

**CPE 1140**

**Circuits / DC Circuit Fundamentals Lab**

**Fall 2021**

Laboratory Report

Lab# 5

Superposition Circuit Analysis

Submitted by: Bruce Liu

Laboratory Date: 10/14/2021

Date of Submission: 10/18/2021

# Prelab:

# Diagram, schematic Description automatically generated

Superposition circuit 1:

Resistor reduction:

R4 + R3 = 1620Ω

R 4+3 || R2 = 1620\*2000/2000+1620 = 895.027Ω

Rth = R 1+ (4+3||2) +5 = 470 + 895.027 +510 = 1875.027Ω

Diagram, calendar

Description automatically generated

Thevenin equivalent circuit:

Vth / Rth = Is

Is = 2.666

This is also the value of I r1 and I ­r5

Current divider:

I target = R other / R ­sum \* I­ source

I­ 3+4 = 2000/3620 \*2.666 \*10­-3

I­ 3 and 4 = 1.472 mA

I­ 2 = 1620/3620 \*2.666 \*10­-3

I­ 2 =1.193 mA

**Diagram

Description automatically generated**

Superposition circuit: 2

Resistor reduction

R1 + R5 = 470 + 510 = 980Ω

R1+5 || R2 = 980\*2000/2980 = 657.718Ω

Rth = R3 + R 1+5 || 2 R5 = 620+657.718+1000 = 2277.718Ω

Thevenin circuit:

Diagram

Description automatically generated

V­th/Rth = 6.585 mA = I R3 =I R4

Current divider

I target = R other / R ­sum \* I­ source

I r1 & r5 = 2000/2980 \* 6.585 \* 10-3

I r1 & r5 = 4.419 mA

I r2 = 980/2980 \* 6.585 \* 10-3

I r2 = 2.165 mA

Diagram

Description automatically generated with low confidence

Full superposition circuit and assumed current directions

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Circuit current label | Circuit 1 (mA) | Circuit 2 (mA) | sum of currents(mA) | Superposition circuit (mA) |
| I r 1 | 2.666 | 4.419 | -2.666 + 4.419 | 1.753 |
| I r 2 | 1.193 | 1.732 | 1.193 + 2.165 | 3.358 |
| I r 3 | 1.472 | 5.268 | -1.472 + 6.585 | 5.113 |
| I r 4 | 1.472 | 5.268 | -1.472 + 6.585 | 5.113 |
| I r 5 | 2.666 | 4.419 | 2.666 - 4.419 | 1.753 |

# Lab data:

Note: I redid this in my home lab.

Initial data:

|  |  |  |  |
| --- | --- | --- | --- |
| Resistor label | Resistor value (Ω) | Resistor measured (Ω) | Resistor range(Ω) |
| R1 | 470 | 463.5 | 446.500 – 493.500 |
| R2 | 2000 | 1965 | 1900.000-2100.000 |
| R3 was not in inventory so 2 resistors in series | 620(intended) = 68+550 = 618 | 612.1 | 589.00 – 651.000 |
| R3s1 | 68 | 67.6 | 64.600-71.400 |
| R3s2 | 550 | 544 | 522.500-577.500 |
| R4 | 1000 | 988 | 950.000-1050.00 |
| R5 | 510 | 500.0 | 484.000-535.500 |

R1

Graphical user interface

Description automatically generated with medium confidence

R2

Graphical user interface, text, application

Description automatically generated

R3 series

Graphical user interface, application

Description automatically generated

R3s1

Graphical user interface

Description automatically generated with medium confidence

R3s2

A picture containing logo

Description automatically generated

R4

Graphical user interface

Description automatically generated

R5

Graphical user interface, application

Description automatically generated

|  |  |  |
| --- | --- | --- |
| Voltage label | Voltage intended(V) | Voltage measured(V) |
| V1 | 5 | 5.0044 |
| V2 | 15 | 15.009 |

V1

Graphical user interface

Description automatically generated

V2

Graphical user interface, text, application

Description automatically generated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Circuit current label | Circuit 1 (mA) | Circuit 2 (mA) | sum of currents(mA) | Superposition circuit calculated(mA) | Superposition circuit measured(mA) |
| I r 1 | 2.709 | 4.501 | -2.709 + 4.501 | 1.800 | 1.785 |
| I r 2 | 1.215 | 2.207 | 1.215 + 2.207 | 3.422 | 3.421 |
| I r 3 | 1.493 | 6.707 | -1.493 + 6.707 | 5.214 | 5.207 |
| I r 4 | 1.493 | 6.707 | -1.493 +6.707 | 5.214 | 5.206 |
| I r 5 | 2.708 | 4.501 | -2.709 + 4.501 | 1.800 | 1.785 |

Circuit 1:

I r 1

# A picture containing graphical user interface Description automatically generated

I r 2

Graphical user interface

Description automatically generated with medium confidence

I r 3 & r 4

Graphical user interface

Description automatically generated with medium confidence

I r 5

A picture containing graphical user interface

Description automatically generated

Circuit 2:

I r 1 & r 5

Graphical user interface

Description automatically generated

# I r 2

Graphical user interface

Description automatically generated with medium confidence

I r 3

Graphical user interface

Description automatically generated with medium confidence

I r 4

A picture containing graphical user interface

Description automatically generated

Superposition circuit:

I r 1

Text

Description automatically generated with low confidence

I r 2

A picture containing graphical user interface

Description automatically generated

I r 3

Graphical user interface

Description automatically generated with medium confidence

I r 4

A picture containing graphical user interface

Description automatically generated

I r 5

Graphical user interface

Description automatically generated with medium confidence

Lab multimeter data:

Graphical user interface, application, table

Description automatically generated

Analysis:

|  |  |  |  |
| --- | --- | --- | --- |
| Resistor label | Resistor value (Ω) | Resistor measured (Ω) | Resistor range(Ω) |
| R1 | 470 | 463.5 | 446.500 – 493.500 |
| R2 | 2000 | 1965 | 1900.000-2100.000 |
| R3 was not in inventory so 2 resistors in series | 620(intended) = 68+550 = 618 | 612.1 | 589.00 – 651.000 |
| R3s1 | 68 | 67.6 | 64.600-71.400 |
| R3s2 | 550 | 544 | 522.500-577.500 |
| R4 | 1000 | 988 | 950.000-1050.00 |
| R5 | 510 | 500.0 | 484.000-535.500 |

|  |  |  |
| --- | --- | --- |
| Voltage label | Voltage intended (V) | Voltage measured(V) |
| V1 | 5 | 5.004 |
| V2 | 15 | 15.009 |

Prelab data:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Circuit current label | Circuit 1 (mA) | Circuit 2 (mA) | sum of currents(mA) | Superposition circuit (mA) |
| I r 1 | 2.666 | 4.419 | 2.666 + 4.419 | -1.753 |
| I r 2 | 1.193 | 1.732 | 1.193 + 2.165 | 3.358 |
| I r 3 | 1.472 | 5.268 | -1.472 + 6.585 | 5.113 |
| I r 4 | 1.472 | 5.268 | -1.472 + 6.585 | 5.113 |
| I r 5 | 2.666 | 4.419 | 2.666 + 4.419 | -1.753 |

Lab measurements:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Circuit current label | Circuit 1 (mA) | Circuit 2 (mA) | sum of currents(mA) | Superposition circuit calculated(mA) | Superposition circuit measured(mA) |
| I r 1 | 2.709 | 4.501 | 2.709 - 4.501 | -1.800 | -1.778 |
| I r 2 | 1.215 | 2.207 | 1.215 + 2.207 | 3.422 | 3.421 |
| I r 3 | 1.493 | 6.707 | -1.493 + 6.707 | 5.214 | 5.207 |
| I r 4 | 1.493 | 6.707 | -1.493 +6.707 | 5.214 | 5.206 |
| I r 5 | 2.708 | 4.501 | 2.709 - 4.501 | -1.800 | -1.782 |

Multisim data:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Circuit current label | Circuit 1 (mA) | Circuit 2 (mA) | sum of currents(mA) | Superposition circuit calculated(mA) | Superposition circuit (mA) |
| I r 1 | 2.666 | 4.42 | 2.666-4.42 | -1.754 | -1.753 |
| I r 2 | 1.193 | 2.164 | 1.193+2.164 | 3.357 | 3.359 |
| I r 3 | 1.473 | 6.589 | -1.473+6.589 | 5.116 | 5.113 |
| I r 4 | 1.473 | 6.587 | -1.473+6.589 | 5.116 | 5.112 |
| I r 5 | 2.666 | 4.42 | 2.666-4.42 | -1.754 | -1.753 |

Conclusion:

After redoing the lab and prelab calculations, the results mostly match. Redoing the lab, I still had issues with signs. Even in Multisim it was annoying. There must be a better way to go. Some issues were user error on what direction to measure current. All my resistors were lower than the specified values; but are in the specification range. Therefore, all my current values were slightly higher. Also, the voltage is also slightly higher than intended which can also contribute to the slightly higher current. I cannot say that superposition can be confirmed or not. Due to the high probability for human error. Error cannot submit Multisim file due to file type restriction.

I learned that this may be a bad circuit to implement in real life. Might be a situation of error. So, if I am hooking up a source and are getting values lower than intended it might be a superposition circuit situation. I learned that I could copy and paste a column of calculations for power shell to calculate. I learned I need to remake my workspace if I am to do screen shots for circuit measurements since I needed to stand up each time I measured. I learned my 3045x Siglent multimeter can export to excel files. If only if I can figure out how to get it to take a single measurement rather than hundreds per second.

appendix:

Multisim simulation screen shots:

Circuit 1:

Diagram

Description automatically generated

Circuit 2:

Diagram, schematic

Description automatically generated\

Superposition circuit:

Diagram

Description automatically generated

Home circuit photo:

A picture containing text, indoor

Description automatically generated