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Lab 2: Resistive Networks

Introduction: In this lab, the main objective is to explore the features of resistive networks, and calculate/measure their voltage and current. Also, to learn about the input resistance.

Step 1:

1.1. [RP1]

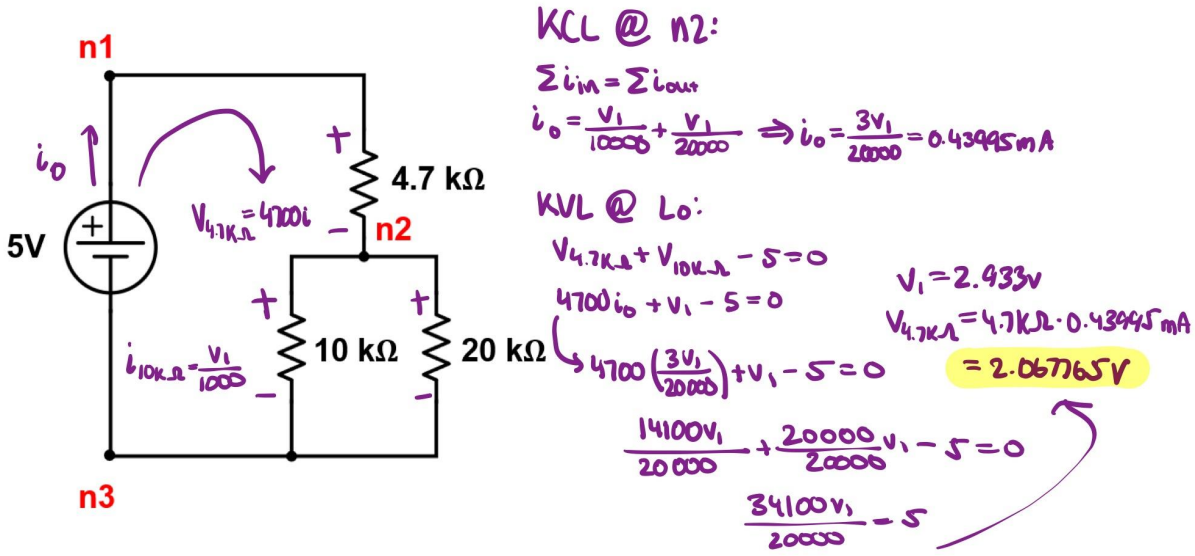


Figure 1. Resistive network schematic.

1.2. [RP2]

measured $V_{4.7k\Omega} = 2.067765\ V$

1.3. [RP3]

$\%\ error = \left|\frac{2.0674\ V - 2.067765\ V}{2.0677655\ V}\right| * 100 = 0.0177\ \%$

Our prediction was mostly accurate to the measured value. The percent error was less than 0.02% which means our calculated value was very close to the measured value.

Step 2:

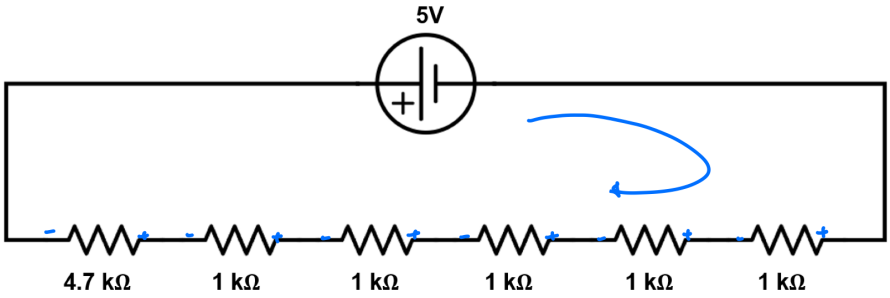


Figure 2. Series resistive network schematic

2.1. [RP4]

$$V_{4.7k\Omega} = V_{in}\left(\frac{V_{4.7k\Omega}}{5 * V_{1k\Omega} + V_{4.7k\Omega}}\right) = 5V\left(\frac{4700\ V}{9700\ V}\right) = 2.4227\ V$$

$$V_{1k\Omega} = V_{in}\left(\frac{V_{1k\Omega}}{5 * V_{1k\Omega} + V_{4.7k\Omega}}\right) = 5V\left(\frac{1000\ V}{9700\ V}\right) = 0.5155\ V$$

2.2. [RP5]

measured $V_{4.7k\Omega} = 2.4216\ V$

measured $V_{1k\Omega} = 0.51569\ V$

2.3. [RP6]

$$\%\ error_{4.7k\Omega} = \left|\frac{2.4216\ V - 2.4227\ V}{2.4227\ V}\right| * 100 = 0.0454\ \%$$

$$\%\ error_{1k\Omega} = \left|\frac{0.51569\ V - 0.5155\ V}{0.5155\ V}\right| * 100 = 0.0369\ \%$$

Our predictions are pretty close to the measured value. The percent error is less than 0.05%, which means that the difference between the measured values and our calculated values are negligible.

