Engineering 65 - Circuit Theory

ID no. 100340871

Lab no. 5

“Thévenin Equivalent Circuit”

Lab Report By:

Hao Dinh Mai, Edwardo Aguilar

ID no. 100248784, 100363502

Professor

Pinto De Castro

TA

Derek Hollenbeck

Section

Friday 9:00 am - 11:50 am

Date

October 14, 2022

Fall 2022

Objective

The mission statement of this lab is to understand the Thevenin equivalent theorem both in terms of mathematical and circuitry analysis. For the purpose of this lab, the focus are to examine complex circuits, assemble these models, apply Thevenin equivalent formula to compute for voltage and resistance in respect to desired terminals of the circuits models; ultimately, engaging in the measurement of the circuit model with the application of the thevenin theorem via introducing resistance load to the circuit to conceive the thevenin resistance, voltage and current from within the circuit. Thus, in hindsight, the collected measured data and computed theoretical values once compared should align in close proximity to each other.

Introduction

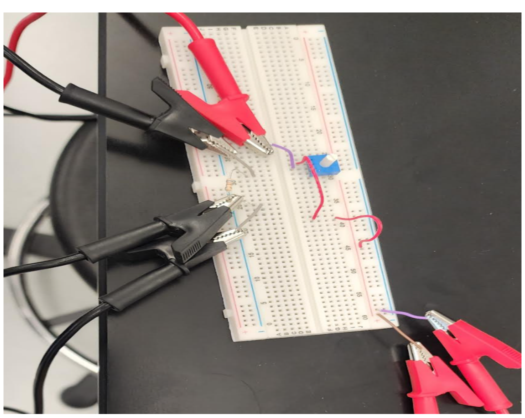
This lab is a deep dive into the Thevenin theorem from circuit analysis. The theory proposed that one may be able to compute the current and voltage present at an element of a circuit without the need to apply extensive mathematical theorems. The idea is to replace any terminal reference point with an equivalent thevenin circuit with resistance in series with the power supply, which we can then apply the formula to find the thevenin equivalent voltage via $V_{rh} = V_s(R3/R1+R3)$, then we shall compute for the resistance of the load which is defined as $R_{th} = (R1*R3/R1+R3)+R2$. Furthermore, beyond the theory, the interactivity of the lab consists of constructing the models of circuits from the lab instruction for the purpose of actual measurement to compare the proximity between the theoretical and measured values.

Method and Procedure

First located the 470 Ohm, 680 Ohms, 1kOhm, 2.2 kOhm, 3.3 kOhm and 5.6 kOhm. Then ensure that the following items are 2 digital multimeter and power supply, a breadboard and cables and wires for connecting the circuit. The first circuit will be divided into three loops, the first region is the biggest which the second and third region of circuit will bind to. The first region will have a 10V, v2, power source in series with the R5 resistors. Now, for the second region, there exists, R3 in parallel to R5, to the left bottom is R1 which is connected to the ground, and on the right is a power source of 15 V,v1, which lies in the middle of the first and second region. The third region following the divider of 15V in series of R4 in parallel to the first region voltage source, and enclosing the third region is R2 with 1kOhms resistance. Extending from the third region of the circuit will be two wires representing terminal A and terminal B. Then, power supply should be introduced into the circuit at v1 will be applied 15V while V2 will be applied 10 V. Next, we shall introduce a 680 Ohms resistance acting as the load to the circuit. Terminal A and B will alternatingly be left open for the measurement of the corresponding terminal. Then we shall remove the load from the circuit and measure the voltage between terminal A and B which in accordance to the thevenin theorem V_ab is equivalent to the thevenin voltage. One complete, the next phase prompts that while the circuit load is still removed, we will then short circuit between the terminal with a wire and measure the Thevenin resistance using the multimeter.

The last procedure of the lab consists of constructing a series circuit with the voltage source and resistance as the thevenin voltage and resistance derived from the previous lab procedure while still maintaining the load as 680 ohms. Hence, using the breadboard, we introduced the terminals with wires via purple and brown shown in the picture, the power will lead into the potentiometer. Within the potentiometer exists three terminals which acts as a slider mitigating current or allowing more current flow. Additionally, connected to the first terminal is a wire that will lie in series to the introduced voltage source while another wire will be connected to the second terminal of the potentiometer which will also lay in series with the load with another wire introducing a power source into the circuit. Now, using the multimeter connect it to the circuit to measure the current in which turning the potentiometer will match the reference resistance of the R_th value. Then we will take the measurement for both the voltage and current from the circuit and compare it with our recorded values from above which we will account for the percentage in errors.

Results and Data Discussion



(which was obtained during preliminary lab work)

	Theoretical Value*	Measured Value
Voltage v_{AB}	337.18 mV	375 mV
Current (in the load resistance $RLoad$)	554.68 uA	464 uA

	Theoretical Value*	Measured Value
Voltage $v_{AB} = V_{Th}$	706.82 mV	698 mV

	Theoretical Value*	Measured Value
R_{Th}	594.27 ohms	586 ohm

- Measure the voltage across and current flowing through the loa

Voltage = 698 mV
Current = 400 uA

culate the percent difference between the voltage and current for the
ginal circuit vs equivalent circuit). Explain the difference.

Voltage % difference = 1.13%
Current % difference = 27.798 %

Data summary

For the first part of the lab, we consider the circuit given for analysis by first applying the mesh analysis to find all the current that exists within the circuit. There is three region which indicates three loops, for the first loop, we derived 470I1 +5.6(I1-I3)+15 = 0, for loop 2 we got -15+3.3K(I2-I33)+1KI2 = 0, and loop 3 will equates to 3.3(I3-I2) + 5.6K(I3-I1)+2.2KI3+10=0. Through simplification, and applying them to a matrix, we derived the current as -15, 15, and -10. Plugin the resolve from matrix into the equation for KVL will will have the current value which applied with the thevenin voltage formula, V_th = I2*R2 we know that V_th is 0.7062 V.

By simplifying the current, we can derive Rth as 594 ohms and by using the Thevenin current formula, Vth /(Rth+RL) we derived the value 0.554 mA. For the comparison of our data it seems that the data recorded and measured are in close proximity to each other with the margins of less than 2%. However, the issue is confronted when we build the second model to resemble the first circuit using the known thevenin current and voltage values. During the measurement process, though, Thevenin voltage data recorded compared to the theoretical complies with an error margin of one percent. Nonetheless, the current that we measured is 27 % in errors no matter the adjustments that were made to the circuit. I believe the error could have been contributed to the multimeters decimal displacement error. As we asked our TA for advice in regards to correction of the error margin, we used another multimeter within the lab to measure the current which used varying values such as 400, 500 and 650 uA.

Conclusion

Conclusively, this lab has demonstrated the implementation and theoretical analysis of the thevenin theorem by interactive construction of circuit models, applying the thevenin formula to find the thevenin resistance, current and voltage by mesh analysis, and then ultimately thevenin properties to convert the current derived values into desired thevenin variable. The depth of the lab was fully explored with all the criteria suffice via modeling for the circuit, finding the thevenin voltage by applying mesh analysis to find both current and voltage, and by the the formula explained with the data summary - we will be able compute the theoretical numbers to which our interactive experiment will use as reference. From the exemplification of our circuit model and the data that is collected all measured data collected aligns. One exception has been mentioned before is the voltage error margin between the theoretical thevenin and the measured values which we could address by employing a reliable multimeter to substantiate our lab data.