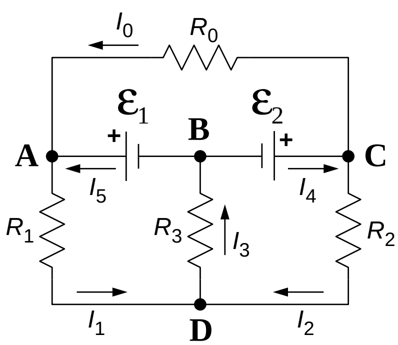
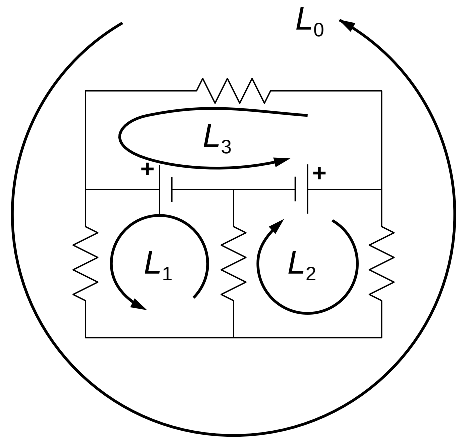
26-23. The following diagram provides generic names for the components, currents, junctions, and loops in the problem:





(a) Using the junction rule at junction **D**:

$$I_1 + I_2 = I_3 = 3 + 5 = 8 \text{ A}$$

Note that we can quickly find the other unknown currents using different junctions. Using junction **A**:

$$I_0 + I_5 = I_1 \Rightarrow I_5 = I_1 - I_0 = 1 \text{ A}$$

Using junction **C**:

$$I_4 = I_2 + I_0 = 5 + 2 = 7 \text{ A}$$

Junction **B** provides a check:

$$I_3 = I_4 + I_5 \Rightarrow 8 = 7 + 1$$

(b) Using loop L_1:

$$\begin{aligned} \mathcal{E}_1 - I_1R_1 - I_3R_3 &= 0 \\ \mathcal{E}_1 &= I_1R_1 + I_3R_3 = 3 \cdot 4 + 8 \cdot 3 = 36 \text{ V} \end{aligned}$$

Using loop L_2:

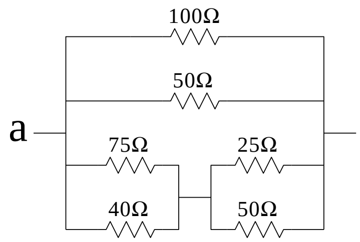
$$\begin{aligned} \mathcal{E}_2 - I_2R_2 - I_3R_3 &= 0 \\ \mathcal{E}_2 &= I_2R_2 + I_3R_3 = 5 \cdot 6 + 8 \cdot 3 = 54 \text{ V} \end{aligned}$$

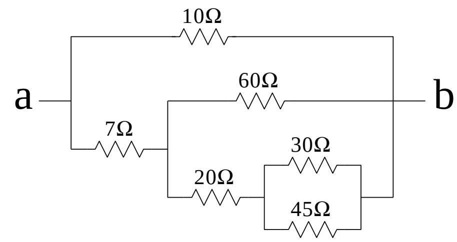
(c) Using L_0:

$$\begin{aligned} -I_0R_0 - I_1R_1 + I_2R_2 &= 0 \\ -I_1R_1 + I_2R_2 &= I_0R_0 \\ \frac{-I_1R_1 + I_2R_2}{I_0} &= R_0 = \frac{-3 \cdot 4 + 5 \cdot 6}{2} = 9 \ \Omega \end{aligned}$$

Remark: This problem is a bit unusual: typically $\mathcal{E}$s are known and Is are unknown (as in the lab, $\mathcal{E}$ is easier to measure than I). In any case, Kirchhoff rules will do the trick.

