ECEN 214-301 – Electric Circuit Theory

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Summer 2020

Lab 3: Equivalent Networks and Superposition

**Submitted by:**

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| **Table 1.** UIN, names, and section numbers. | | | |
| **Student Name** | **UIN** | **Section #** | **Group #** |
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**Date Performed: June 9th, 2020**

**Due Date: June 21th, 2020**

**TA : Chen Gong**

I. Objective

The purpose of the experiment is to understand how to create a Thevenin circuit and to see how voltage measurements when two different sources are swap in and out from a circuit using superposition. This process will show how to use superposition to find the voltage of a given element.

II. Procedure

Materials Required

* Two 1.5V batteries 3 -- 1.0 kΩ resistors
* ¼ W 2 --2.0 kΩ resistors
* ¼ W 1 -- 3.3 kΩ resistor
* ¼ W 2 --5.1 kΩ resistors
* ¼ W 1 -- 1N4148 diode A selection of colored 24 gauge connection wires
* at least 7 strands

Steps

Task One: Verify Thevenin’s Equivalent

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1. Construct circuit shown in **Figure 3.4** in lab 3 onto the breadboard.
2. Measure the voltage constructed from the two battery sources in series.
3. Select two resistors that are not equal to 2kΩ.
4. Place the two resistors where the load resistor gets connected and measure the load voltage using the voltmeter.
5. Place the 2kΩ resistor at the load resistor connection and measure the load voltage using the voltmeter.
6. Calculate the Thevenin equivalent circuit using the measurements at step 4.
7. Predict the load voltage for the 2kΩ using the Thevenin circuit derived.
8. Discuss differences between the theoretical load voltage and the

Task Two: Verify the Superposition Principle

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1. Construct the circuit shown in **Figure 3.5** in lab 3 onto the breadboard.
2. Measure the voltage on the 1kΩ resistor and record.
3. Remove the 3V voltage source and replace with wire and measure the voltage against the 1kΩ resistor.
4. Record measurement into notebook.
5. Place 3V source back into original position and connections on breadboard.
6. Take out the 4V source and replace with wire.
7. Measure the voltage against the 1kΩ resistor.
8. Record the measurement into notebook.

Task Three: Check the Superposition Principle Validity for a non-linear Device

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1. Take out the diode to be used in the circuit.
2. Construct circuit shown in **Figure 3.6** in lab 3 onto the breadboard.
3. Keeping both sources in the circuit measure the voltage across the 1kΩ resistor.
4. Take out the 3V source and replace the connections with a wire.
5. Measure the voltage across the 1kΩ resistor.
6. Place the 3V source back into the circuit.
7. Take out the 4V source and replace the connections with a wire.
8. Measure the voltage against the 1kΩ resistor.
9. Record the measurement into the notebook.

III. Difficulties

One of my batteries that were previously in the battery holder were dead, so I replaced it with one of my spare batteries.

IV. Results

Equations:

Task One

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| --- | --- | --- | --- | --- | --- |
| **Table 1.** Task One Measurements | | | | |  |
| Load Resistance(Ω) | Load Voltage(V) | (V) |  | (mA) |  |
| 5,000 | 1.10 | 1.6 | 2,170 | 0.39 | 0.767 |
| 3,000 | 0.876 |
| 2,000 | 0.786 |

NOTE: I chose resistor value with the same difference from the other in case of graphing it would be easier to see the relationship.

**How I found the Thevenin?**

I found the Thevenin voltage by rearranging the voltage divider formula to find the Thevenin voltage. Then I plug in the already found Thevenin R and load voltage and load resistance into the formula to find the Thevenin voltage. Do this for both the 5kΩ and the 3kΩ then find the average Thevenin voltage. To find the Thevenin resistance I had to replace the source with a short then solve to find the Equivalent resistance leaving the load resistor alone.

Task Two

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| --- | --- |
| **Table 2.** Task Two Measurements | |
| V1 v.s V2 | 1kΩ Voltage(V) |
| Both | 0.258 |
| V1 | -0.284 |
| V2 | 0.543 |

**Does superposition apply to this circuit?**

Yes, superposition applies to the circuit because the total voltage after adding the voltage with only V1 and only V2 is the same voltage as with both sources.

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| **Table 3.** Theoretical v.s actual v.s simulated voltages | | | | | |
| Sources | Measured 1kΩ Voltage | Calculated 1kΩ Voltage | % Difference | Spice 1kΩ Voltage | % Difference(Spice and Measured) |
| Both | 0.259 | -0.25 | 4.07 | -0.26 | 0.384 |
| V1 | -0.283 | 0.27 | 2.07 | 0.26 | 9.4 |
| V2 | 0.543 | -0.56 | 3.04 | -0.56 | 3.04 |

Task Three

|  |  |
| --- | --- |
| **Table 4.** Task Three Measurements | |
| V1 v.s V2 | 1kΩ Voltage(V) |
| Both | 0.002 |
| V1 | -0.145 |
| V2 | 0 |

**Does superposition apply to this circuit?**

No, superposition does apply because the total voltage added together from only V1 and only V2 does not equal the same as the voltage with both sources in. The diode did not allow for the non-restricted flow of current on one direction and current is what caused voltage across resistors. Therefore, the diode is the factor that didn’t allow for the superposition principle.

Conclusion

Task one proved that a Thevenin equivalent with combination of the voltage divider equation can be used to predict accurate measurements. The very low difference between the calculated and measured values for task one proves the equation true. Task two shows the principle of superposition by measuring the voltage of the 1 kilo-ohm resistor with and without one source and the voltages added together is equal to the voltage with both sources in therefore the superposition applies to the circuit. Task three is the same process of Task Two but with a diode added but in this case superposition doesn’t apply because the diode restricts the movement of current in one direction.