LAB NOTEBOOK
DATE
EECT 111

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LAB 1 – RESISTOR VARIABILITY – 29 AUG 2018

- Purpose:
  - Learn the how resistors vary using 20 resistors with the same color code.
- Equipment Used:
  - 1- Digital multi-meter
  - 20 – resistors with the same color code (brown, black, red, gold)
  - Excel
  - Class data

LAB 1 - RESISTOR VARIABILITY - PROCESS

- Select 20 resistors
- Measure each resistor with the multi-meter
- Place data in excel to find the following values:

Min:	0.9796
Max:	1.0042
Average:	0.995005
Standard Dev.:	0.007515

Sample	Measured Value
1	1.0038
2	0.9923
3	0.9836
4	1.0027
5	0.9923
6	0.9895
7	0.9899
8	0.9912
9	0.9895
10	0.9990
11	1.0033
12	0.9916
13	0.9914
14	1.0035
15	0.9911
16	1.0042
17	1.0029
18	1.0018
19	0.9796
20	0.9869

LAB 1 - RESISTOR VARIABILITY - CLASS DATA

- Take the data that the entire class has found during their lab to find the following value:

MIN	0.9747
MAX	1.0078
AVERAGE	0.9947
STANDARD DEVIATION	0.0084

AH	DD	EH	MV	RM
0.9819	0.9894	0.9915	0.9858	1.0038
0.9825	1.0022	0.9898	1.0054	0.9923
0.9893	0.9801	0.9994	1.0023	0.9836
0.9905	1.0046	0.9903	1.0025	1.0027
1.0009	0.9807	0.99	0.9858	0.9923
1.0028	1.0065	0.9845	1.0023	0.9895
0.9784	0.9993	0.9904	1.0041	0.9999
1.0022	0.992	1.0054	0.9885	0.9912
0.987	0.9993	1.0041	1.0017	0.9895
1.0074	0.9974	0.9918	0.9791	0.999
0.9902	0.9994	0.9931	0.9791	1.0033
1.0018	0.9819	0.9948	0.9933	0.9916
1.0005	0.9803	1..0039	0.9912	0.9914
0.9911	0.9867	0.9928	1.0031	1.0035
0.9997	1.0022	1.0033	0.9952	0.9911
1.0012	1.0044	0.9963	0.9747	1.0042
1.0065	0.9776	1.0048	1.0078	1.0029
0.9865	1.0008	0.9971	1.0058	1.0018
0.9801	0.9835	0.9876	1.0023	0.9796
1.0023	1.0015	0.9826	1.0011	0.9869

LAB 1 – RESISTOR VARIABILITY - OBSERVATIONS

- Each resistor is a 1 k ohm resistor
- The general resistor tolerance is +/- 5% which is indicated by the gold strip
- None of the resistors measured today go outside of this tolerance
- No pictures of the actually resistors during measurement were taken
- Although the resistance varies from quite a bit it is more often than not within the required tolerance

LAB 2 - READING/SORTING RESISTORS – 5 SEPT 2018

- Purpose:
  - 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 Used:
  - 1 – Digital Multi-meter
  - 15 – Unique resistors

LAB 2 – READING/SORTING RESISTORS - PROCESS

- By color we measure each resistor with a multi-meter to determine its value for the following resistors:

	Color Code	Measured Value(Ω)
100 =	Blown Black Brown Gold	98.3
220 =	Red Red Brown Gold	218
330 =	Orange Orange Brown Gold	323
470 =	Yellow Violet Brown Gold	463
1K =	Brown Black Red Gold	1k
2.2K =	Red Red Red Gold	2.16k
3.3K =	Orange Orange Red Gold	3.28k
4.7K =	Yellow Voilet Red Gold	4.6k
10K =	Brown Black Orange Gold	9.9k
22K =	Red Red Orange Gold	21.6k
33K =	Orange Orange Orange Gold	32.9k
47K =	Yellow Violet Orange Gold	47k
100K =	Brown Black Yellow Gold	99.7k
1M =	Brown Black Green Gold	1M
10M =	Borwn Black Blue Gold	10.1M