Step 3:

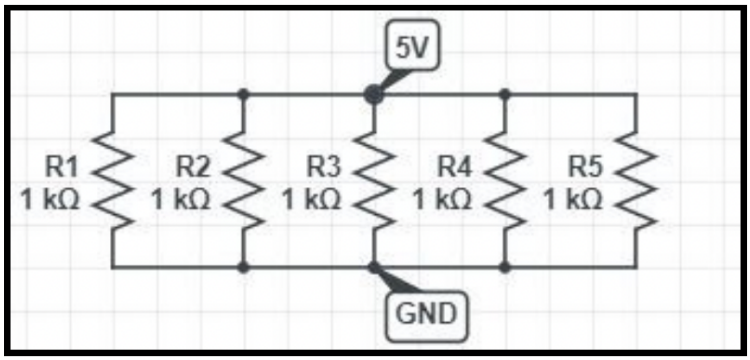


Figure 3. Parallel resistive network schematic

3.1. [RP7]

$$I = \frac{V}{R} = \frac{5V}{1k\Omega} = 5\ mA$$

3.2. [RP8]

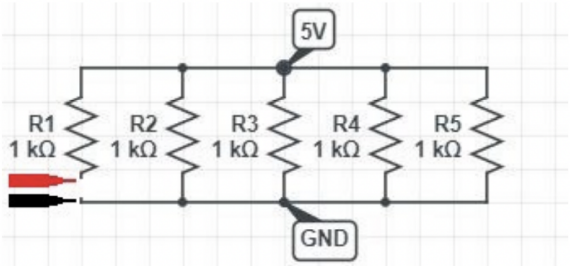


Figure 4. Example of applying DMM probes to measure the current through R1. Pull the ground terminal of R1 and connect it to the red probe, then connect the black probe to the ground.

measured $I_{1k\Omega} = 4.9705\ mA$

3.3. [RP9]

$$\%\ error_{1k\Omega} = \left|\frac{4.9705\ mA - 5\ mA}{5\ mA}\right| * 100 = 0.59\ \%$$

The percent error is less than 0.6%, which means that the difference between the measured values and our calculated values are negligible.

Step 4:

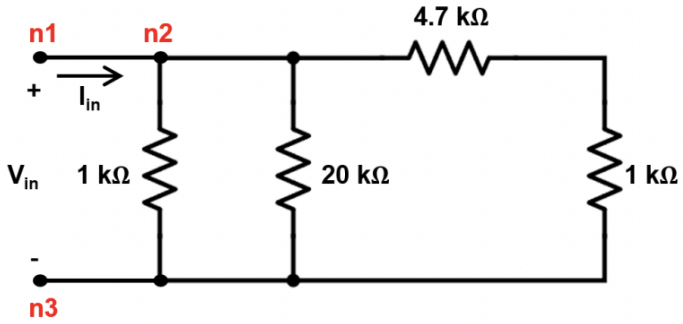


Figure 5. Resistive network schematic.

4.1. [RP10]

$$R_{in} = \frac{V_{in}}{I_{in}} = \frac{V_{in}}{V_{in}(\frac{1}{R_{1k\Omega}}+\frac{1}{R_{20k\Omega}}+\frac{1}{R_{1k\Omega}+R_{4.7k\Omega}})} = \frac{1}{(\frac{1}{1k\Omega}+\frac{1}{20k\Omega}+\frac{1}{5.7k\Omega})} = 0.81603\ k\Omega\ = 816.03\ \Omega$$

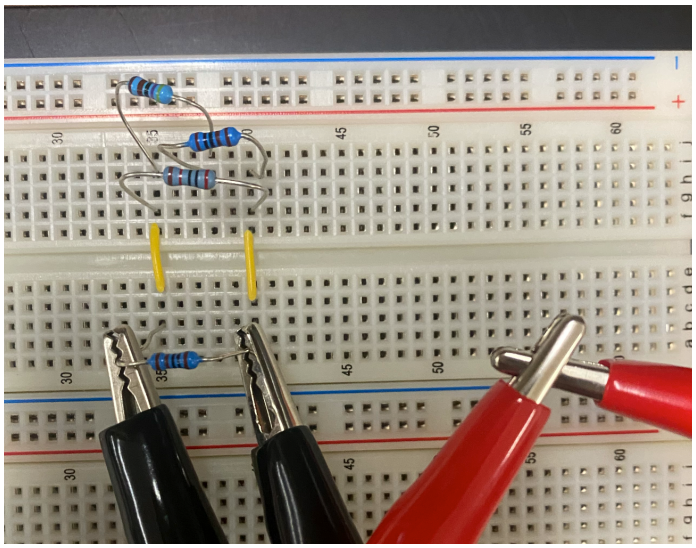
4.2. [RP11]

measured $V_{in} = 4.9769\ V$

measured $I_{in} = 6.1008\ mA$

$$R_{in} = \frac{V_{in}}{I_{in}} = \frac{4.9769\ V}{6.1008\ mA} = 815.778\ \Omega$$

