omega$$

P 2.16 The 20 Ω and 30 Ω resistors are in parallel and have an equivalent resistance of $R_{eq1} = 12\ \Omega$. The 40 Ω and 60 Ω are in parallel and have an equivalent resistance of $R_{eq2} = 24\ \Omega$. Next we see that R_{eq1} and the 4 Ω resistor are in series and have equivalent resistance of $R_{eq3} = R_{eq1} + 4 = 16\ \Omega$. Finally, R_{eq2} and R_{eq3} are in parallel and the overall equivalent resistance is

$$R_{ab} = \frac{1}{\frac{1}{R_{eq2}} + \frac{1}{R_{eq3}}} = 9.6\ \Omega$$

P 2.47 At node 1 we have: $\frac{V_1}{20} + \frac{V_1 - V_2}{10} = 1$

At node 2 we have: $\frac{V_2}{5} + \frac{V_2 - V_1}{10} = 2$

The equations can be rewritten as

$$\begin{aligned} 0.15V_1 - 0.1V_2 &= 1 \\ -0.1V_1 + 0.3V_2 &= 2 \end{aligned}$$

Solving simultaneously we get $V_1 = 14.29$ and $V_2 = 11.43$
Then we have $i_1 = \frac{V_1 - V_2}{10} = 0.2857A$

P 2.49 Writing KCL equations at nodes 1, 2, and 3 we have

$$\frac{V_1}{5} + \frac{V_1 - V_2}{15} + \frac{V_1 - V_3}{15} = 0$$
$$\frac{V_2 - V_1}{15} + \frac{V_2 - V_3}{15} = 4$$
$$\frac{V_3}{25} + \frac{V_3 - V_2}{15} + \frac{V_3 - V_1}{15} = 0$$

These equations can be rewritten as

$$.333V_1 - 0.06667V_2 - 0.06667V_3 = 0$$
$$-0.06667V_1 + 0.1333V_2 - 0.06667V_3 = 4$$
$$-0.06667V_1 - 0.06667V_2 + 0.1733V_3 = 0$$

Solving simultaneously we get $V_1 = 15$, $V_2 = 50$, and $V_3 = 25$

P 2.51 Writing KCL equations at nodes 1 and 2, we have

$$\frac{V_1}{21} + \frac{V_1}{28} + \frac{V_1 - V_2}{9} = 3$$
$$\frac{V_2 - V_1}{9} + \frac{V_2}{6} = -3$$

which can be rewritten as

$$0.194V_1 - 0.111V_2 = 3$$
$$-0.111V_1 + 0.278V_2 = -3$$

Solving simultaneously we find $V_1 = 12$ and $V_2 = -6$.
If the source is reversed, the algebraic signs of the node voltages are reversed.

P 2.54 Once a 1 Amp source is connected to a and b, three nodal equations can be written

$$\frac{V_1 - V_2}{10} + \frac{V_1 - V_3}{20} = 1$$
$$\frac{V_2}{10} + \frac{V_2 - V_1}{10} + \frac{V_2 - V_3}{10} = 0$$
$$\frac{V_3}{20} + \frac{V_3 - V_1}{20} + \frac{V_3 - V_2}{10} = 0$$

Solving simultaneously, we find $R_{eq} = V_1 = 13.33\ \Omega$

P 2.62 Writing KVL equations around each mesh, we have

$$5i_1 + 7(i_1 - i_3) + 100 = 0$$
$$11(i_2 - i_3) + 13i_2 - 100 = 0$$
$$9i_3 + 11(i_3 - i_2) + 7(i_3 - i_1) = 0$$

which can be rewritten as

$$
\begin{aligned}
12i_1 - 7i_3 &= -100 \\
24i_2 - 11i_3 &= 100 \\
-7i_1 - 11i_2 + 27i_3 &= 0
\end{aligned}
$$

Solving, we obtain i_1 = -8.741 A, i_2 = 3.846 A, and i_3 = -0.6993 A. Then, the power delivered by the source is P = $100(i_1 - i_2)$ = 1259 W.