# Nodal and Mesh Analysis:
# Comparison of Analysis, Simulated, and Experimental Results

ECE 2100 Circuit Analysis
version 30 September 2021

## Equipment and Supplies

| |
|---|
| variable DC voltage source |
| digital multimeter |
| resistors (1/4W)<br>1kΩ; 2.2kΩ; 3.3kΩ; 4.7kΩ; |

## Pre-Laboratory Assignment (STEPS 1-8)

1. Consider the circuit of Figure 1. Write nodal analysis equations for node voltages $V_2$ and $V_3$. **Use symbolic voltage source and resistor values, e.g. $V_S$ and $R_1$ (not 10V and 1k) in your equations.** Note you are given $V_1$.

2. Reproduce Table 1 in your lab notebook.

3. Use your equations from pre-lab step 1 to find numeric values for all node voltages and enter into Table 1 analysis column.

4. Consider the circuit of Figure 1. Write mesh analysis equations for mesh currents $I_1$ and $I_2$. **Use symbolic voltage source and resistor values, e.g. $V_S$ and $R_1$ (not 10V and 1k) in your equations.**

5. Use your equations from pre-lab step 4 to find numeric values for all mesh currents and enter into Table 1 analysis column.

6. Simulate the circuit using LTspice® (DC operating point simulation) and tabulate node voltages and mesh currents in Table 1 simulated column. **Your simulated and analysis results should closely match**.

7. Find the resistance $R_{eq}$ seen by the source; that is, the equivalent resistance between terminals a and b with Vs removed. Enter as $R_{eq}$ in Table I analysis column.

8. Change the LTspice® simulation type to a DC Transfer simulation with Output V(V2) and input Vs. Run the simulation. The input impedance is the equivalent resistance $R_{eq}$ 'seen' by the source. Enter as $R_{eq}$ in simulated column. **Your simulated and analysis result should closely match**.

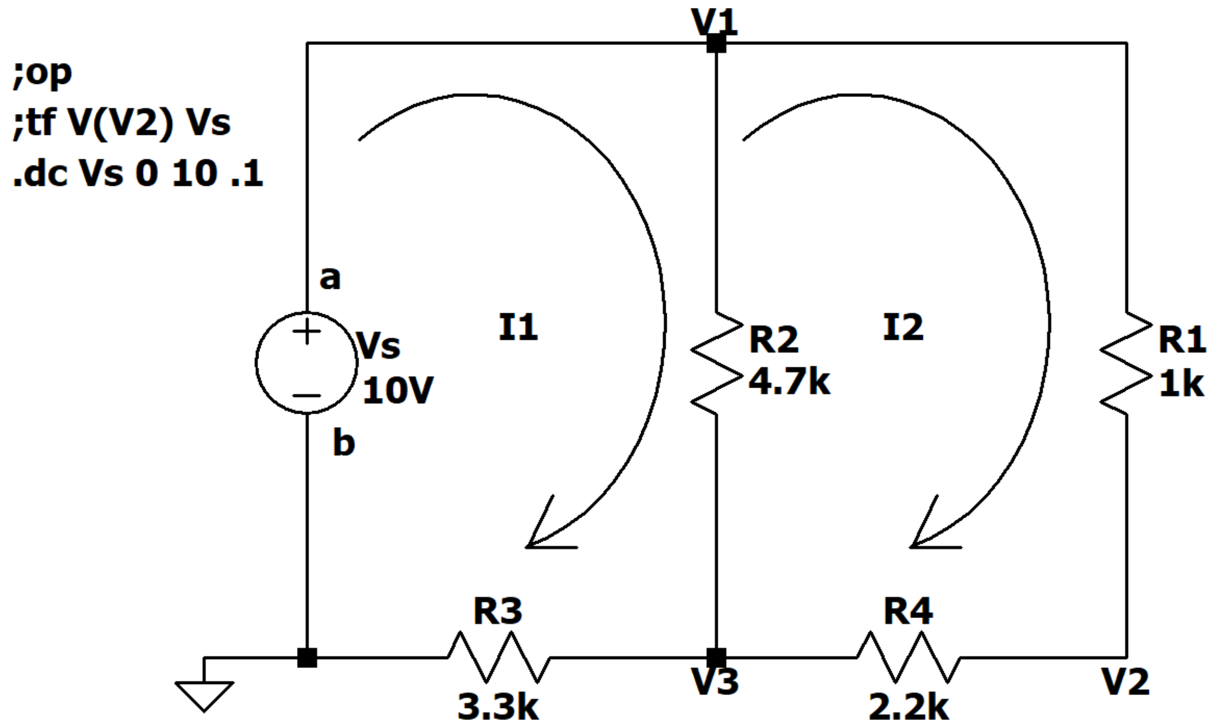


**Figure 1. Resistive Circuit**

| | analysis | simulated | experimental | % error (simulated vs analysis) | % error (experimental vs. analysis) |
|---|---|---|---|---|---|
| $V_S$ | | | | | |
| $V_1$ | | | | | |
| $V_2$ | | | | | |
| $V_3$ | | | | | |
| $I_1$ | | | | | |
| $I_2$ | | | | | |
| Req | | | | | |

**Table 1. Results**

## Procedures

### Req

1. Construct the circuit of Figure 1 **without the voltage source**.

2. Measure the resistance $R_{eq}$ 'seen' by the voltage source using your ohmmeter.
   Enter in Table 1 experimental column.

   **DO NOT PROCEED UNLESS YOUR $R_{eq}$ CLOSELY MATCHES THE PREDICTED VALUE.**

### Measuring Node Voltages and Mesh Currents

3. Ensure DMM is in voltmeter mode.
   Set power supply to 0V.
   Set power supply current limit to 1.2*10V/$R_{eq}$.
   Connect the voltage source to the circuit and enable the power supply output.
   Starting at 0V slowly adjust the power supply to 10V.

   Measure and record the voltage source value $V_S$ in Table 1 experimental column.

4. Measure node voltages and mesh currents. Place your measurements in Table 1 experimental column. Watch units!

5. Power off the circuit.

6. Compute the percentage errors for each row in Table 1 as indicated.
   **DO NOT DISASSEMBLE YOUR CIRCUIT** unless your experimental results match predicted values.

### Measuring Resistor Values

7. After circuit disassembly measure and record each resistor value using your ohmmeter.
   Do not touch resistor ends when measuring resistance. Lay the resistor flat on the bench and then press the probe leads onto the resistor leads while holding only the plastic part of the probes (of course we never touch any part of an energized circuit!).

8. Return DMM to voltmeter mode.

### Analysis

1. Why is the current limit set to 1.2*10V/$R_{eq}$ in lab step 3?

2. Using your equations from the pre-lab and your **measured** resistor and voltage source values, recompute node voltages and mesh currents. Then recompute the experimental errors by comparing experimental values to the updated analysis results. Present your results in a table like Table 1. Did your experimental errors improve?

3. Perform a LTspice® DC Sweep analysis. Use a linear sweep of Vs from 0 to 10V with a 0.1V increment. Plot Vs versus the current provided by Vs. Measure the slope. Compare this value to Req. Should these numbers match? If your slope is negative, something is wrong (why?).

## Credits and Copyright

Adapted from material developed by current and former ECE faculty, including Professor Joseph Kelemen. Thanks to Dr. Binu Narakathu and Brian Durant for improvements to this lab.