Laboratory 3
Thevenin's Theorem

Key Concepts:
- Thevenin's Theorem
- Equivalent resistance and voltage

Equipment Needed:
- Digital Multimeter (2)
- Protoboard

Components Needed:
- (2) 100 Ω, 10 kΩ Resistors
- (1) 2.7 kΩ Resistors
- (1) 1 kΩ, 100 kΩ, 1 MΩ, 10 MΩ Resistors
- (1) Variable resistor

Overview:
In this laboratory you will practice using Thevenin's Theorem and gain understanding of how it applies to circuits. The laboratory has four parts:
Part A: Theoretical Calculations
Part B: Thevenin Equivalent circuit
Part C: Applying Thevenin's Theorem
Part D: Application of Thevenin's Theroem

Procedure

Part A:
Before constructing the circuit, calculate the Thevenin equivalent resistance of $R_{TH}$ and the Thevenin voltage $V_{TH}$ as seen by the load resistor $R_L$.

Calculated values:
$V_{TH} =$ ____________________
$R_{TH} =$ ____________________
$I_L =$ ____________________

![Diagram](attachment:image.png)
Now measure the voltage across the load resistor and the current through it.

Measured Values:

\[ V_{RL} = \quad \quad \quad \quad \quad I_{RL} = \quad \quad \quad \quad \quad \]

Question: How do the currents compare? How does the measured voltage compare to the Thevenin equivalent voltage? Why should this be?

**Part B**

Construct the Thevenin equivalent circuit using the voltage and resistance calculated above. Measure the voltage across the load resistor and the current through it.

Measured Values

\[ V_L = \quad \quad \quad \quad \quad I_L = \quad \quad \quad \quad \quad \]

Question: How do the measured current and voltage compare to the calculated Thevenin values and to the values measured above?
Part C

Construct the circuit below, using a 1 kΩ resistor as $R_L$. Measure the current $I_L$ through $R_L$. Record the resistance and current values in the table, and repeat the measurements with values of 10 kΩ, 100 kΩ, 1 MΩ for $R_L$.

<table>
<thead>
<tr>
<th>Resistance $R_L$ (Ω)</th>
<th>Current $I_L$ (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</table>

Question: What can we say about $I_L$ as long as $R_L \ll R$? In other words, the 5 v power supply and R act like a constant ________ source? Why is this?

Question: As far as $R_L$ is concerned, is there any difference between your original circuit in Part A and your Thevenin equivalent circuit in Part B? Explain.

Question: In terms of $V_{TH}$ and $R_{TH}$ in Part B, what is the open-circuit voltage ($V_{oc}$) between A and B? (That is, the voltage between A and B as $R_L \rightarrow \infty$.)

Question: In terms of $V_{TH}$ and $R_{TH}$ in Part B, what is the short-circuit current ($I_{sc}$)? (That is, the current at A as $R_L \rightarrow 0$.)

Question: How is $R_{TH}$ related to $V_{oc}$ and $I_{sc}$?
Part D:

Construct the circuit below. R₂ should be a variable resistor, and R₄ is the unknown.

Question: Use the results of Thevenin's Theorem applied to this circuit to show how R₄ may be determined.

Determine the value of R₄ using your results from above:  \( R₄ = \) _____________________

Use the DMM to measure the value of R₄ directly: \( R₄ = \) _____________________

Question: How do the two values compare? Which do you think is a better estimate? Why?