LAB 2 – READING/SORTING RESISTORS - OBSERVATIONS

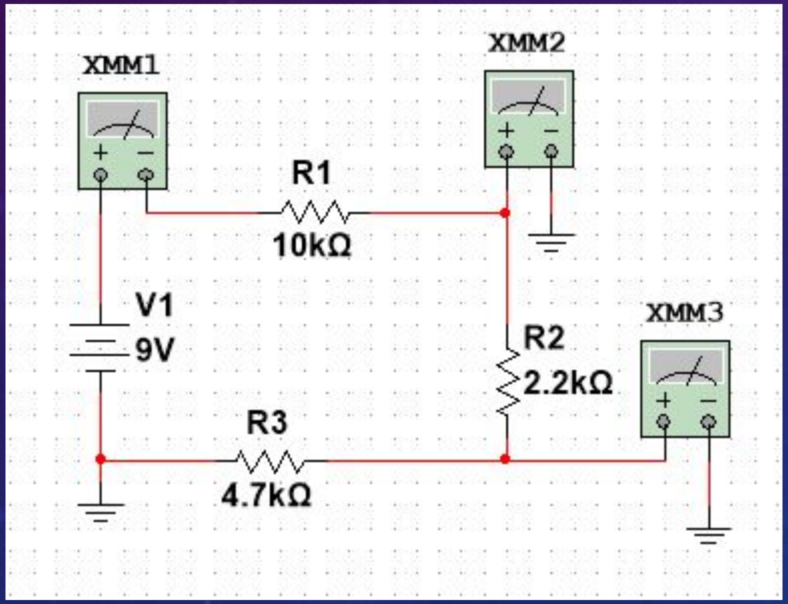
- As we were measuring the resistors, I stared to notice that the colors rotate through a pattern: Brown, Red, Orange, Yellow.
- This made predicting the next resistor color easy. The other observation that I have is that very few of the resistors are exactly measured at there value.
- No pictures were taken during this lab.

LAB 3 – SERIES RESISTORS – 12 SEPT 2018

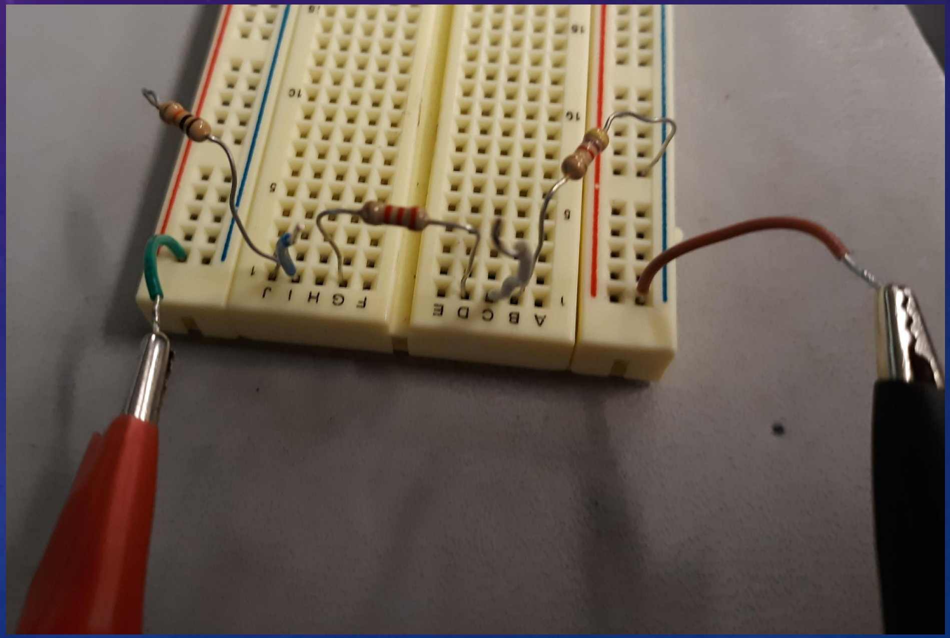
- Purpose:
  - Experiment with series circuits and verify that the simulation, analysis and test results all agree
- Equipment Used:
  - 1- Digital Multi-meter
  - 3 – Resistors
  - Microsoft Excel
  - MultiSim

LAB 3 - SERIES RESISTORS - PROCESS

MultiSim Creation



Lab Creation



LAB 3 – SERIES RESISTORS - RESULTS

Excel Calculations

	A	B	C	D	E
1		Meausred	Calculated	Simulated	
2					
3	R1=	9770	10000	10000	Ω
4	R2=	22000	2200	22000	Ω
5	R3=	45800	4700	47000	Ω
6	Rt=	=SUM(B3:B5)	=C3+C4+C5	=D3+D4+D5	Ω
7					
8	It=	0.50911	=C9/C6	0.5325	Amps
9	V1=	9	9	9	V
10	VA=	3.66	=((C4+C5)/(C6))*C9	3.675	V
11	VB=	2.48	=(C5/(C6))*C9	2.503	V

Final Results

	Meausred	Calculated	Simulated	
R1=	9.8E+3	10.0E+3	10.0E+3	Ω
R2=	22.0E+3	2.2E+3	22.0E+3	Ω
R3=	45.8E+3	4.7E+3	47.0E+3	Ω
Rt=	77.6E+3	16.9E+3	79.0E+3	Ω
It=	509.1E-3	532.5E-6	532.5E-3	Amps
V1=	9	9	9	V
VA=	3.66	3.675	3.675	V
VB=	2.48	2.503	2.503	V

LAB 3 – SERIES RESISTORS - OBSERVATIONS

- Observed how a circuit works in series. Adding in resistance and subtracting in voltage.
- Learned how to calculate the total resistance in a series circuit, and how to find the voltage without current in lab this week.
- There were slight differences in the measured values and the calculated, this is most likely do to the equipment's ability to carry current.

