Simulation of Ohm's Law

1 Objectives

- To understand and verify Ohm's Law using Python-based simulation.
- To represent the relationship between voltage, current, and resistance using Python code.
- To plot the Voltage-Current (V-I) characteristics of a resistor and confirm the linearity of the graph.
- To calculate the resistance from the slope of the V-I graph obtained through Python.

2 Prerequisites

- Basic understanding of Ohm's Law: $V = I \cdot R$
- Familiarity with Python programming and using libraries like `NumPy` for numerical calculations and `Matplotlib` for data visualization.
- Understanding how to interpret graphs and slopes in the context of Ohm's Law.

3 Theory

Ohm's Law states that the current (I) flowing through a conductor is directly proportional to the voltage (V) across it and inversely proportional to its resistance (R):

$$V = I \cdot R$$

In this experiment, a **resistor** will be used to verify the V-I characteristics by applying different voltage values and calculating the corresponding current using Ohm's Law.

Voltage-Current (V-I) Characteristics: A graph of voltage versus current for a resistor should produce a straight line, with the slope of this line corresponding to the resistance R.

4 Tasks

1. **Simulate and Analyze V-I Characteristics of a Resistor**
   - Simulate the Voltage-Current (V-I) relationship for a fixed resistor using a range of voltage values.
   - Analyze the results to verify if the V-I relationship follows Ohm's Law.
   - Plot the V-I graph and confirm the linearity of the curve.
2. **Determine Resistance from Experimental Data**
   - Use the plotted V-I graph to determine the slope of the line.

- Calculate the resistance using the inverse of the slope:

$$R = \frac{1}{\text{slope}}$$

- Compare this calculated resistance with the known value to evaluate the accuracy of the simulation.

3. **Explore the Effect of Varying Resistance**
   - Repeat the V-I analysis for multiple resistor values.
   - Observe and document how the slope of the V-I graph changes with different resistances.
   - Confirm whether the linearity is preserved and analyze the trend in the graph's slope with changing resistance.

5 Expected Outcomes

- A **linear V-I graph** demonstrating that current increases linearly with voltage for a fixed resistor, as predicted by Ohm's Law.
- The **calculated resistance** based on the slope of the V-I graph should match the nominal value of the resistor used.
- Understanding of how Python can be used to model and simulate Ohm's Law.
- Observation of how the slope of the V-I graph changes with different resistor values.