26-59. It is important to realize that you can move the wires to produce more obvious circuits as shown below:





(a) Symbolically this circuit is: $100\|50\|\Big[(75\|40)+(25\|50)\Big]$. Working through the block []:

$$\frac{75\cdot 40}{75+40}+\frac{25\cdot 50}{25+50}=42.754\ \Omega$$

The parallel combination of three yields:

$$\begin{aligned}\frac{1}{R_{eq}} &= \frac{1}{100}+\frac{1}{50}+\frac{1}{42.754}=0.05339\ \Omega^{-1}\\ R_{eq} &= 18.7\ \Omega\end{aligned}$$

(b) Symbolically this circuit is: $10\|\Big[7+\Big(60\|\{20+30\|45\}\Big)\Big]$. Working through the block {}:

$$20+\frac{30\cdot 45}{30+45}=38\ \Omega$$

Working through the block $\Big[\Big]$:

$$7+\frac{60\cdot 38}{60+38}=30.265\ \Omega$$

and finally:

$$\frac{10\cdot 30.265}{10+30.265}=7.52\ \Omega$$

13. (old exam) Symbolically this circuit is: $1\text{k} + \{7\text{k}\|(2\text{k}+3\text{k}+2\text{k})\} + 5\text{k}$. See that the {} block: is $7\text{k}\|7\text{k} = 3.5\text{k}$, so the result is $1\text{k}+3.5\text{k}+5\text{k} = 9.5\text{k}\Omega$. The current though the battery is $I = V/R = 15/9.5 = 1.58$ mA. The voltage drop across the $\{7\text{k}\|(2\text{k}+3\text{k}+2\text{k})\}$ is $15-(1+5)\cdot 1.58 = 5.53$ V. The current through $(2\text{k}+3\text{k}+2\text{k})$ is $I = V/R = 5.53/7 = .789$ mA; this same current goes through the $3\text{k}\Omega$ resistor.

14. (old exam) Using currents in mA and resistances in $\text{k}\Omega$ (as $\text{m}\times\text{k} = 1$):

$$\begin{aligned} I_1 &= I_2 + I_3 \\ 15 - 2I_1 - 3I_2 - 5 - 5I_2 &= 0 \\ 15 - 2I_1 - 7I_3 &= 0 \\ -5 - 5I_2 + 7I_3 - 3I_2 &= 0 \end{aligned}$$

I'll use the top three equations:

$$\begin{aligned} 0 &= -I_1 + I_2 + I_3 \\ 10 &= 2I_1 + 8I_2 \\ 15 &= 2I_1 \qquad + 7I_3 \end{aligned}$$

I hope you will enter these equations into your calculator to find a solution. I'll proceed the long way: eliminate I_3 from the last equation using the first: $I_3 = I_1 - I_2$:

$$\begin{aligned} 10 &= 2I_1 + 8I_2 \\ 15 &= 9I_1 - 7I_2 \end{aligned}$$

Multiplying the top equation by 4.5 produces equal coefficients of I_1:

$$\begin{aligned} 45 &= 9I_1 + 36I_2 \\ 15 &= 9I_1 - 7I_2 \end{aligned}$$

Now subtract:

$$\begin{aligned} 30 &= 43I_2 \\ \frac{30}{43} &= I_2 = .698 \text{ mA} \end{aligned}$$

Given I_2 we can substitute into any of the loop equations, e.g.:

$$\begin{aligned} 10 &= 2I_1 + 8I_2 = 2I_1 + 8\,\frac{30}{43} \\ 10 - \frac{240}{43} &= 2I_1 \\ \frac{430-240}{43\cdot 2} = \frac{95}{43} &= I_1 = 2.21 \text{ mA} \end{aligned}$$

Then $I_3 = I_1 - I_2 = 65/43 = 2.21 - .698 = 1.51$ mA. It's always wise to check your work; I'll check the bottom equation:

$$-5-5I_2+7I_3-3I_2 = -5-8I_2+7I_3 = -5-8\times.698+7\times1.51 = -10.584+10.570 = -.014 \approx 0$$