EETC 111 LAB "NOTEBOOK"

MORGUN J. WERLING

Fall semester, 2017

Instructor: DR. ANDREW BELL PHD

PRELUDE

- MESSAGE TO INSTRUCTOR:

ALTHOUGH IN OUR DISCUSSION ABOUT THE EXPECTATIONS OF THIS "NOTEBOOK" YOU MENTIONED THAT A PDF COPY OF A PHYSICAL NOTEBOOK/BINDER WOULD BE ACCEPTABLE, I DECIDED TO MAKE A SLIDESHOW AS YOU EXPRESSLY REQUESTED.

- **NOTE:**
  - **ON THE NOTE THAT YOU MADE ABOUT "SUBMITTING WHAT YOU WOULD GIVE TO YOUR BOSS IN A PRODUCTION SETTING". WORKING IN PRODUCT DEVELOPMENT FOR AMERICAN COACH/FLEETWOOD/REV I HAVE TROUBLE WITH THIS STATEMENT. THIS IS BECAUSE IF I WERE TO GIVE MY BOSS A SLIDESHOW FOR A PRODUCT APPROVAL OR PRODUCT DETAIL, I WOULD BE FIRED. I MEAN NO DISRESPECT BY THIS STATEMENT, I SIMPLY WANTED TO CONVEY MY FEEDBACK ON THIS ASSIGNMENT—IN MY OPPINION, IF A DIGITAL NOTEBOOK IS PREFERED, A SCANNED COPY OF A PHYSICAL NOTEBOOK, OR A PDF VERSOION OF A NOTEBOOK(EBOOK STYLE) WOULD BE A BETTER OPTION, NOT ONLY WOULD THESE FORMATS PRESENT INFORMATION IN A MORE CONCISE WAY, IT WOULD ALSO SAVE TIME FOR BOTH THE STUDENTS AND INSTRUCTOR.**
  - **MY USE OF ALL CAPS IS MY WAY OF KEEPING WITH THE "PRODUCTION SETTING" SCHEME. I WAS ALWAYS TAUGHT THAT ALL PRODUCTION PRINTS/DOCUMENTS SHOULD BE IN CAPITAL LETTERS. IN MY LIMITED EXPERIENCE (A LITTLE OVER A YEAR) IN PRODUCT DEVELOPMENT, I FOUND THIS TO BE TRUE, I HAVE A HARD TIME BREAKING THE HABIT OF STANDARD CAPITALIZATION, AND HOPE THAT YOU FORGIVE ME FOR MIXED USAGE IF ANY IS FOUND. WITH THAT SAID, ANY TEXT COPIED FROM THE WORKSHEETS IS IN THE FORMAT USED IN THE WORKSHEET, AND FOR EASE OF READING, THE OBSERVATIONS ARE ALSO IN STANDARD CAPITALIZATION.**

LAB 1- RESISTOR VARIABILITY

9-7-17

Lab 1 –Resistor Variability

Lab 1 –Resistor Variability

Names: MORGUN WERLING ; BRETT BARNETT
Date: 7 September 2017

The purpose of this lab is to:
Learn the how resistors vary using 20 resistors with the same color code.

Select a set of 20, 1 kohm resistors.
Measure and record the resistance of each resistor.
Equipment needed:
1 – Digital Multimeter
1 – 20 resistors with the same color code.

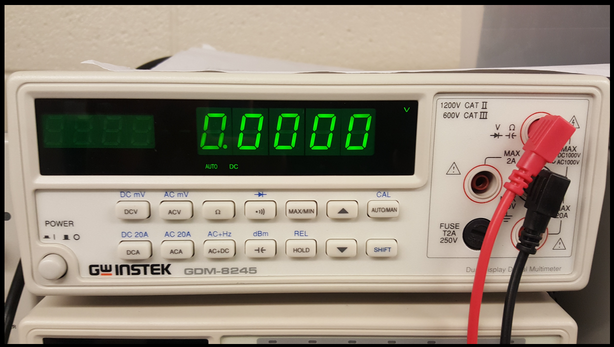


FIGURE 1:MULTIMETER USED

Lab 1 –Resistor Variability

DATA

Sample	Measured value (Ω)
1	982.3
2	986.8
3	983.5
4	980.2
5	979.5
6	1005.1
7	982.0
8	978.9
9	978.0
10	980.5
11	983
12	981.5
13	991.7
14	996.4
15	995.7
16	974.4
17	978.1
18	977.2
19	979.4
20	1001.9

Min =	974.4
Max =	1005.1
Mean	984.805
STDEV	8.66982
Nominal Ω	1000
Tolerance	5%
Min value	950
Max Value	1050

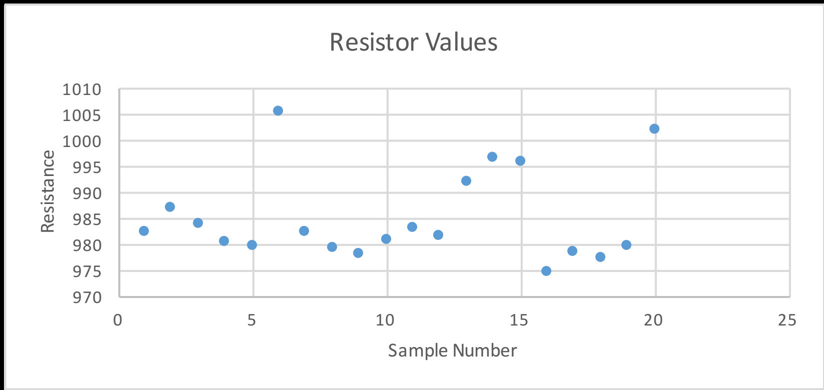


FIGURE 2: CHART OF MEASURED VALUES

Lab 1 –Resistor Variability

Resistor color code = **Brown, Black, Red, Gold**
Resistor value = **1 KΩ**
Resistor tolerance = **±5%**

Using Microsoft Excel plot the resistor values and determine:

Smallest resistance = **974.4 Ω**
Largest resistance = **974.4 Ω**
Average resistance = **974.4 Ω**
Standard Deviation = **8.6698 Ω**

Do any of your resistor values exceed the part tolerance?

NO; ACCEPTABLE RANGE: 950 Ω<X<1050 Ω

OBSERVATIONS:

- **THE MEASURED VALUES WERE TYPICALLY LOWER THAN THE NOMINAL VALUE OF 1000Ω.**

LAB 2- READING AND SORTING RESISTORS

9-7-17

Lab 2 – Reading and Sorting Resistors

Names: **MORGUN WERLING , BRETT BARNETT**
Date: **9-7-17**

The purpose of this lab is to:
Learn the resistor color code using 15 resistors which must be sorted from smallest to largest value. Build a resistor kit that includes 15 resistors and, sort resistors based on color code from smallest to largest and measure the resistance of each resistor and verify sorting

Equipment needed:

1 – Digital Multimeter
1 – 15 unique resistors

FIGURE 1: MULTIMETER USED FOR MEASUREMENTS

DATA & OBSERVATIONS

Observations:

THE MEASURED VALUES OF THE SMALLER RESISTORS WERE TYPICALLY LOWER THAN NOMINAL VALUE, WHILE THE MEASURED VALUES OF THE LARGER RESISTORS WERE TYPICALLY HIGHER THAN NOMINAL.

	Color Code	Measured Value
100 =	Brown, Black, Brown Gold	**98.55 Ω**
220 =	Red, Red, Brown, Gold	**216.95 Ω**
330 =	Orange, Orange, Brown, Gold	**322.73 Ω**
470 =	Yellow, Violet, Brown, Gold	**462.7 Ω**
1K =	Brown, Black, Red, Gold	**990.5 Ω**
2.2K =	Red, Red, Red, Gold	**2.16 KΩ**
3.3K =	Orange, Orange, Red, Gold	**3.27 KΩ**
4.7K =	Yellow, Violet, Red, Gold	**4.73 KΩ**
10K =	Brown, Black, Orange, Gold	**9.72 KΩ**
22K =	Red, Red, Orange, Gold	**22.25 KΩ**
33K =	Orange, Orange, Orange, Gold	**33.17 KΩ**
47K =	Yellow, Violet, Orange, Gold	**46.25 KΩ**
100K =	Brown, Black, Yellow, Gold	**99.24 KΩ**
1M =	Brown, Black, Green, Gold	**1.01 MΩ**
10M =	Brown, Black, Blue, Gold	**10.23 MΩ**

LAB 3: SERIES RESISTORS

9-14-17

Lab 3 – Series Resistors
Names: **Morgun Werling, Brett Barnett**
Date: **9-14-17**

The purpose of this lab is to:
Experiment with series circuits and verify that the simulation, analysis (calculations) and test results all agree.

From the resistor kit select 3 resistors (10K, 2.2K, 4.7K)

Measure and record the value of each resistor. Connect the resistors as shown in Figure 1. Measure and record the total resistance, RT. Then connect the resistors as shown in Figure 2, the 9V come from the Elvis II (Modular Engineering Educational Laboratory Platform). Then measure and record with the Digital Multimeter the current and voltages of the series circuit.

Equipment needed:

1 – Digital Multimeter
1 – Elvis II
3 – resistors.

Lab 3 – Series Resistors

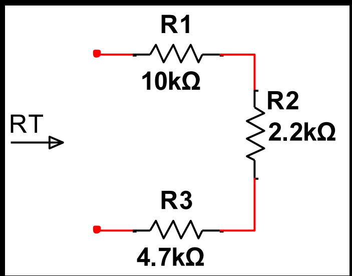


Figure 1: WORKSHEET IMAGE

	Measured	Calculated	Simulated
R1 =	**9.734kΩ**	**10kΩ**	**10kΩ**
R2 =	**2.1563kΩ**	**2.2k Ω**	**2.2kΩ**
R3 =	**4.6304kΩ**	**4.7kΩ**	**4.7kΩ**
RT =	**16.528kΩ**	**16.9kΩ**	**16.9kΩ**

Figure 2: WORKSHEET DATA TABLE

Measured = using Digital Multimeter
Calculated = based on color code and Excel values
Simulated = Multisim simulation

Lab 3 – Series Resistors

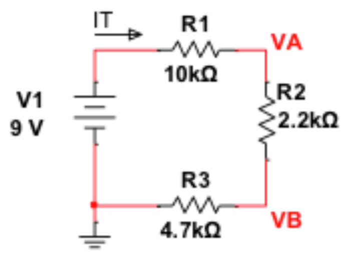


Figure 2

	Measured	Calculated	Simulated
IT =	553.3µA	532.5 µA	532.5µA
V1 =	9.040V	9.000V	9.000V
VA =	3.714V	3.675V	3.675V
VB =	2.533V	2.503V	2.503V

Measured = using Digital Multimeter
Calculated = based on color code and Excel values
Simulated = Multisim simulation

FIGURE 3: WORKSHEET IMAGE 2 & WORKSHEET TABLE 2

Lab 3 – Series Resistors

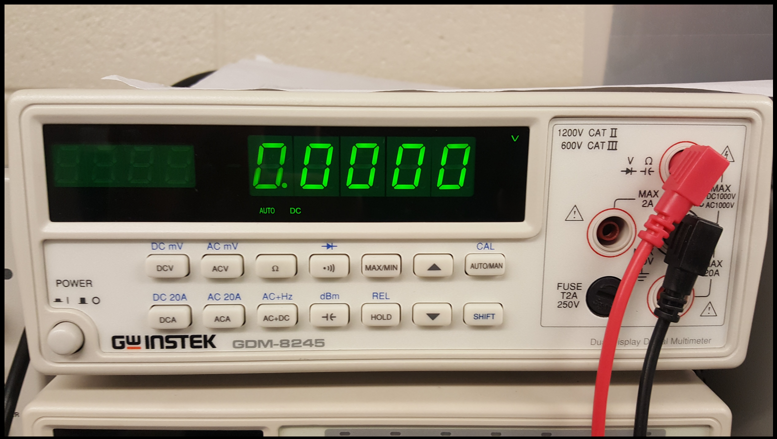


FIGURE 4: MULTIMETER USED

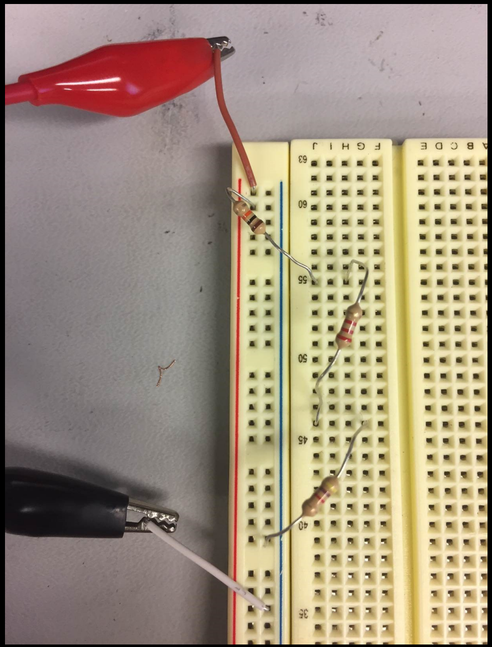


FIGURE 5. COMPLETED CIRCUIT

Observations: The measured values for Voltage were slightly higher than those for the calculated and simulated values, this could be due to the measured initial voltage being .04V higher than the calculated initial voltage; however, it is most likely because the physical resistors were all lower resistance than the nominal value. The physical conductors did not impart enough resistance to offset this difference.

