Lab Report 4

Aidan Chin and Aidan Carey

Introduce and define all concepts

Solder through-hole components into a printed circuit board (PCB) • Thevenin equivalent circuit analysis

The purpose of this Lab (4) is to familiarize ourselves with the process of through-hole soldering components into a printed circuit board and practice Thevenin equivalent circuit analysis through practical study.

Components: are discrete parts of the circuit that do a specific function on the electric current going through.
https://www.protoexpress.com/kb/basic-components-overview/#:~:text=Some%20of%20the%20most%20commonly,switches%2C%20ICs%2C%20and%20connectors.

Printed circuit board: also known as PCB, these are boards with pads and lines printed on them that connect components together
https://learn.sparkfun.com/tutorials/pcb-basics/all

Soldering: soldering is a technique used to join 2 pieces of metal together by melting a type of solder in the gap, in this case we use soldering to join the component to the PCB
https://www.twi-global.com/technical-knowledge/faqs/what-is-soldering

Through-hole: A method to attach components to a pcb through soldering leads that fit through holes drilled into the pcb
SMT and Through-Hole Soldering | World's Way.

Thevenin Equivalent - Thevenin Voltage, is voltage measured at an open circuit at the 2 terminals
Thevenin resistance is the resistance measured at those terminals if the voltage source is replaced with a short circuit (a wire)
http://hyperphysics.phy-astr.gsu.edu/hbase/electric/thevenin.html

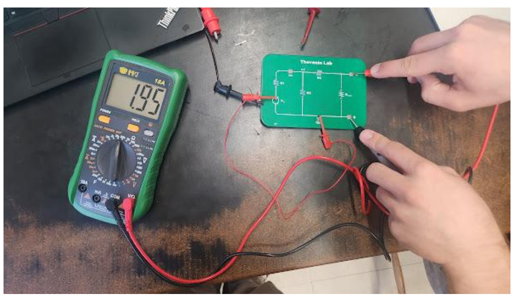
Motivation for experiment

The motivation for this experiment was to become familiar with the soldering equipment, and use it to solder resistors and header pins to the circuit board. After doing so, we can then use the new circuit and supply power to it, and measure the voltages and resistance, and compare them to our own calculations based on thevenin's theorem.

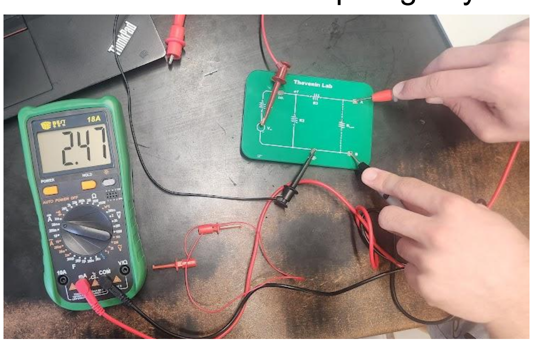
1) **Experimental diagram**

Experimental Diagram (drawing + PICTURE with labels) (How did you measure?)

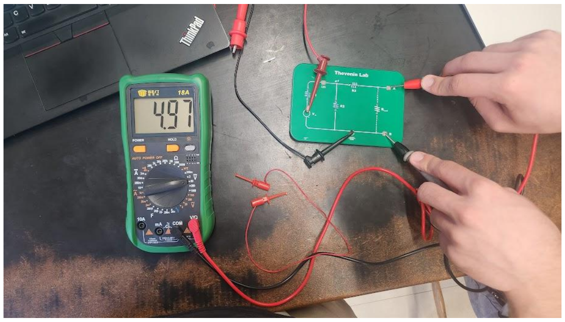
Measured Thevenin Resistance by measuring the resistance across the terminals with the voltage source replaced with short circuit



Measured Thevenin amperage by measuring the current across the 2 terminals



Thevenin Voltage measured by measuring voltage across the terminals



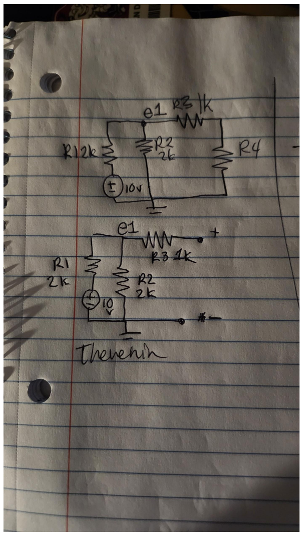


Table - Thevenin measurements

	Measured	Calculated	% error	Formula
Thevenin Voltage	4.97 Volts	5 v	.6%	$V_{out} = V_{in}[\frac{R_2}{R_1+R_2}];\ 10[\frac{2k}{2k+2k}] = 5$
Thevenin Current	2.47 mA	2.5 mA	1.2%	$I = \frac{V}{R};\ \frac{5}{2000} = .0025A = 2.5mA$
Thevenin Resistance	1950 Ohms	2000 Ohms	2.5%	$r = R_3 + \frac{R_1R_2}{R_1+R_2};\ 1k + \frac{2k*2k}{2k+2k} = 2k$

Analysis for calculations

All of the work for our calculations are included in the table. Our calculations were accurate, the largest error only being 2.5%. Our voltage calculation was 5V, which compares well to the measured 4.97V. The measured current was 2.47mA, which checks well with our calculation of 2.5mA. And lastly, our calculated resistance was only 50 Ohms higher than the measured resistance. The calculated 2000 Ohms versus the measured value of 1950 Ohms is a 2.5% error, which is small enough to verify that Thevenin's theorem was indeed accurate.