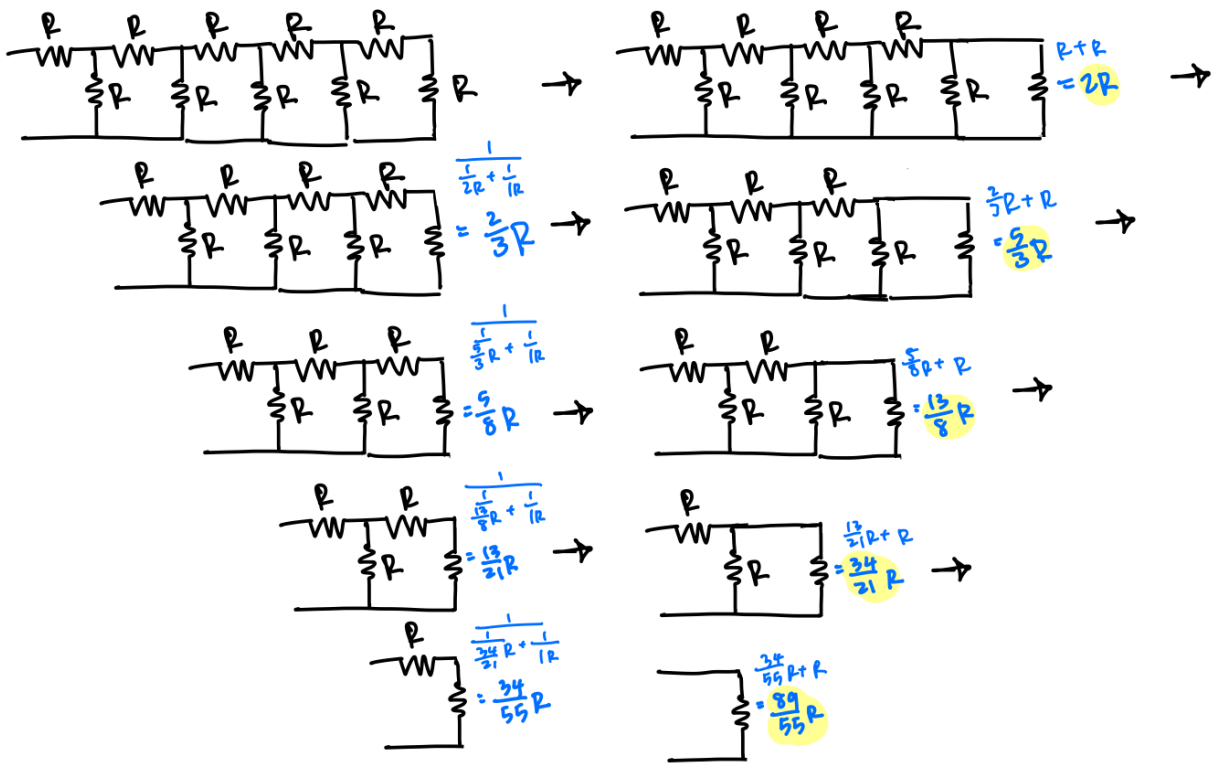
4.3. The measured input resistance values are the same when V_{in} = 3.3 V and when V_{in} = 5 V. Following Ohm's law, resistance is a constant that is independent of V_{in} and I_{in}, since the voltage is proportional to the current. [RP12]



[RP13]

Step 5:

5.1.