LAB 4 : BLACK BOX DESIGN

9-21-17

Names: **Morgun Werling, Brett Barnett**
Date: **9-21-2017**

The purpose of this lab is to:
Learn about series circuits

The voltage applied to a Black Box is 9V and the measured current draw is 10mA. Design a 3 resistor series circuit that meets the voltage and current requirements using "standard" resistor value.

Equipment needed:
›
1 – Digital Multimeter
1 – Elvis II
3 – Standard Resistors

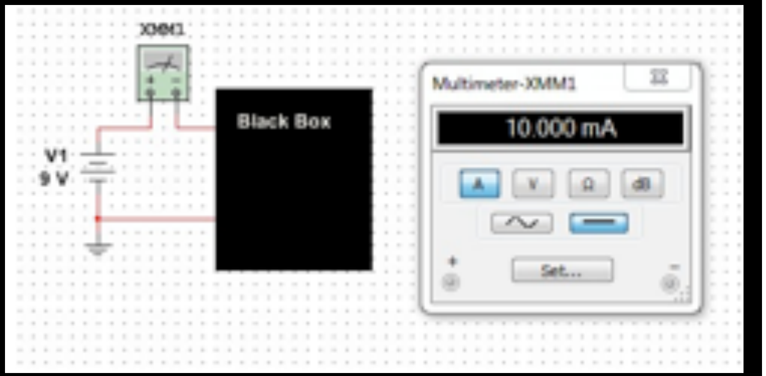


Figure 1?
(was not labeled on worksheet

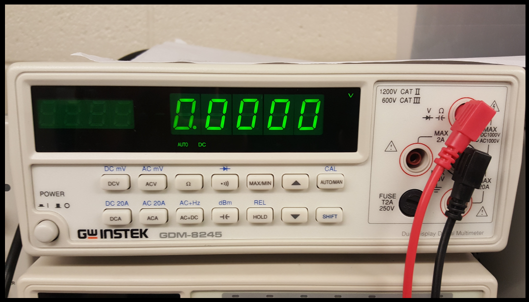


FIGURE 2: DIGITAL MULTIMETER USED

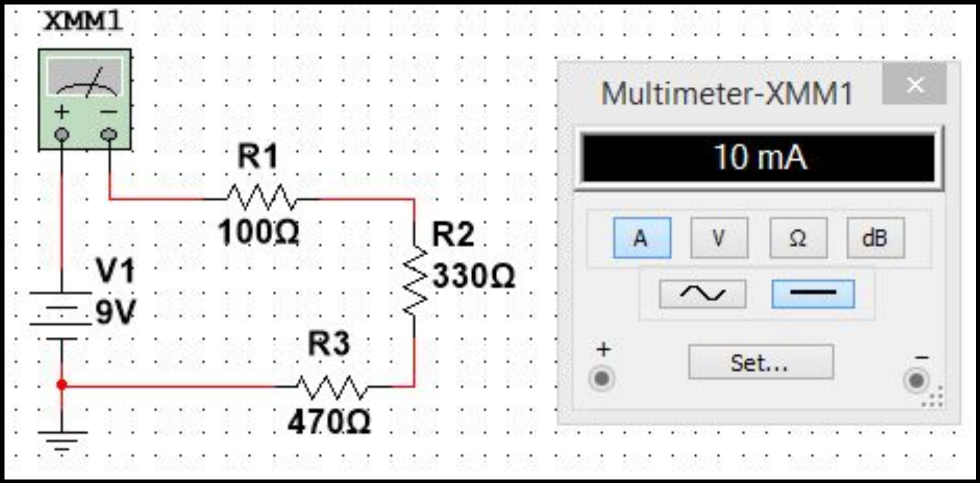


FIGURE 3: SIMULATION IMAGE

DATA

	Design	Measured	Calculated	Simulated
V1 =		**9.055V**	**9V**	**9V**
IT =		**10.064mA**	**10mA**	**10mA**
RT =		**889.2 Ω**	**900Ω**	**900 Ω**
R1 =		**98.56 Ω**	**100 Ω**	**100 Ω**
R2 =		**324.86 Ω**	**330 Ω**	**330 Ω**
R3 =		**465.7 Ω**	**470 Ω**	**470 Ω**

FIGURE 4: WORKSHEET TABLE

Calculated Values: Vt, It and RT	
V1	9
IT	10.0E-3
RT	900.0E+0
R1	100.0E+0
R2	330.0E+0
R3	470.0E+0

FIGURE 5: EXCEL TABLE

OBSERVATIONS

- **Although the measured data varied slightly from the calculated/simulated data, the end result was very close to the desired circuit. The deviations were due to variations in resistance values, as well as the inability to—reasonably—introduce exactly 9v.**
- ***Note: Unexpected energy dissipation most likely did not influence values significantly***

LAB 6: BLACK BOX DESIGN

9-28-17

Names: MORGUN WERLING , BRETT BARNETT
Date: 9-28-17

The purpose of this lab is to:
Learn about parallel circuits

The voltage applied to a Black Box is 9V and the measured current draw is 4.6 mA. Design a 2 resistor parallel circuit that meets the voltage and current requirements using "standard" resistor value.

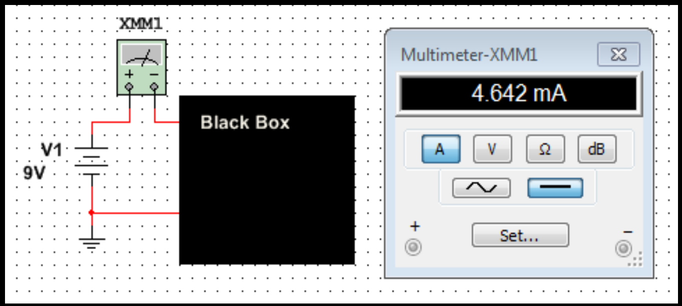


FIGURE 1?
(IMAGE NOT LABELED ON WORKSHEET)

Equipment needed:

1 – Digital Multimeter
1 – Elvis II
3 – Standard Resistors

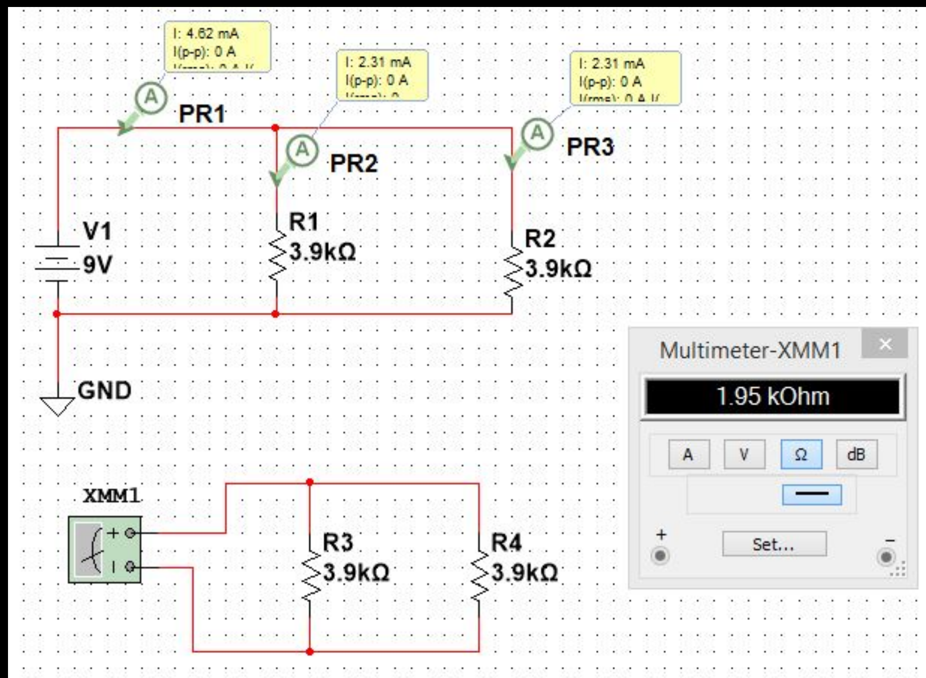


FIGURE 2: SIMULATION IMAGE

DATA

	Design	Measured	Calculated	Simulated
V1 =	9V	9.056	9V	9V
IT =	4.60mA	4.4416mA	4.6mA	4.62mA
RT =	1.956Ω	1.9386Ω	1.95Ω	1.95kΩ
R1 =	3.913kΩ	3.8815Ω	3.90kΩ	3.9kΩ
R2 =	3.913kΩ	3.8694	3.90kΩ	3.9kΩ

FIGURE 3: WORKSHEET SPREADSHEET

deciding resistors to use	
V1	**9**
IT	**4.60E-03**
RT	1.95652E+03
R1	3.91304E+03
R2	3.91304E+03

V1=	9 V
IT=	4.60E-03 A
RT=	1.95E+03 Ω
R1=	3.90E+03 Ω
R2=	3.90E+03 Ω

FIGURE 4: EXCEL SPREADSHEET

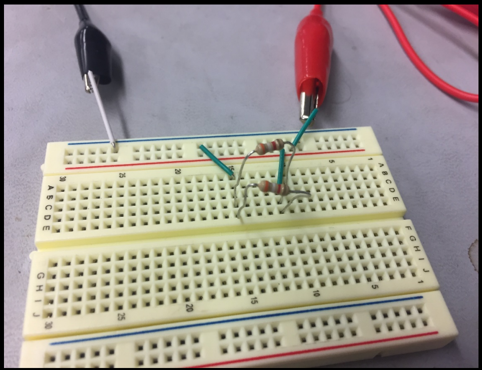


FIGURE 5: CIRCUIT FOR MEASURING RT & IT

OBSERVATIONS

- We noticed that exact values for resistors are more difficult to calculate for parallel circuits, than series circuits. It is much more difficult to get “even” or “whole” values.

LAB 7: 4 RESISTOR PARALLEL CIRCUIT

10-5-17

LAB 7: 4 RESISTOR PARALLEL CIRCUIT

Names: **MORGUN WERLING, BRETT BARNETT**
Date: **10-5-17**
The purpose of this lab is to:
Learn about parallel circuits

The voltage applied to 4 parallel resistors x is 9V. Measure all the resistor values, total current and all the branch currents.

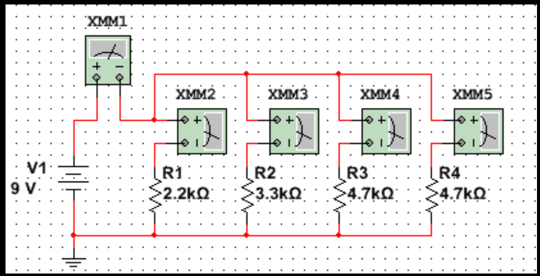


FIGURE 1: WORKSHEET IMAGE

1 – Digital Multimeter
1 – Elvis II
3 – Standard Resistors

LAB 7: 4 RESISTOR PARALLEL CIRCUIT

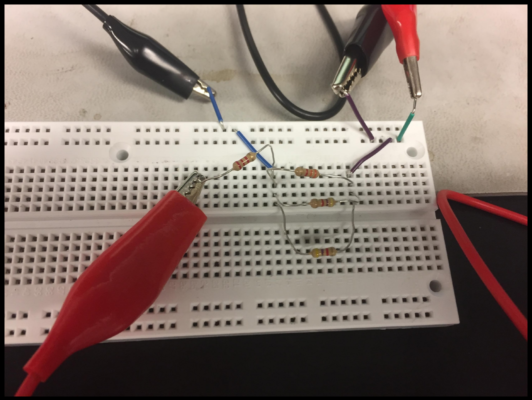


Figure 2: Configuration used to measure total current.