2) **Experimental diagram**

Refer to previous drawings

TABLE – Load resistance for maximum power transfer

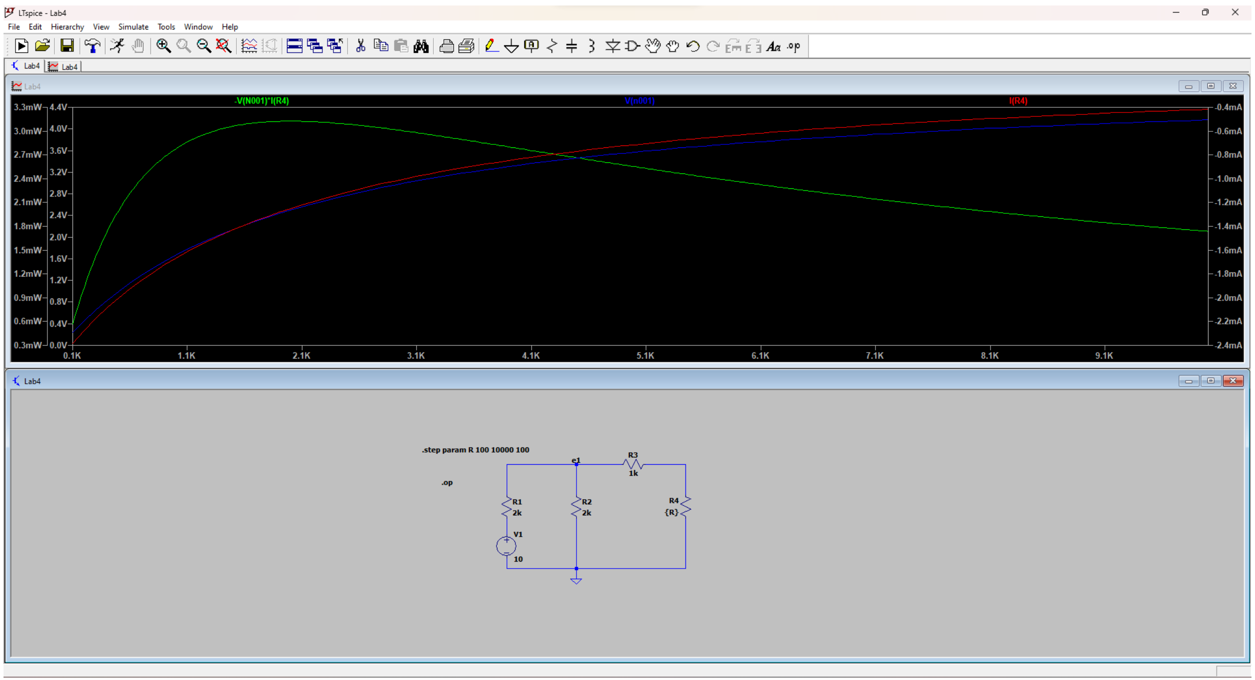
Maximum Power Transfer	Formula	Value
Calculated	$(0.00125A)^2 \times Rth$ (Rth = 2000 Ohms)	0.003125 W
Measured	$(0.001247A)^2 \times Rth$ (Rth = 1950 Ohms)	0.003032 W
Percent error	2.96% error	<<<<

Analysis (show your work for calculations)

The work for our calculations is provided in the table. Maximum power transfer can be calculated by squaring the current between node A and node B, then multiplying by the Rth value of the circuit. The maximum power transfer theorem states that there is 0.003125 Watts of power dissipated through the R load resistor

SPICE Simulation diagram

PLOT - SPICE Simulation



Analysis

In this simulation, the values in the simulated circuit are mirroring real life, except to test the calculated thevenin values and load resistance for maximum power dissipation. As is reflected in the simulation graph, the maximum power dissipation is the same at around 3 mW or .003 W, at this value, the resistance is 2k Ohms and the current across the resistor is 2.5 mA, exactly as calculated and measured

Conclusion – Summarize ALL main results. Quantitatively compare results and calculations and discuss sources of error and uncertainty

In this lab, we were successfully able to solder resistors and header pins to a circuit and use it to confirm Thevenin's theorem. Supplying power to the circuit, we were able to calculate the Thevenin voltage (5V), the Thevenin current (2.5mA) and the Thevenin resistance (2000 Ohms). These values compared well to the measured values read by the power supply, the largest error only being 2.5% under our calculated values. The measured values included a Thevenin voltage of 4.97V (0.6% error), a Thevenin current of 2.47mA, (1.2% error) and a Thevenin resistance of 1950 Ohms (2.5% error) Some of this error could result from the tolerance in resistors (usually 5%), a loose connection between the power supply and the circuit board, or error by hand while connecting the two nodes in a closed loop. Nonetheless, these values are close enough to conclude that Thevenin's theorem can be applied to this circuit.

For power dissipation, our measured vs calculated values were also slightly different, but still very close. This was expected because none of the measured values were exact to our calculations. The calculated power value came to be 0.003125 W, where the measured power was 0.003032 W. This leaves us with a 2.96% error (within tolerance of the resistor) . The power value means that a fraction of a watt is the power dissipated by the resistor.