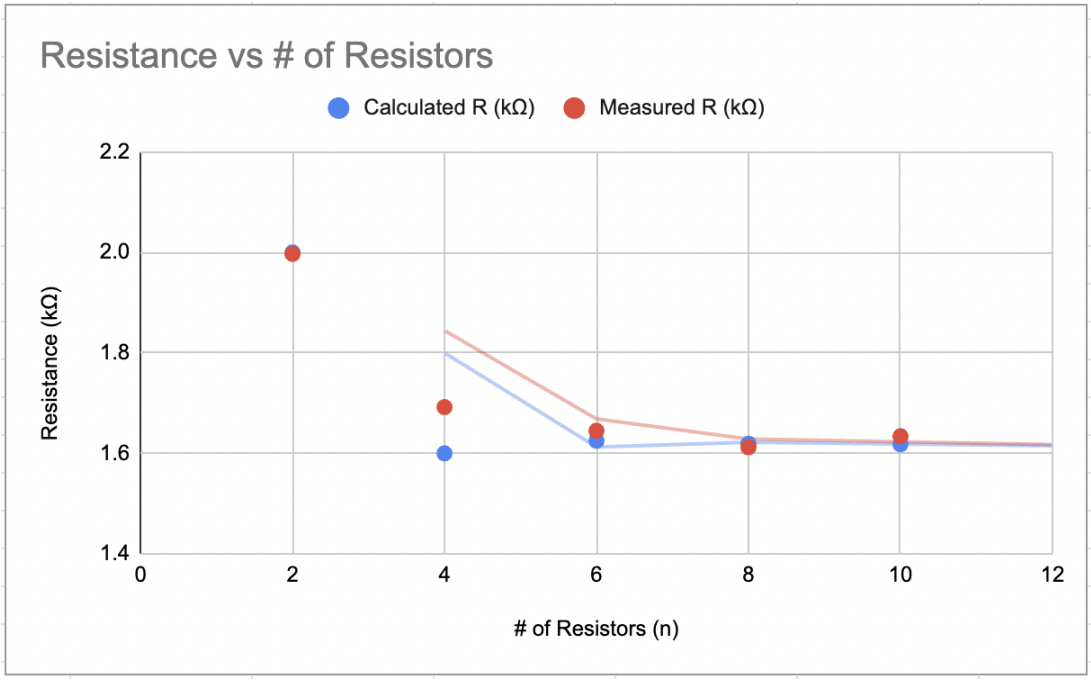


5.2.

Figure 6 with	Calculated R_{AD}	Measured R_{AD}
2 R	2 kΩ	1.997 kΩ
4 R	5/3 kΩ	1.692 kΩ
6 R	13/8 kΩ	1.645 kΩ
8 R	34/21 kΩ	1.612 kΩ
10 R	89/55 kΩ	1.634 kΩ

Table 2. Calculated and measured values of the resistive network with a different number of resistors **[RP14]**

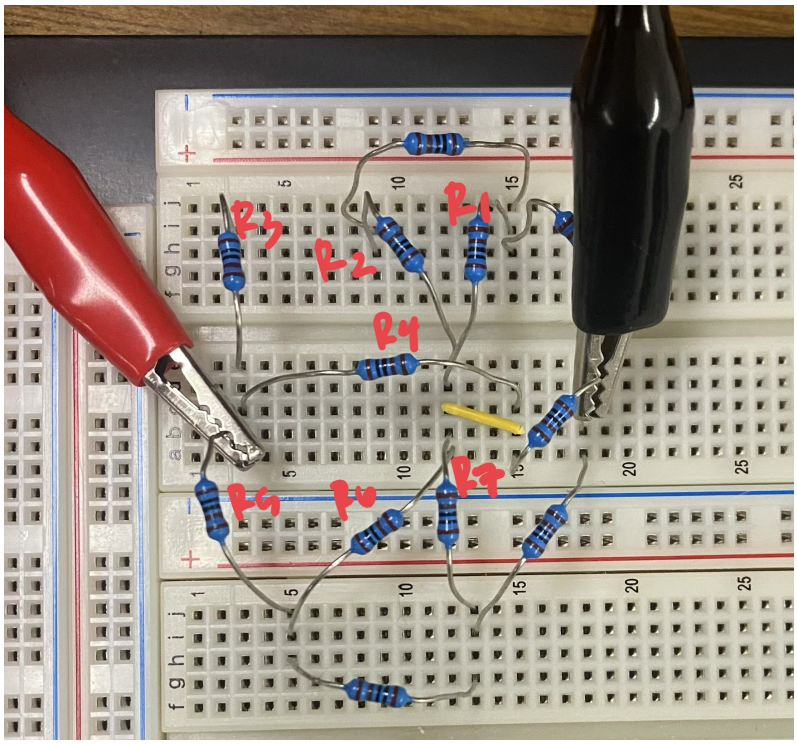
5.3. [RP15]



The input resistance is converging to approximately 1.61 kΩ. [RP16]

Step 6:

6.1. [RP17]



6.2. **[RP18]**

measured resistance $= 997.77\ \Omega$

6.3. **[RP19]**

Resistor Terminals	Measured Resistance (Ω)
1-7	997.77
2-7	768.15
3-7	768.63
4-7	529.04
5-7	529.08
6-7	632.50

Conclusion:

Based on all of the data from the lab, we can conclude that the basic method and/or the voltage divider formula gives values that are really close to the measured values, with percentage errors of less than 0.6%. This shows that analyzing the circuit by hand is a sufficient method of circuit analysis. We also discovered that adding resistors to the circuit does not necessarily increase the resistance, instead, the resistance depends on whether the connections are made in parallel or series.