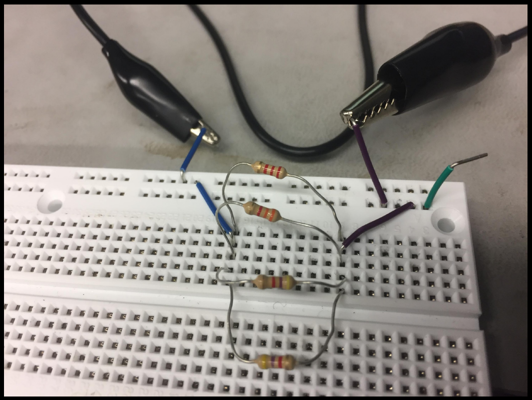


Figure 3: configuration used to measure total resistance

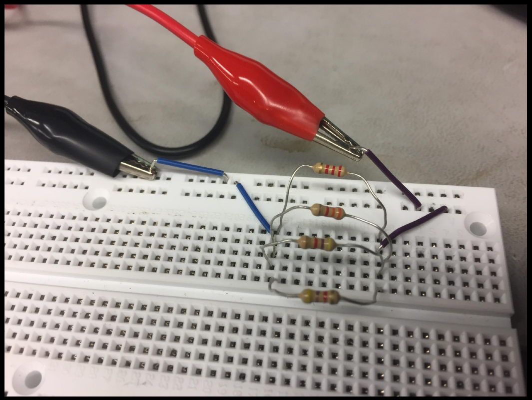


Figure 4: Completed circuit

LAB 7: 4 RESISTOR PARALLEL CIRCUIT

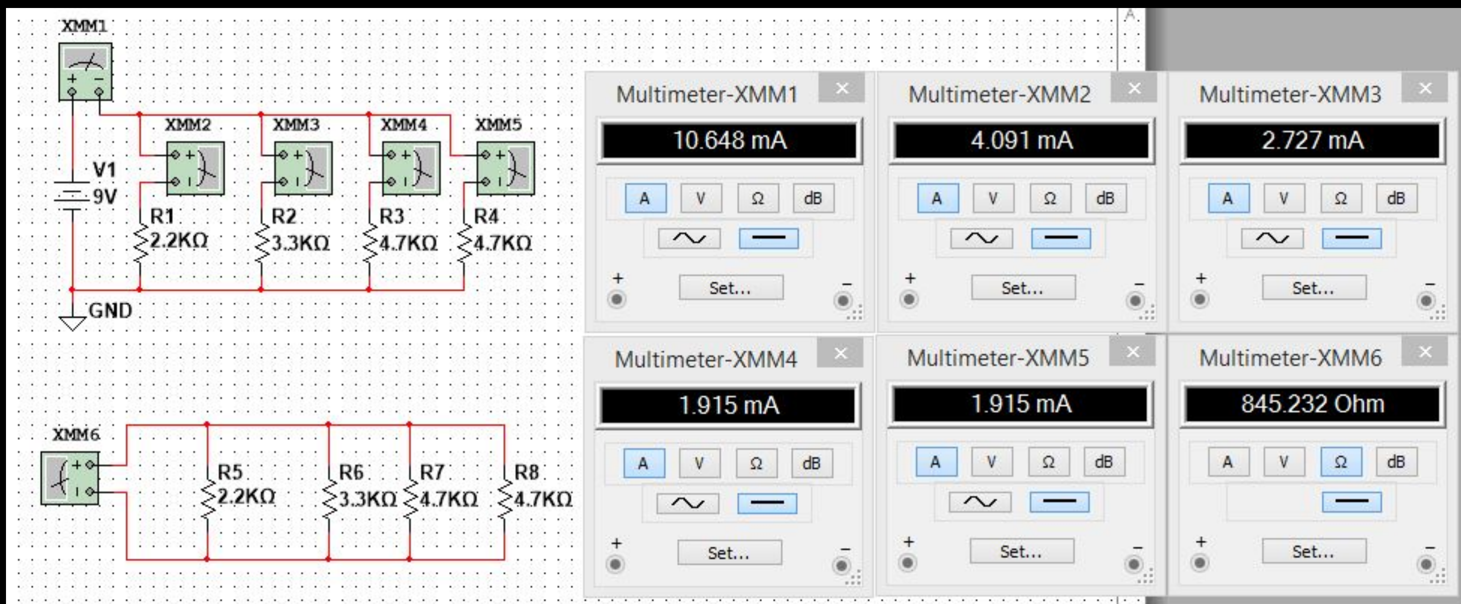


FIGURE 5: SIMULATION IMAGE

DATA

	Measured	Calculated	Simulated
V1 =	**9.065V**	**9V**	**9V**
RT =	**831.6**	**845.2**	**845.232**
I1 =	**4.022mA**	**4.1mA**	**4.091mA**
I2 =	**2.713mA**	**2.7mA**	**2.727mA**
I3 =	**1.922mA**	**1.9mA**	**1.915mA**
I4 =	**1.890mA**	**1.9mA**	**1.915mA**
IT =	**10.76mA**	**10.6mA**	**10.648mA**

FIGURE 6: WORKSHEET SPREADSHEET 1

	Design	Measured
R1 =	**2.2K**	**2.152K**
R2 =	**3.3K**	**3.240K**
R3 =	**4.7K**	**4.614K**
R4 =	**4.7K**	**4.696K**

FIGURE 7: WORKSHEET SPREADSHEET 2

R1	2.2E+3	Ω
R2	3.3E+3	Ω
R3	4.7E+3	Ω
R4	4.7E+3	Ω
V1	9	V
RT	845.2	Ω
I1	4.1E-3	Ω
I2	2.7E-3	Ω
I3	1.9E-3	Ω
I4	1.9E-3	Ω
IT	10.6E-3	Ω
IT	10.6E-3	Ω

FIGURE 8: EXCEL SPREADSHEET

OBSERVATIONS

- **In a parallel circuit, the typical current/voltage/resistance laws still apply--with that said--The measured values varied slightly from expected. Some values were slightly lower than calculated, while some were higher than calculated.**

LAB 8: BLACK BOX 3 DESIGN

10-5-17

LAB 8: BLACK BOX 3 DESIGN

Names: **MORGUN WERLING, BRETT BARNETT**
Date: **10-5-17**

The purpose of this lab is to:
Learn about building a circuit that produces exactly 1.3V

Using at least 3 equal value resistors (in the Black Box) design a circuit that produces an output voltage of 1.3V. Then adjust R1 so that the output voltage is exactly 1.3V.

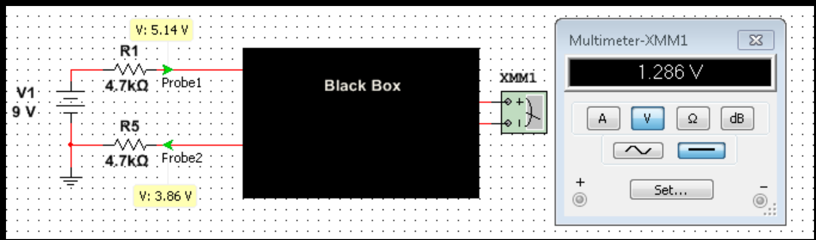


FIGURE 1: WORKSHEET IMAGE

Equipment needed:

1 – Digital Multimeter
1 – Elvis II
5 – Standard Resistors
1 – 5 Kohm pot

LAB 8: BLACK BOX 3 DESIGN

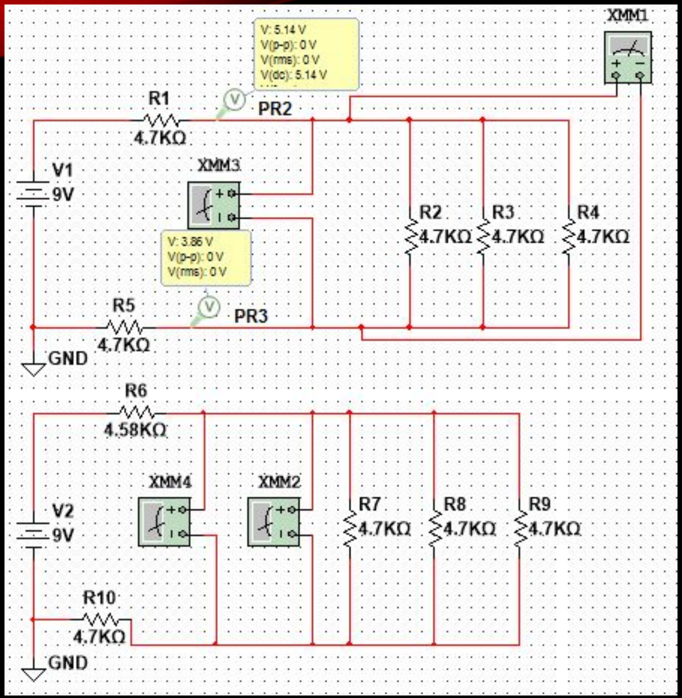


FIGURE 2: SIMULATION IMAGE

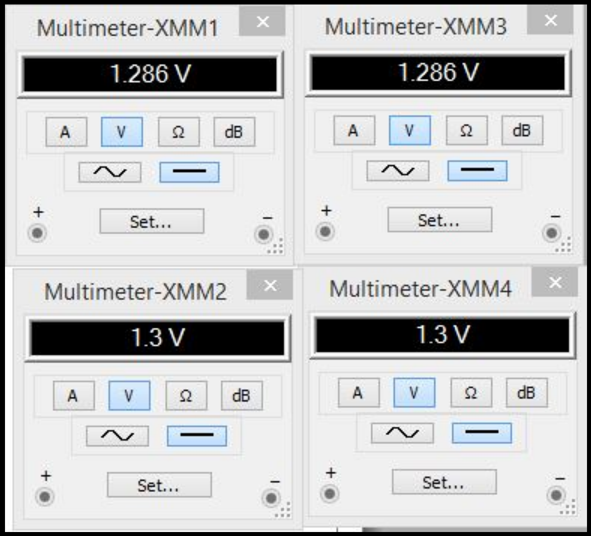


FIGURE 3: SIMULATION INSTRUMENTS IMAGE

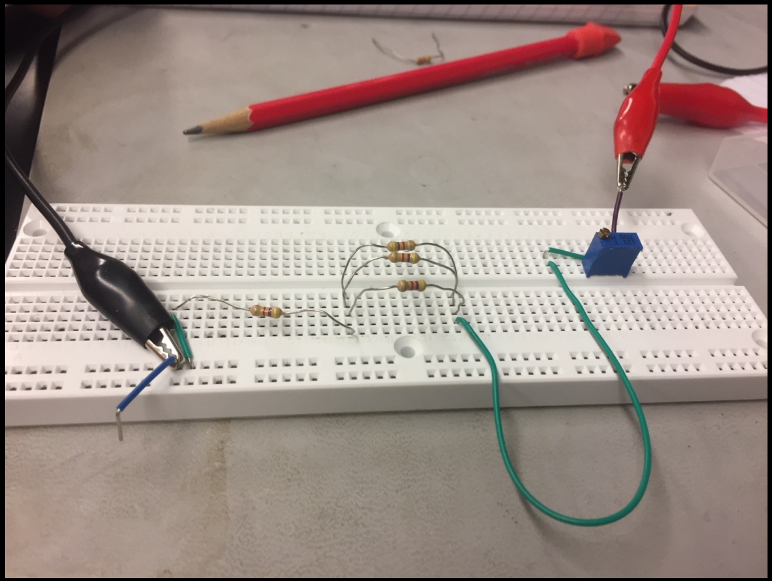


FIGURE 4: COMPLETE CIRCUIT. SHOWN IS THE COMPLETED CIRCUIT USED FOR COLLECTING THE MEASURED VALUES FOR THE LAB.

DATA

	Design	Measured
R1 =	**4.7KΩ**	**4.7003K**
R2 =	**4.7KΩ**	**4.615KΩ**
R3 =	**4.7KΩ**	**4.627KΩ**
R4 =	**4.7KΩ**	**4.637KΩ**
R5 =	**4.7KΩ**	**4.615KΩ**
R(Black Box) =	**1.57KΩ**	**1.5455K Ω**
R1adj =	**4.58KΩ**	**4.560KΩ**

FIGURE 5: WORKSHEET SPREADSHEET 1

	Measured	Calculated	Simulated
V1 =	**9.066V**	**9V**	**9 V**
VA =	**5.151V**	**5.14V**	**5.14V**
VB =	**3.8668V**	**3.86V**	**3.86V**
VA - VB =	**1.2838V**	**1.28V**	**1.286V**
(VA - VB) adj =	**1.3005V**	**1.3V**	**1.3V**

FIGURE 6: WORKSHEET SPREADSHEET 2

R1=	4.70E+03 Ω
R2=	4.70E+03 Ω
R3=	4.70E+03 Ω
R4=	4.70E+03 Ω
R5=	4.70E+03 Ω
Rbb=	1.57E+03 Ω
R1adj=	4.58E+03 Ω
RT=	1.10E+04 Ω
V1	9 V
VA	5.14 V
VB	3.86 V
VA-VB	1.28 V
(VA-VB)adj	1.3 V

FIGURE 7: EXCEL SPREADSHEET

OBSERVATIONS

- **Calculating the required resistor values when combining a series circuit with a parallel circuit was much more difficult than the previous labs, reason being that the current was not provided and had to be calculated to find the parallel branches' resistance. And then the calculations needed to be done again to find the resistor value for R1 to make the voltage drop across the black box exactly 1.3V.**

LAB 9/MIDTERM: SERIES/PARALLEL RESISTORS

10/12/17-10/19/17

Names: **MORGUN WERLING**, BRETT BARNETT
Date: 10/12/17 – 12/19/17

The purpose of this lab is to:
Experiment with series circuits and verify that the simulation, analysis (calculations) and test results all agree.

From the resistor kit select 8 resistors: 2 each 470Ω, 2 each 1kΩ, and 1 each of the following:
2.2kΩ, 3.3kΩ, 4.7kΩ, 10kΩ

Measure and record the value of each resistor. Connect the resistors as shown in Figure 1. Measure and record the total resistance, RT. Then connect the resistors as shown in Figure 2, the 9V come from the Elvis II (Modular Engineering Educational Laboratory Platform). Then measure and record with the Digital Multimeter the current and voltages of the series circuit

AFTER THE ABOVE
Adjust R2 so that the VA voltage is equal to 4.5V. Then measure the value of the new R2 and calculate and simulate a value that would produce the 4.5V.

