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CECS 211 Section 01
Lab 2
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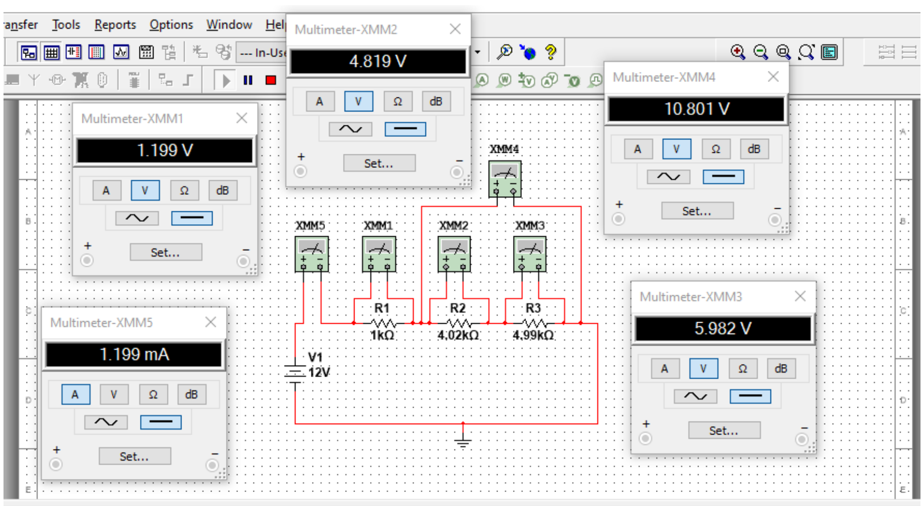

This screenshot shows KVL in action by displaying various voltage values across three resistors with different values.

Total resistance: The resistance of R_1 is $1\,\mathrm{k\Omega}$, the resistance of R_2 is $4.02\,\mathrm{k\Omega}$, and the resistance of R_3 is $4.99\,\mathrm{k\Omega}$; the total resistance R_{net} is $(1 + 4.02 + 4.99)\ \mathrm{k\Omega} = 10.01\,\mathrm{k\Omega}$.

XMM5: Ohm's Law ($V = IR$) can be modified to find the current of a circuit when the voltage and resistance are known: $I = V/R$. Plugging in V and R into this equation:

$$
\begin{aligned}
I = \frac{V}{R} = \frac{V_s}{R_{\text{net}}} &= \frac{12\,\mathrm{V}}{10.01 \times 10^3\,\Omega} \\
&= 0.001\,199\,\mathrm{A} = 1.199\,\mathrm{mA}
\end{aligned}
$$

This value is displayed in XMM5.

XMM1, XMM2, and XMM3: This is an example of KVL. The amount of voltage going through each resistor can be calculated by Ohm's Law: $V = IR$. Plugging in the amount of current I that was calculated in the last section ($1.199\,\mathrm{mA}$) and the amount of resistance of R_1 which is $1\,\mathrm{k\Omega}$, we can calculate the following:

$$
\begin{aligned}
V_{R_1} = IR_1 &= (1.199 \times 10^{-3}\,\mathrm{A})(1 \times 10^3\,\Omega) \\
&= 1.199\,\mathrm{V}
\end{aligned}
$$

This is indeed the value displayed by XMM1. Calculating the expected values for XMM2 and XMM3 can be calculated in a similar way:

$$\begin{aligned} V_{R_2} = IR_2 &= (1.199 \times 10^{-3}\,\mathrm{A})(4.02 \times 10^{3}\,\Omega) \\ &= 4.82\,\mathrm{V} \end{aligned}$$

$$\begin{aligned} V_{R_3} = IR_3 &= (1.199 \times 10^{-3}\,\mathrm{A})(4.99 \times 10^{3}\,\Omega) \\ &= 5.98\,\mathrm{V} \end{aligned}$$

The XMM2 and XMM3 digital multimeters display the values 4.819 V and 5.982 V, respectively. These values are the same as were calculated (to two decimal points). Thanks to KVL, the three values for voltage across the three resistors add up to the original voltage of the DC power source:

$$\begin{gathered} \text{Clockwise from the top-left corner, before XMM5:} \\ +V_{R_1} + V_{R_2} + V_{R_3} - V_s = 0\,\mathrm{V} \\ +1.199\,\mathrm{V} + 4.82\,\mathrm{V} + 5.98\,\mathrm{V} - 12\,\mathrm{V} = 0\,\mathrm{V} \\ -0.001\,\mathrm{V} = 0\,\mathrm{V} \end{gathered}$$

(The last line is due to rounding error.)

XMM4: XMM4 is unique due to the fact that it is spanning two resistors instead of only one. This means that it is measuring the voltage going across two resistors. The amount of voltage can be inferred to be higher than any other singular measurement, because the resistance is higher, and voltage and resistance are directly proportional quantities. The expected value of the measurement can once again be acquired through the use of Ohm's Law, adding together the resistances of R_2 and R_3:

$$\begin{aligned} V_{R_{2+3}} &= I(R_2 + R_3) \\ &= (1.199 \times 10^{-3}\,\mathrm{A})(4.02 \times 10^{3}\,\Omega + 4.99 \times 10^{3}\,\Omega) \\ &= (1.199 \times 10^{-3}\,\mathrm{A})(9.01 \times 10^{3}\,\Omega) \\ &= 10.80\,\mathrm{V} \end{aligned}$$

Sure enough, this is the value displayed on XMM4. An interesting but expected observation that could be made is the fact that the readings in XMM1 and XMM4 add up to the total amount of voltage applied to the circuit by the power source; that is, $1.199\,\mathrm{V} + 10.801\,\mathrm{V} = 12\,\mathrm{V}$. This is another example of KVL in action in a circuit.