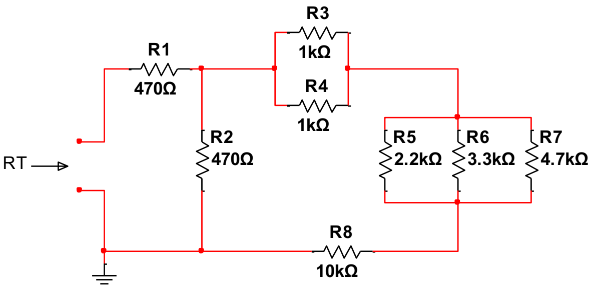


Figure 1: Series/Parallel Circuit

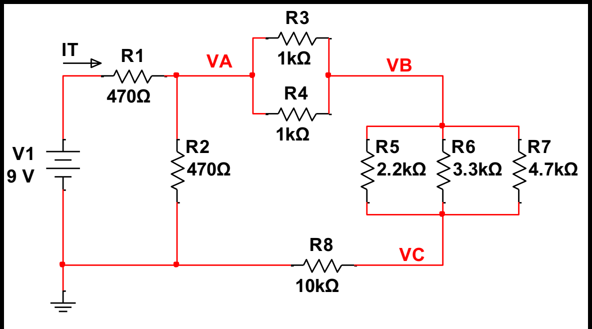


Figure 2: Series/Parallel Circuit

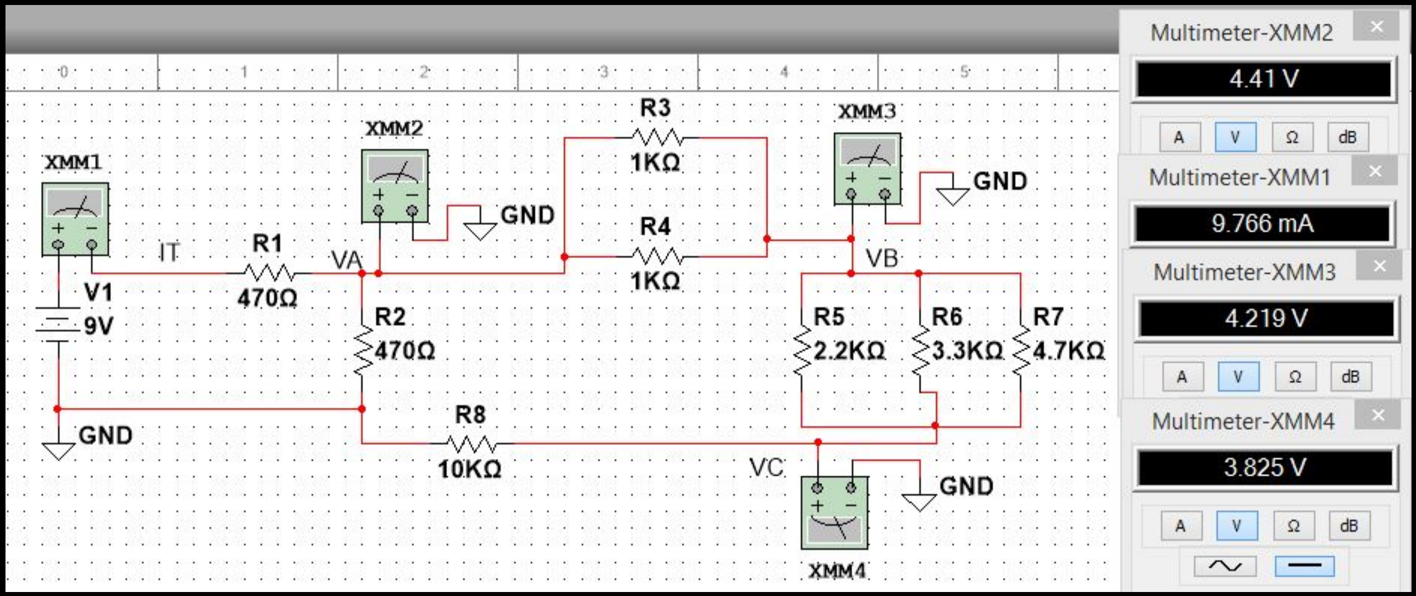


FIGURE 3: COMPLETE CIRCUIT SIMULATION IMAGE

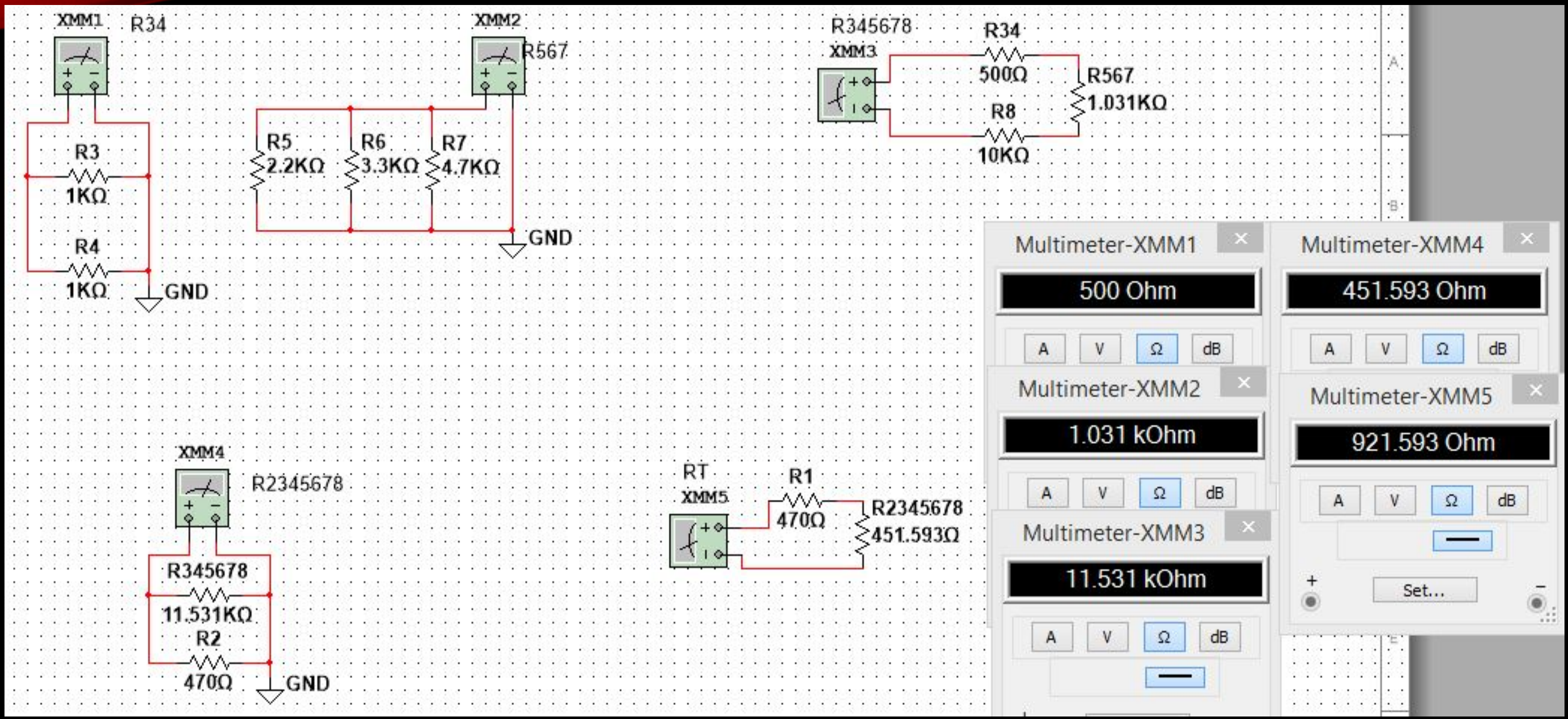


FIGURE 4: RESISTANCE SUMS SIMULATION IMAGE

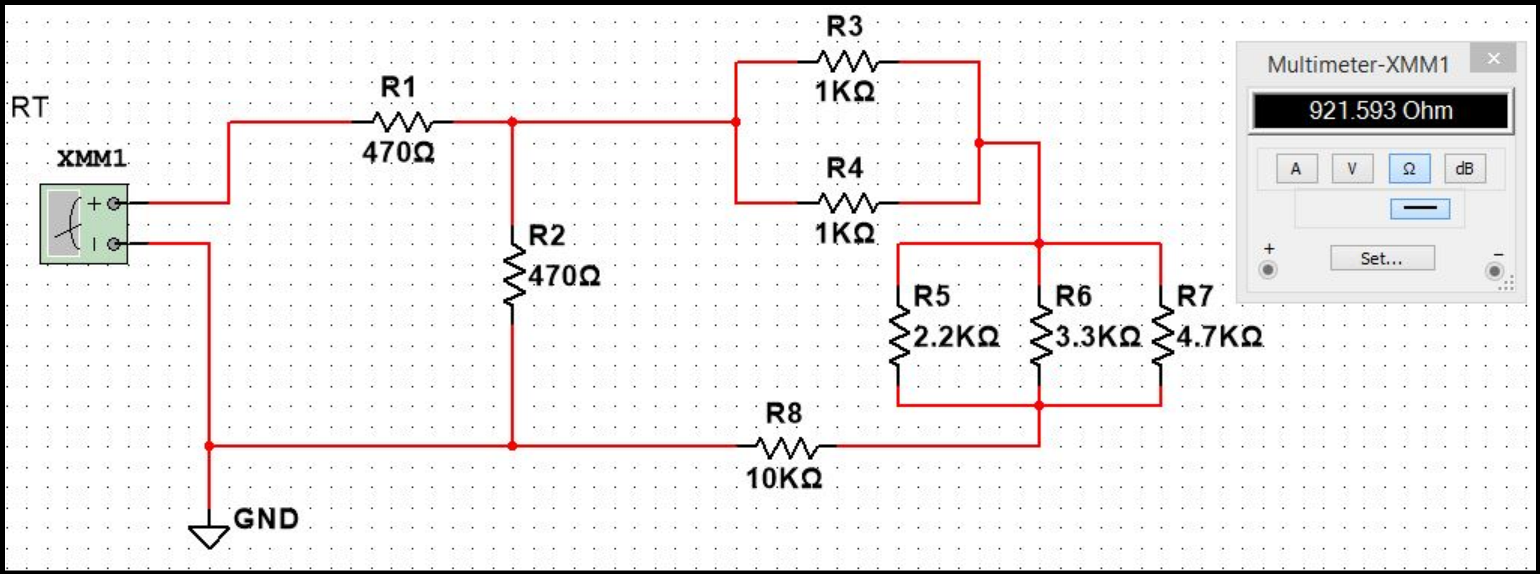


FIGURE 5: TOTAL RESISTANCE SIMULATION IMAGE

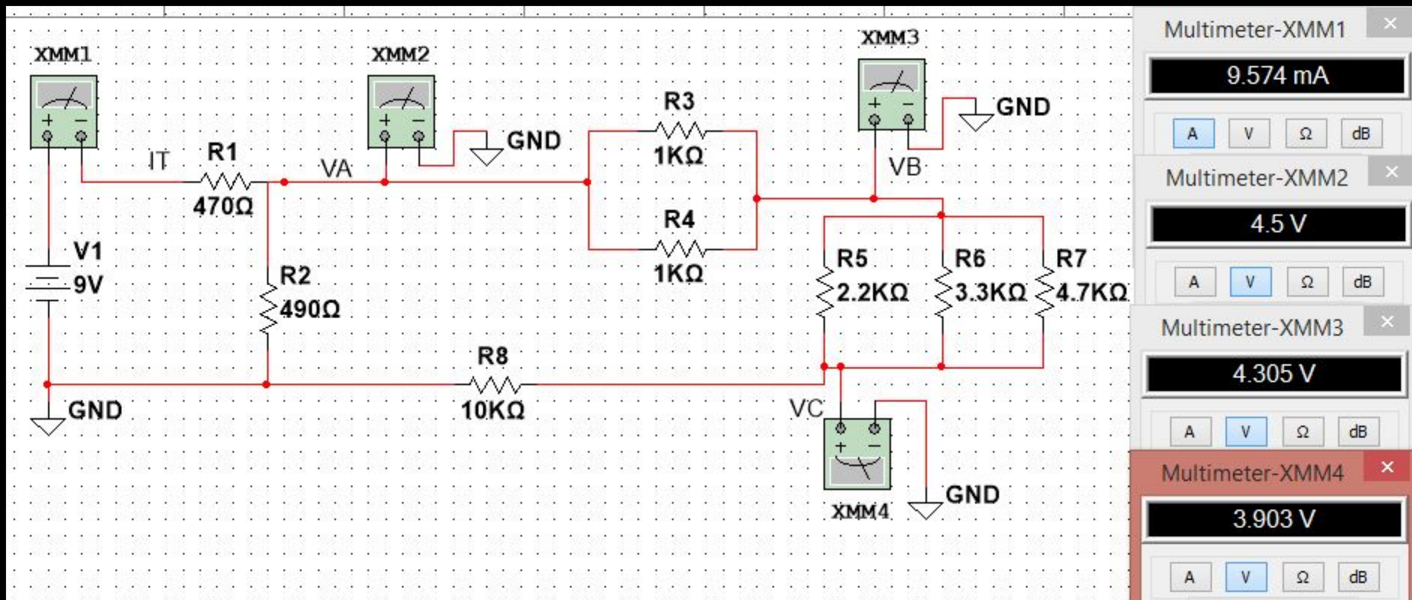


FIGURE 6: R2 ADJUSTED SIMULATION IMAGE

	Expected	Measured
R1 =	470Ω	463.00 Ω
R2 =	470 Ω	462.52 Ω
R3 =	1K Ω	980.1 Ω
R4 =	1K Ω	983.0 Ω
R5 =	2.2K Ω	2.154k Ω
R6 =	3.3K Ω	3.244k Ω
R7 =	4.7K Ω	4.622k Ω
R8 =	10K Ω	9.719k Ω

FIGURE 7: WORKSHEET SPREADSHEET 1

Expected = value you expect it to be

Calculated = using Excel calculations

Simulated = Multisim simulation

Measured = using Digital Multimeter

	Calculated	Simulated	Measured
V1 =	9V	9V	9.067V
IT =	9.766 mA	9.766mA	9.881mA
VA =	4.4V	4.41V	4.4356V
VB =	4.2V	4.219V	4.2408V
VC =	3.8V	3.825V	3.8408V

FIGURE 9: WORKSHEET SPREADSHEET 3 (R2 ADJUSTED)

	Calculated	Simulated	Measured
R34 =	500 Ω	500Ω	490.78 Ω
R567 =	1.031 kΩ	1.031kΩ	1.0116k Ω
R345678 =	11.531kΩ	11.531kΩ	11.225k Ω
R2345678 =	451.593Ω	451.593Ω	444.54 Ω
RT =	921.593Ω	921.593Ω	907.8 Ω

FIGURE 8: WORKSHEET SPREADSHEET 2

	Measured	Simulated	Calculated
VA =	4.500V	4.5V	4.50V
R2 =	476.96 Ω	490Ω	490Ω

FIGURE 10: WORKSHEET SPREADSHEET 4 (R2 ADJUSTED)

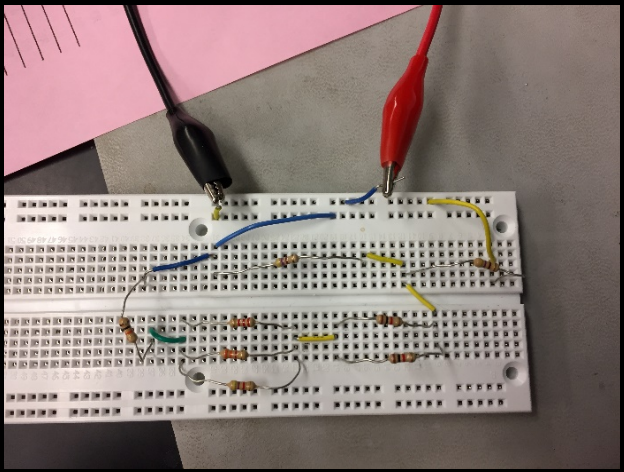


Figure 11: Circuit for the first portion of the lab.
Used to measure the following values: V1, IT, VA, VB, VC

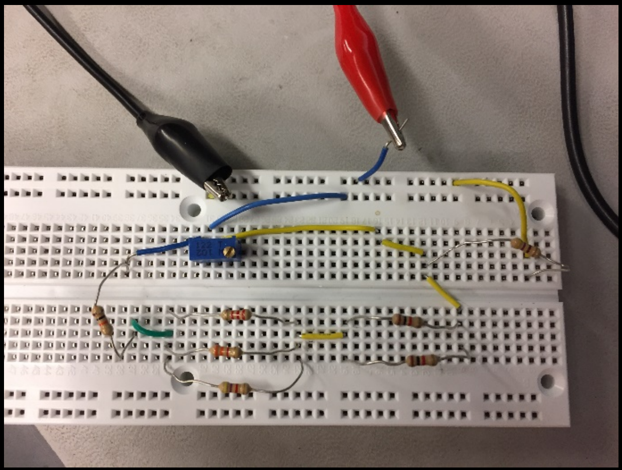


Figure 12: Circuit for the second portion of the lab.
When using a potentiometer to find the correct resistance value for R2, so that VA was measured at exactly 4.5 Volts.

OBSERVATIONS

- The measured resistor values—while within tolerances—were all below the simulated and nominal values. As a result the total resistance of the circuit was around 13 ohms lower than the simulated and calculated value. While this affected our voltage and current readings in the first portion of the lab, the readings of the second portion of the lab were unaffected, except for the reading for R2. Our measured R2 value was actually smaller than the simulated and calculated values, which makes sense because R2 was wired parallel to the majority of the other resistors—which were all lower resistance than nominal. (see figure 2)

OFCA

10/19/17

Name **MORGUN WERLING**
Date **10/19/2017**

The following questions should be answered in two ways: using Excel and simulation using MultiSim. When you are done zip all your work up into a single file called "OFCA.zip" and upload it to the Course Message (of course address it to me)

1: FIND THE FOLLOWING:
Find R_{TH}, V_{TH} and RL for maximum power transfer via analysis (show all work.) Create a plot in Excel for the power transfer.
R_{TH} = **10 Ω**
V_{TH} = **4.5 V**
RL = **10 Ω**

Find R_{TH}, V_{TH} and RL for maximum power transfer via simulation (capture and upload simulation schematic and outputs).
R_{TH} = **10 Ω**
V_{TH} = **4.5 V**
RL = **10 Ω**

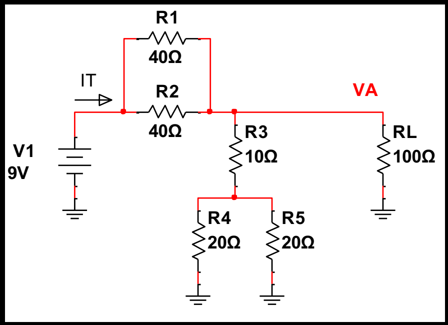


FIGURE 1: WORKSHEET IMAGE

EXCEL DATA

R1	40	Ω
R2	40	Ω
R3	10	Ω
R4	20	Ω
R5	20	Ω
RL	100	Ω
V1	9	V
R12	20	Ω
R45	10	Ω
R345	20	Ω
RTH=	10	Ω
VTH=	4.5	V
RL=	10	Ω

FIGURE 2: EXCEL SPREADSHEET CALCULATIONS

V=	4.5	v
RINT	10	Ω
RL	10	Ω

RL (Ω)	IT (A)	PL (W)
1	0.41	0.167
2	0.38	0.281
3	0.35	0.359
4	0.32	0.413
5	0.30	0.450
6	0.28	0.475
7	0.26	0.490
8	0.25	0.500
9	0.24	0.505
10	0.23	0.506
11	0.21	0.505
12	0.20	0.502
13	0.20	0.498
14	0.19	0.492
15	0.18	0.486
16	0.17	0.479
17	0.17	0.472
18	0.16	0.465
19	0.16	0.457
20	0.15	0.450
21	0.15	0.443
22	0.14	0.435
23	0.14	0.428
24	0.13	0.420
25	0.13	0.413

FIGURE 3: EXCEL LOAD RESISTANCE VS. LOAD POWER CHART DATA

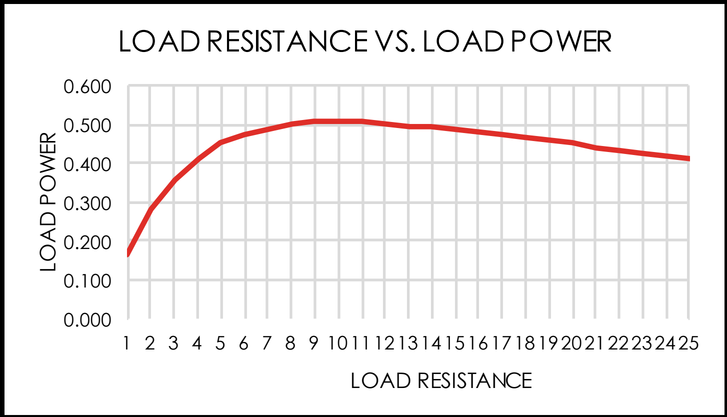


FIGURE 4: EXCEL CHART- LOAD RESISTANCE VS. LOAD POWER

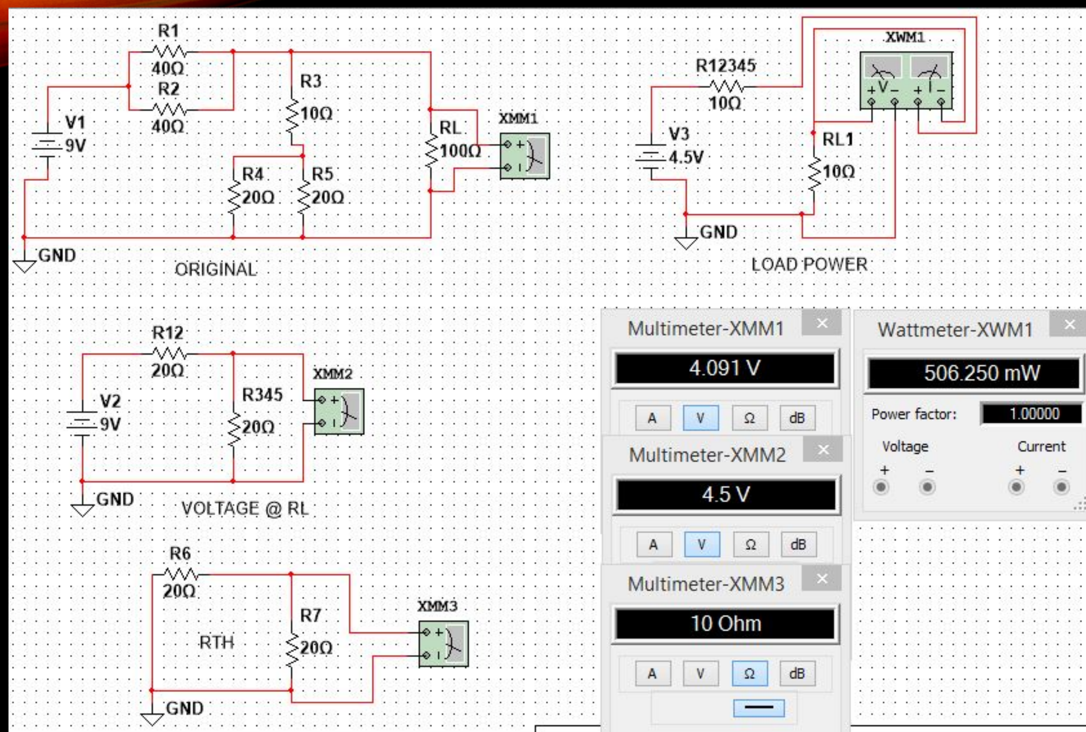


FIGURE 5: SIMULATION IMAGE

LAB 10: SERIES/PARALLEL CAPACITORS

11-16-17

LAB 10: SERIES/PARALLEL CAPACITORS

Names: Morgun Werling, Brett Barnett

Date: 16 November 2017

The purpose of this lab is to:
Experiment with series circuits and parallel combinations of capacitors.

The following capacitors are needed (1 each of the following): 10uF, 22uF and 47uF

Measure and record the capacitance of each capacitor using the LCR meter. Connect the capacitors as shown in Figure 1 and measure and record the total capacitance, CT. Then connect the capacitors as shown in Figure 2 and measure and record the total capacitance, CT.

Equipment needed:
1 – LCR Meter
1 – Elvis II
3 – capacitors

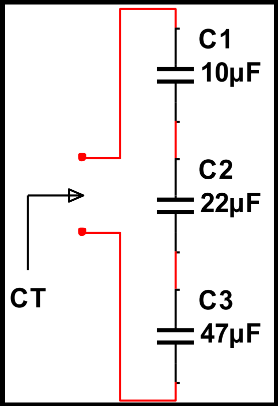


FIGURE 1: SERIES CIRCUIT

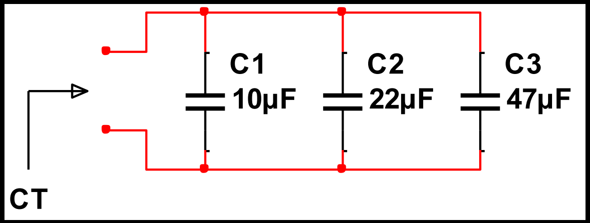


FIGURE 2 : PARALLEL CIRCUIT

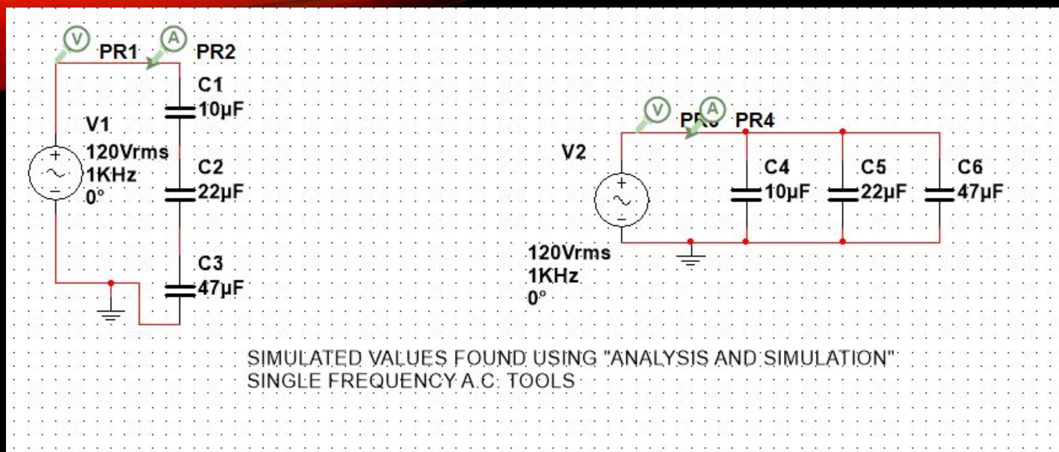


FIGURE 3 :MULTISIM SIMULATIION IMAGE

LAB 10 SIMULATION
Single Frequency AC Analysis @ 1000 Hz

	Variable	Magnitude	Phase (deg)
1	I(C1:1) | I(PR2)	37.68453 m	90.00000
2	-I(V2:1) | I(PR4)	496.37164 m	90.00000
3	V(3) | V(PR1)	1.00000	0.00000e+000
4	V(4) | V(PR3)	1.00000	0.00000e+000
5	1/(2*pi*1000*(V(PR1)/I(PR2)))	5.99768 u	90.00000
6	1/(2*pi*1000*(V(PR3)/I(PR4)))	79.00000 u	90.00000

FIGURE 4 :MULTISIM SIMULATIION DATA IMAGE

Expected = value you expect it to be
Measured = using LCR Meter
Simulated = using Multisim

	Expected	Measured	Simulated
C1 =	10 µf	9.824 µf	10 µf
C2 =	22 µf	20.529 µf	22 µf
C3 =	47 µf	36.048 µf	47 µf
CT =	5.998 µf	5.601 µf	5.998 µf

FIGURE 5: WORKSHEET SPREADSHEET 1 (SERIES CIRCUIT)

FIGURE 1	
C1=	10.0E-6 F
C2=	22.0E-6 F
C3=	47.0E-6 F
CT=	5.998E-6 F

FIGURE 7: EXCEL CALCULATION FOR FIGURE 1 (SERIES CIRCUIT)

	Expected	Measured	Simulated
C1 =	10 µf	9.824 µf	10 µf
C2 =	22 µf	20.529 µf	22 µf
C3 =	47 µf	36.048 µf	47 µf
CT =	79.00 µf	61.318 µf	79.00 µf

FIGURE 6: WORKSHEET SPREADSHEET 2 (PARALLEL CIRCUIT)

FIGURE 2	
C1=	10.0E-6 F
C2=	22.0E-6 F
C3=	47.0E-6 F
CT=	79.0E-6 F

FIGURE 8: EXCEL CALCULATION FOR FIGURE 2 (PARALLEL CIRCUIT)

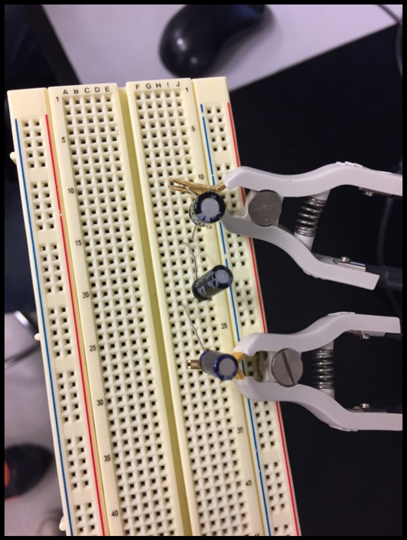


Figure 9: shown is the testing configuration used to measure the series circuit (see figure 1)

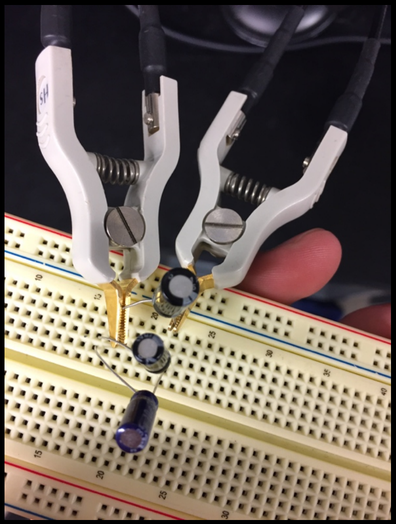


Figure 10: shown is the testing configuration used to measure the parallel circuit (see figure 2)

OBSERVATIONS

Simulated readings were lower than measured readings due to the lower than rated measured values of the capacitors. This is similar to what was observed in previous labs with resistors. The actual values tend to be less than the nominal value, rather than higher.

LAB 11: RC LAB

11-16-17

Names: MORGUN WERLING , BRETT BARNETT

Date: 16 November 2017

The purpose of this lab is to:
Experiment with RC (Resistor & Capacitor) circuits.

The following capacitors are needed (1 each of the following): 0.47uF, 1uF and 2.2uF

Measure and record the resistor value using the DMM and measure and record the capacitor values using the LCR meter in Table 1. Connect the resistor and capacitor as shown in Figure 1. Connect the Function Generator to the input at V1 and connect Channel 1 of the Oscilloscope to the input and Channel 2 to the output. Adjust the voltage of the Function Generator to 1Vpp at the frequencies shown in Table 2. Measure the input and output voltages using the Oscilloscope. Record the results in Table 2.
Change the capacitor and retest.

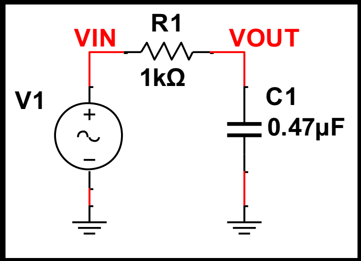


FIGURE 1: RC CIRCUIT

Equipment needed:
1 – Digital Multimeter
1 – LCR Meter
1 – Oscilloscope
1 – Function Generator
1 – Elvis II
3 – capacitors
1 – resistor

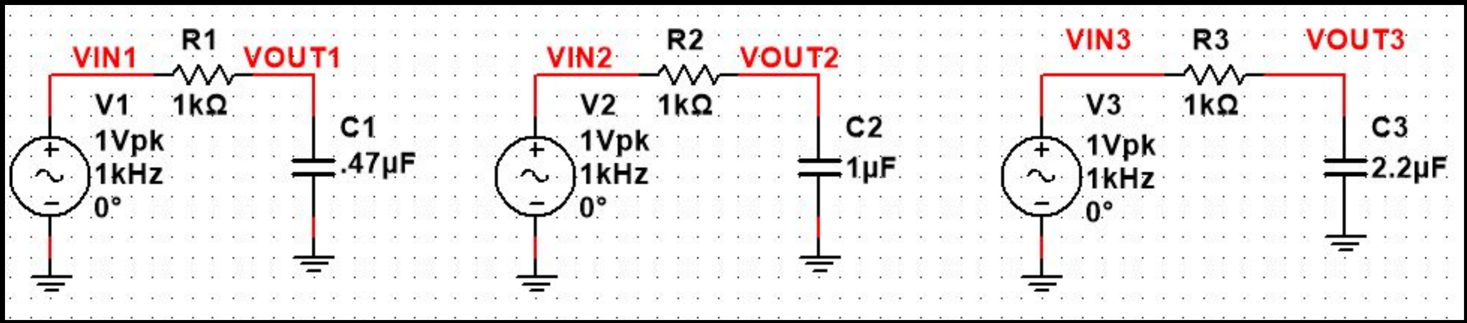


FIGURE 2: MULTISIM SIMULATION IMAGE

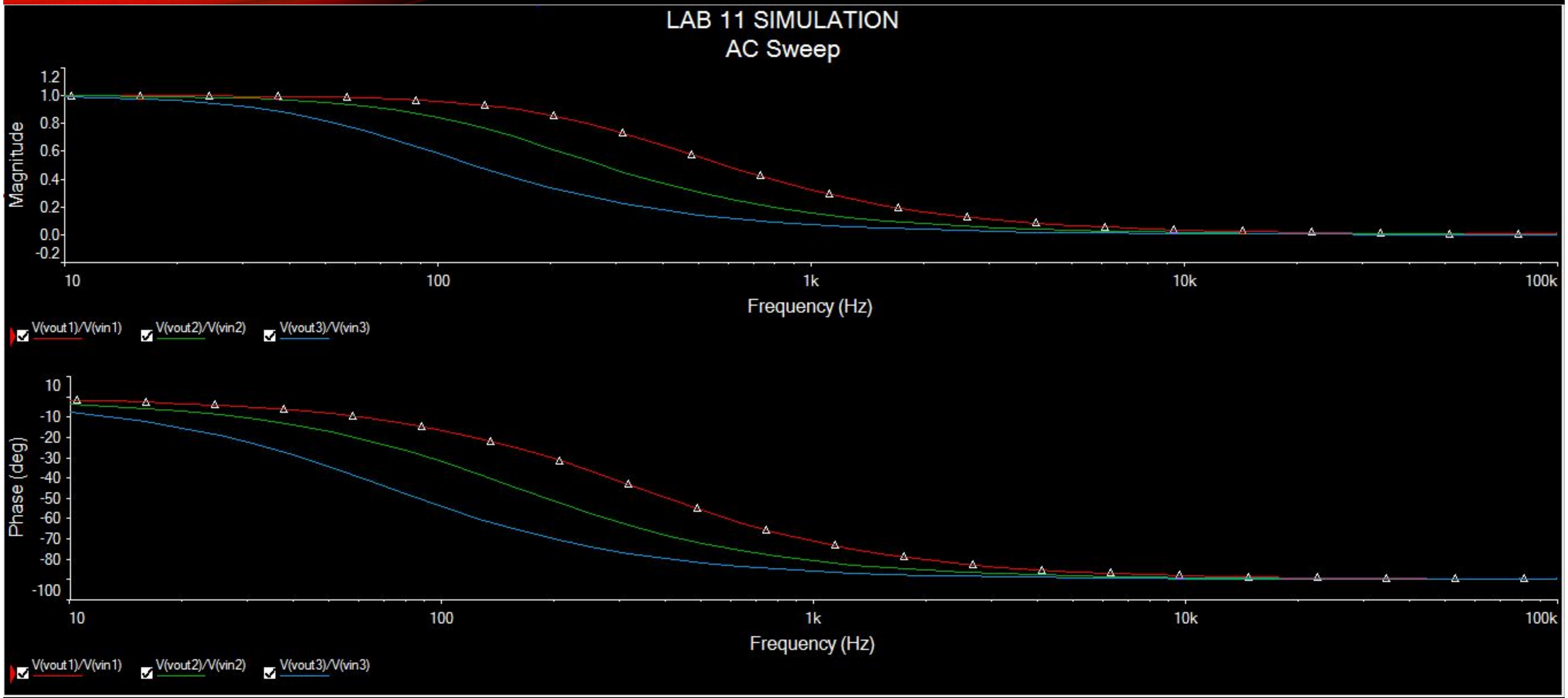


FIGURE 3: MULTISIM SIMULATION DATA IMAGE

	Capacitance or Resistance	
	Expected	Measured
C1 =	.47 µf	.402 µf
C2 =	1 µf	.859 µf
C3 =	2.2 µf	2.218 µf
R1 =	1 kΩ	981.0 Ω

FIGURE 4 – Resistance and Capacitances
Expected = value you expect it to be
Measured = using LCR Meter or DMM

	Output Voltage C = .47 µf			Output Voltage C = 1µf			Output Voltage C = 2.2 µf		
	Expected	Measured		Expected	Measured		Expected	Measured	
Frequency	Output Voltage	Input Voltage	Output Voltage	Output Voltage	Input Voltage	Output Voltage	Output Voltage	Input Voltage	Output Voltage
10	999.564m			998.032m			990.581m		
50	0.989V	1.02V	1.00V	0.954V	1.02V	0.960V	0.824V	1.00V	.820V
100									
200	0.747V	1.02V	.900V	0.469V	1.02V	0.640V	0.235V	1.00v	0.324V
300									
400	0.646V	1.02V	.656V	0.370V	1.02V	0.408V	0.178V	1.00V	.176V
500									
600	0.491V	1.00V	.520V	0.257V	1.02	0.292V	0.120V	1.00V	.116V
700									
800									
900	0.353V	1.00V	0.400V	0.175V	1.00V	0.204V	0.081V	1.02V	0.840V
1,000									
2,000									
3,000									
4,000									
5,000	0.068V	1.02V	0.900V	0.032V	1.00V	0.432V	0.014V	1.00V	0.017V
6,000									
7,000	0.049V	1.00V	0.632V	.023	1.00V	0.320V	0.010V	1.02V	0.013V
8,000									
9,000	0.038V	1.00V	0.496V	0.18V	1.02V	0.264V	0.008V	1.02V	0.010V
10,000	0.034V	1.00V	0.456V	0.016V	1.00V	0.240V	0.007V	1.02V	0.009V

FIGURE 5: RC FREQUENCY RESPONSE TABLE
Expected = value you expect it to be
Measured = Using Oscilloscope

LAB 11: RC LAB

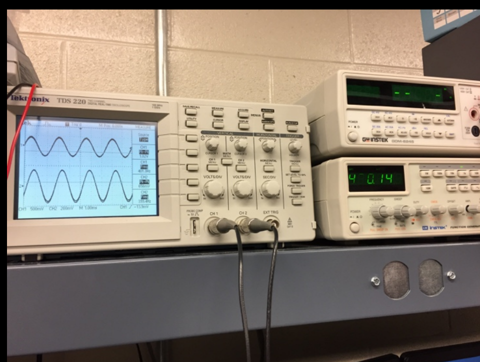


Figure 6: A sample image of the Oscilloscope screen when taking measurements.

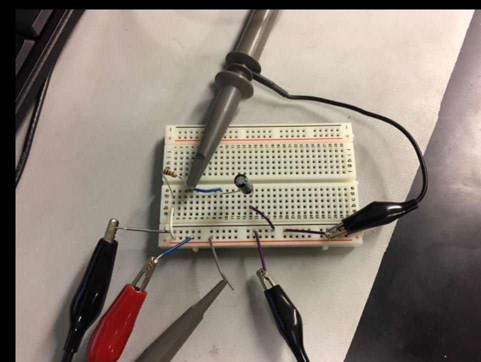


Figure 7: shown is the circuit used to record measurements using the oscilloscope. The capacitor was replaced after all measurements were taken with each capacitor.

OBSERVATIONS

Observations: At lower frequencies, the output voltages measured during the lab were higher than the expected output voltages. At higher frequencies, the measured output voltages tended to be higher than the expected output voltages. While some of the input voltages were 1.02V rather than 1.00V, measured values that were taken at the same frequency with different capacitors—at 1.00V—showed the same results.

LAB 12: SERIES/PARALLEL INDUCTORS

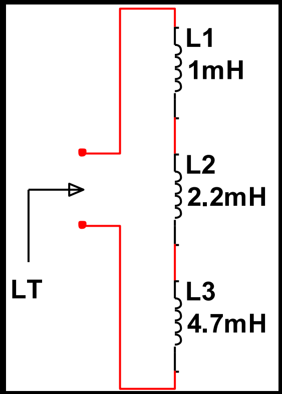
12-7-17

Names: MORGUN WERLING (Lab partner: BRETT BARNETT)
Date: 12-7-17

The purpose of this lab is to:
Experiment with series circuits and parallel combinations of inductors.

The following inductors are needed (1 each of the following): 1mH, 2.2mH and 4.7mH

Measure and record the inductance of each inductor using the LCR meter. Connect the inductors as shown in Figure 1 and measure and record the total inductance, LT. Then connect the inductors as shown in Figure 2 and measure and record the total inductance, LT.
Equipment needed:
– LCR Meter
1 – Elvis II
3 – Inductors



FIGRURE 1: SERIES CIRCUIT

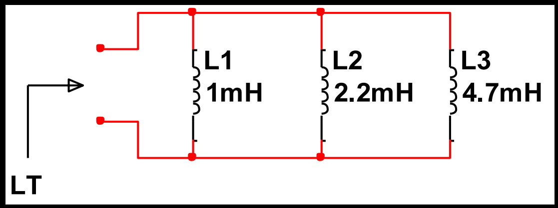


FIGURE 2: PARALLEL CIRCUIT

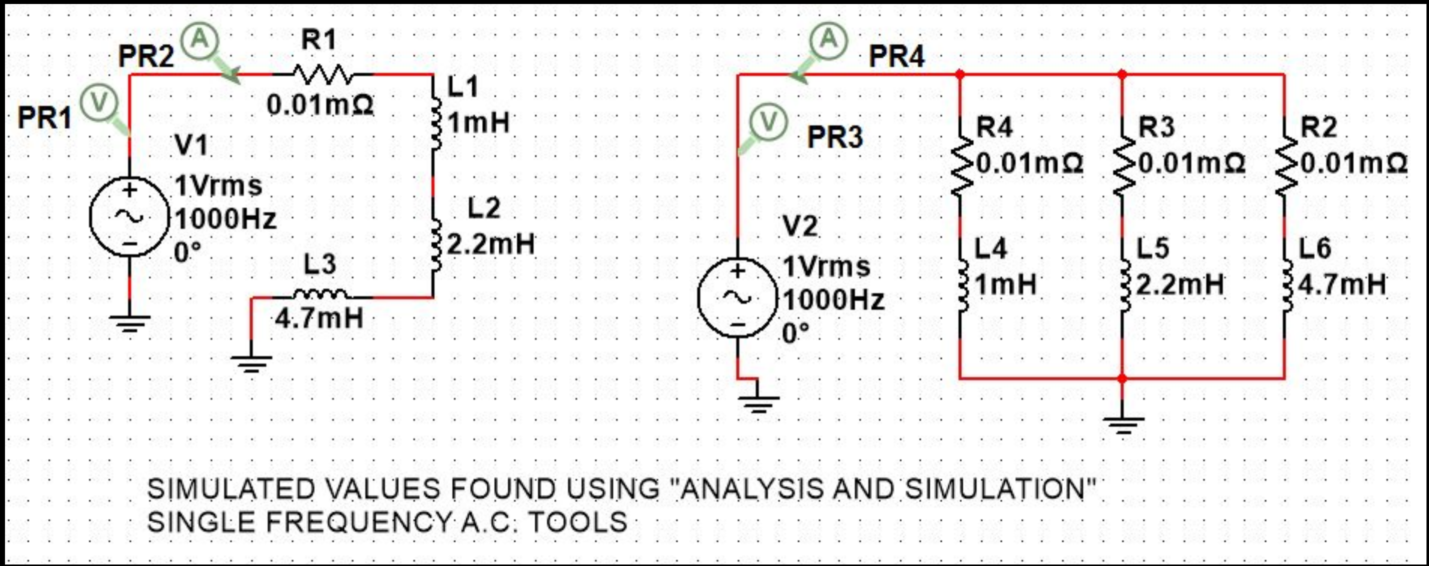


FIGURE 3: MULTISIM SIMULATION IMAGE

LAB 12 SIMULATION
Single Frequency AC Analysis @ 1000 Hz

	Variable	Magnitude	Phase (deg)
1	I(V1:1) | I(PR2)	20.14620 m	90.00001
2	I(V2:1) | I(PR4)	265.36085 m	90.00007
3	V(5) | V(PR1)	1.00000	0.00000e+000
4	V(8) | V(PR3)	1.00000	0.00000e+000
5	(V(PR1)/I(PR2))/(2*pi*1000)	7.90000 m	-90.00001
6	(V(PR3)/I(PR4))/(2*pi*1000)	599.76798 u	-90.00007

FIGURE 4: MULTISIM SIMULATION DATA IMAGE

	Expected	Simulated	Measured
L1 =	1mH	1mH	1.0089mH
L2 =	2.2mH	2.2mH	2.1916mH
L3 =	4.7mH	4.7mH	4.3567mH
LT =	7.9mH	7.9mH	7.4983mH

FIGURE 5: WORKSHEET DATA TABLE (SERIES CIRCUIT, SEE FIGURE 1)

	Expected	Simulated	Measured
L1 =	1mH	1mH	1.0089mH
L2 =	2.2mH	2.2mH	2.1916mH
L3 =	4.7mH	4.7mH	4.3567mH
LT =	599.8uH	599.8uH	1.00111mH

FIGURE 6: WORKSHEET DATA TABLE (PARALLEL CIRCUIT, SEE FIGURE 2)

GIVEN DATA	
L1=	1.000E-03 H
L2=	2.200E-03 H
L3=	4.700E-03 H
SERIES CIRCUIT	
LT=	7.900E-03 H
PARALLEL CIRCUIT	
LT=	599.8E-6 H

FIGURE 7: EXCEL CALCULATED DATA

Expected = value you expect it to be

Simulated = using Multisim

Measured = using LCR Meter

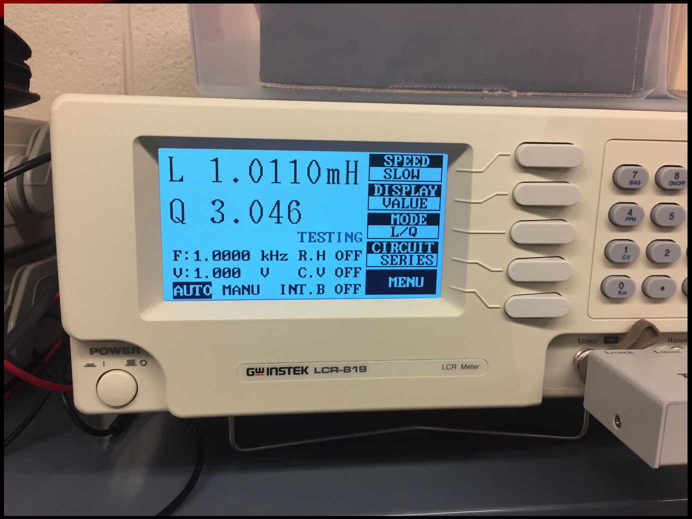


FIGURE 8: SAMPLE IMAGE OF LCR METER USED

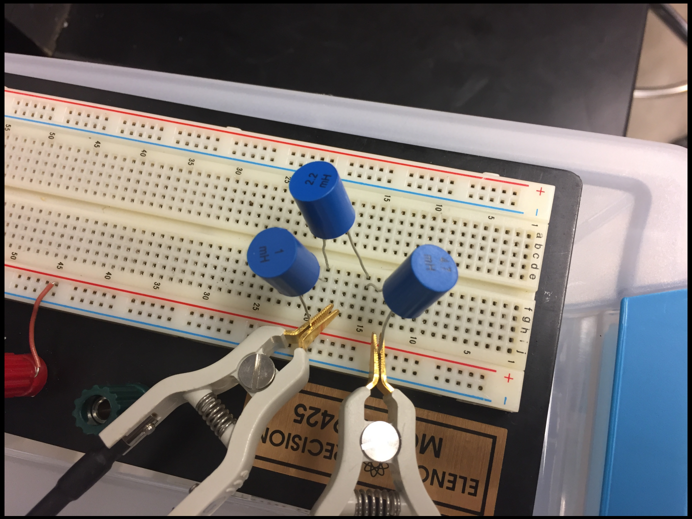


FIGURE 9: BREADBOARDED CIRCUIT USED TO COLLECT LT

OBSERVATIONS

- The measured values collected from the LCR meter were lower than nominal values. The original data for the parallel circuit's measured LT value was incorrect, at 1.0011mH. The measured LT value for the series circuit was lower than expected and simulated.

LAB 13: RL LAB

12-7-17

Names: MORGUN WERLING, (lab partner: BRETT BARNETT)
Date: 12-7-17

The purpose of this lab is to:
Experiment with RL (Resistor & Inductor) circuits.

The following inductors are needed (1 each of the following): 1mH, 2.2mH and 4.7mH

Measure and record the resistor value using the DMM and measure and record the inductor values using the LCR meter in Table 1. Connect the resistor and inductor as shown in Figure 1. Connect the Function Generator to the input at V1 and connect Channel 1 of the Oscilloscope to the input and Channel 2 to the output. Adjust the voltage of the Function Generator to 1Vpp at the frequencies shown in Table 2. Measure the input and output voltages using the Oscilloscope. Record the results in Table 2.
Change the inductor and retest.

Equipment needed:
1 – Digital Multimeter
1 – LCR Meter
1 – Oscilloscope
1 – Function Generator
1 – Elvis II
3 – inductors
1 – resistor, 100 ohm

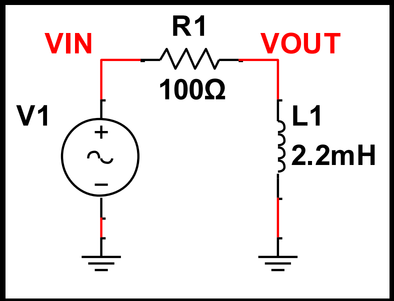


FIGURE 1: RL CIRCUIT

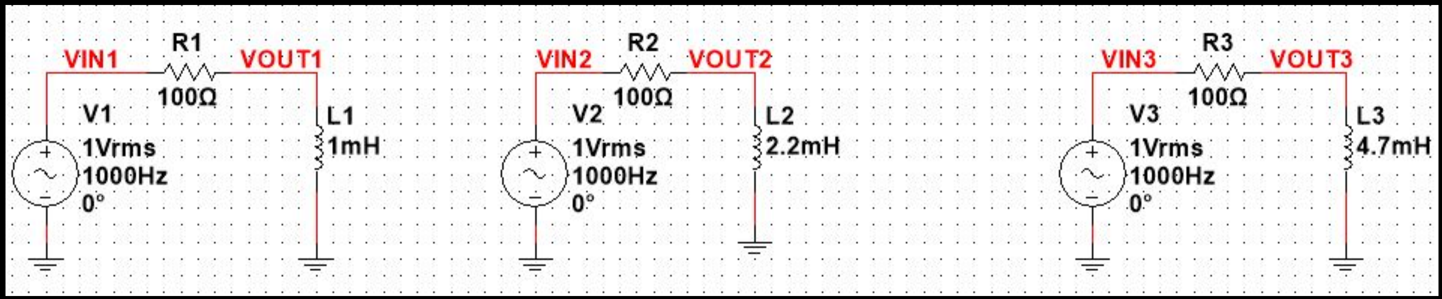


FIGURE 2: MULTISIM SIMULATION

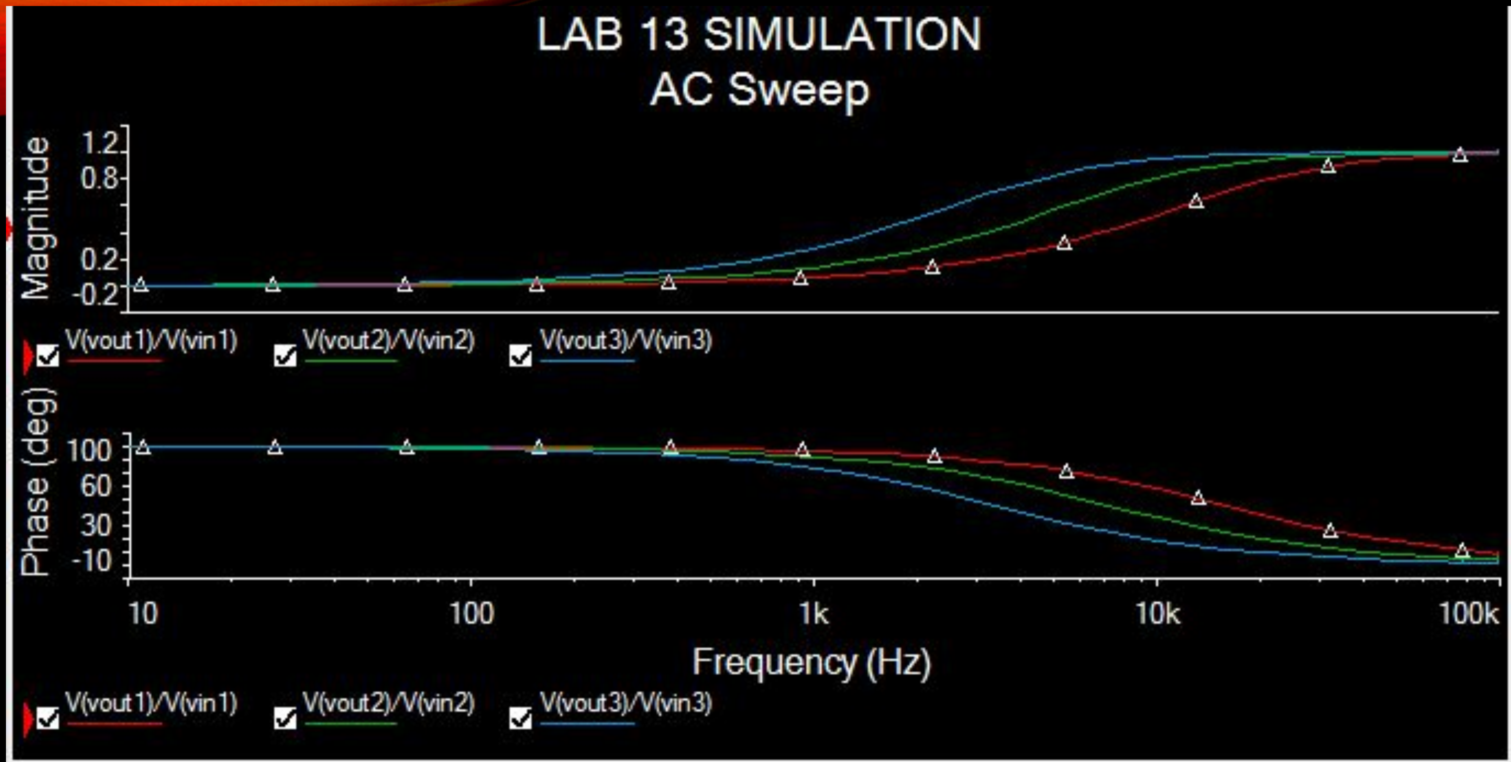


FIGURE 3: MULTISIM SIMULATION DATA

	Inductance or Resistance	
	Expected	Measured
L1 =	1.0mH	1.0089mH
L2 =	2.2mH	2.1916mH
L3 =	4.7mH	4.3567mH
R1 =	100Ω	98.30Ω

FIGURE 4: Resistance and Inductances

Expected = value you expect it to be
Measured = using LCR Meter or DMM

	Output Voltage L = 1 mH			Output Voltage L = 2.2mH			Output Voltage L = 4.7mH		
	Expected	Measured		Expected	Measured		Expected	Measured	
Frequency	Output Voltage	Input Voltage	Output Voltage	Output Voltage	Input Voltage	Output Voltage	Output Voltage	Input Voltage	Output Voltage
10									
50	0.003 V	1.02V	0.0220V	0.007 V	1.00V	.0448V	0.015 V	1.02 V	0.080 V
100									
200	0.013 V	1.00V	0.0264V	0.028 V	1.00V	.0504V	0.059 V	1.02 V	0.092 V
300									
400	0.025 V	1.00V	0.0336V	0.055 V	1.02V	.0664V	0.117 V	1.00 V	0.122 V
500									
600	0.038 V	1.00V	0.0432V	0.083 V	1.02V	0.0880V	0.175 V	1.02 V	0.156 V
700									
800	0.050 V	1.00V	0.0536V	0.110 V	1.00V	0.108V	0.230 V	1.02 V	0.200 V
900									
1,000	0.063 V	1.00V	0.0632V	0.137 V	1.02V	0.132V	0.283 V	1.02 V	0.240 V
2,000									
3,000	0.186 V	1.00V	0.170V	0.384 V	1.02V	0.352V	0.663 V	1.00 V	.552 V
4,000									
5,000	0.300 V	1.00V	0.276V	0.569 V	1.02V	0.528V	0.828 V	1.00 V	0.760 V
6,000									
7,000	0.404 V	1.00V	0.36V	0.694 V	1.02V	0.640V	0.899 V	1.00 V	0.860 V
8,000									
9,000	0.493 V	1.00V	0.464V	.0778 V	1.02V	0.720V	0.935 V	1.02 V	.920 V
10,000	0.532 V	1.02V	0.512V	0.810 V	1.02	0.820V	0.947 V	1.02 V	0.940 V

FIGURE 5: WORKSHEET INDUCTANCE DATA TABLE

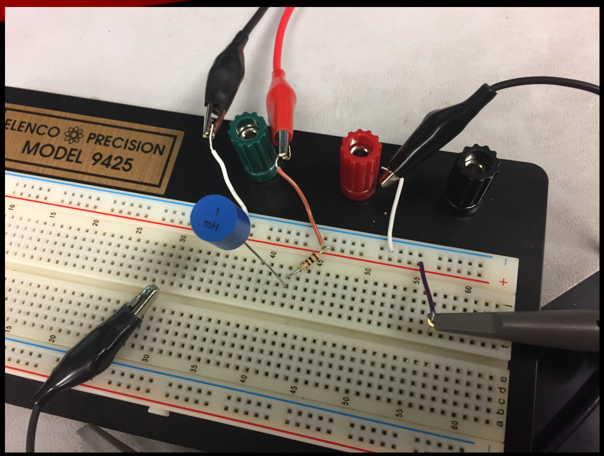


FIGURE 6: 1mH CIRCUIT

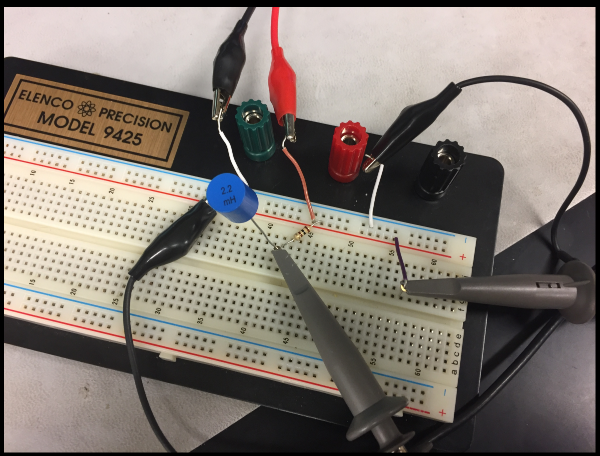


FIGURE 7: 2.2mH CIRCUIT

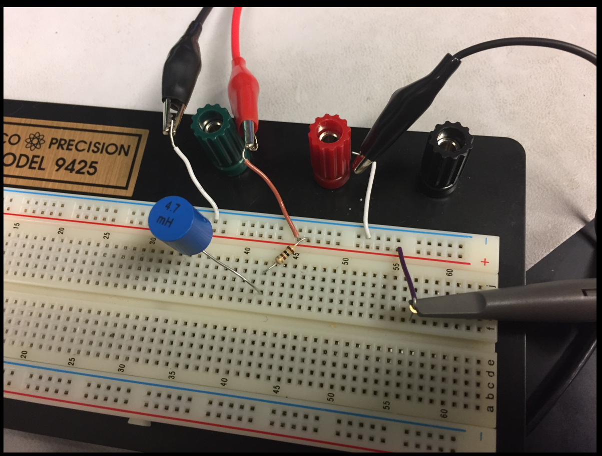


FIGURE 8: 4.7mH CIRCUIT

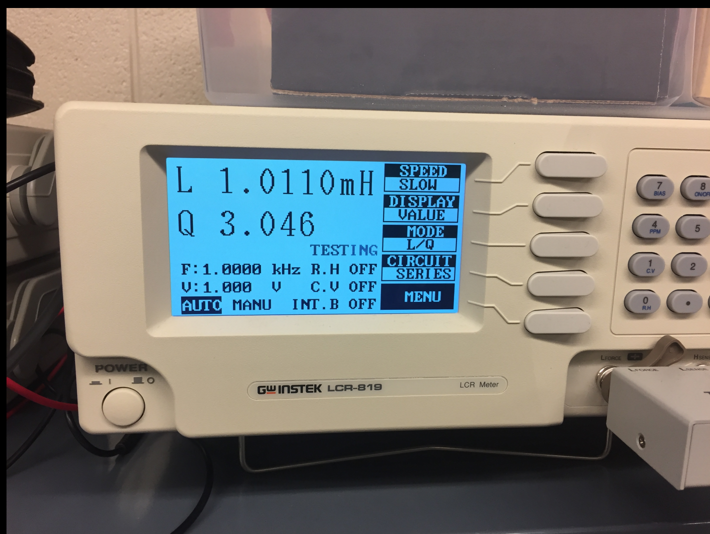


FIGURE 9: SAMPLE IMAGE OF THE LCR METER USED. (READING ON SCREEN IS FOR A DIFFERENT 1mH INDUCTOR THAN USED IN THE LAB

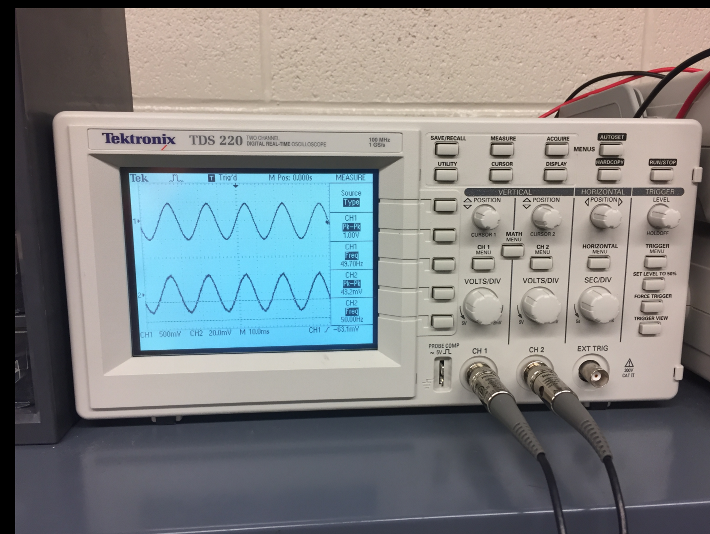


FIGURE 10: IMAGE OF OSCILLOSCOPE USED IN THE LAB

OBSERVATIONS

- The measurements taken in the lab were varied slightly from the simulated measured values. The collected data showed that below 600-800Hz, the measured output voltage was higher than the simulated voltage. Above 600-800Hz, the measured output voltage was lower than the simulated voltage.

END DISCLOSURE

-ALL PHYSICAL EQUIPMENT—WITH THE EXCEPTION OF PERSONAL COMPUTERS—WERE PROPERTY OF IVY TECH COMMUNITY COLLEGE, FORT WAYNE, INDIANA.

- ALL MATERIAL, OTHER THAN OBSERVATIONS, ARE PART OF OR DERIVED FROM THE EETC 111 COURSE.
- THIS POWERPOINT IS FOR THE PURPOSE OF A "LAB NOTEBOOK" UNDER THE DIRECT INSTRUCTION FROM THE COURSE INSTRUCTOR, DR. ANDREW BELL PHD.
- ALL LABS INCLUDED WERE COMPLETED WITH A SINGLE LAB PARTNER : BRETT BARNETT.