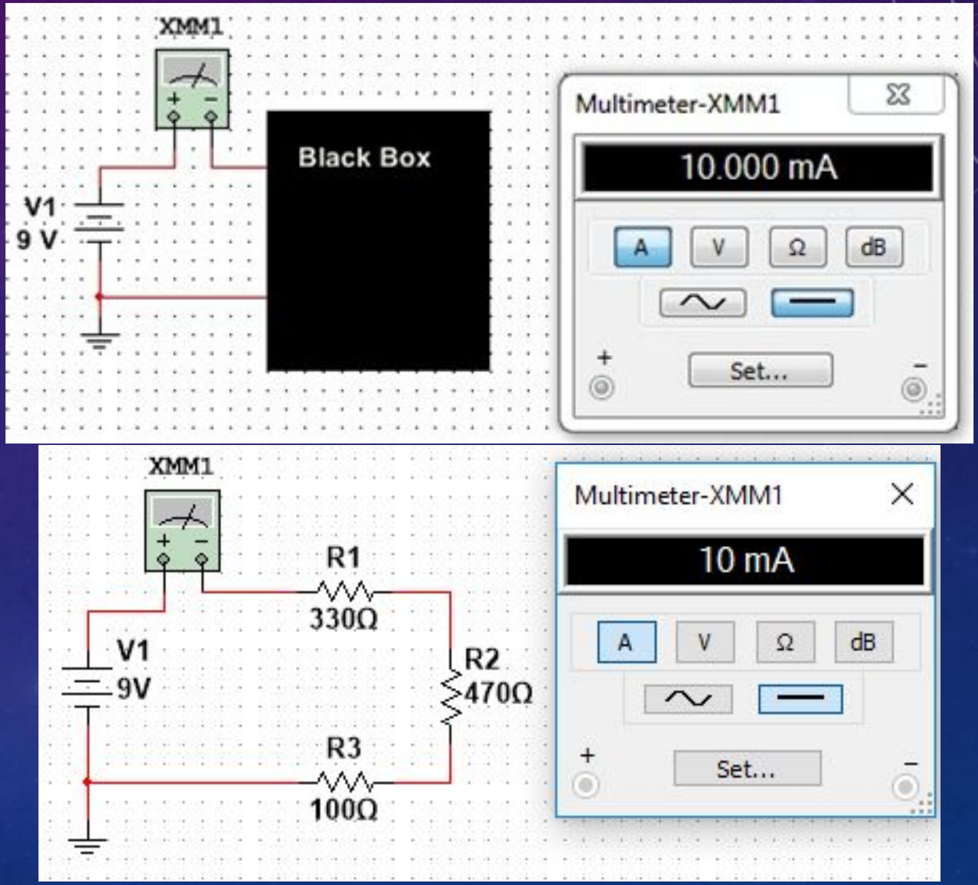
LAB 4 – BLACK BOX DESIGN – 3 NOV 2018

- Purpose:
  - Gain more knowledge on series circuits.
- Equipment used:
  - 1 – Digital Multi-meter
  - 1 – Elvis II
  - 3 – Standard Resistors
  - MultiSim

LAB 4 – BLACK BOX DESIGN - SERIES

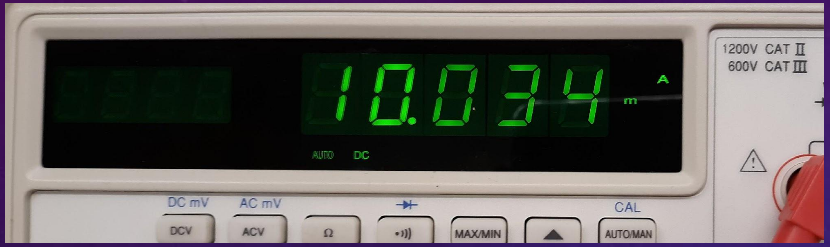
- The first thing that had to be done within this lab was to discover the layout of the Black Box. The Black Box current draw is a given at 10mA with 3 unknown resistors in series provided with 9 volts. In order to find the total resistance you can take this voltage divided by the given current. Doing this gives you a 900Ω total resistance. Since series resistance is the addition of the difference resistors, we decided to use the standard resistors of: 100 Ω, 470 Ω, 330 Ω.

LAB 4 – BLACK BOX DESIGN - SERIES

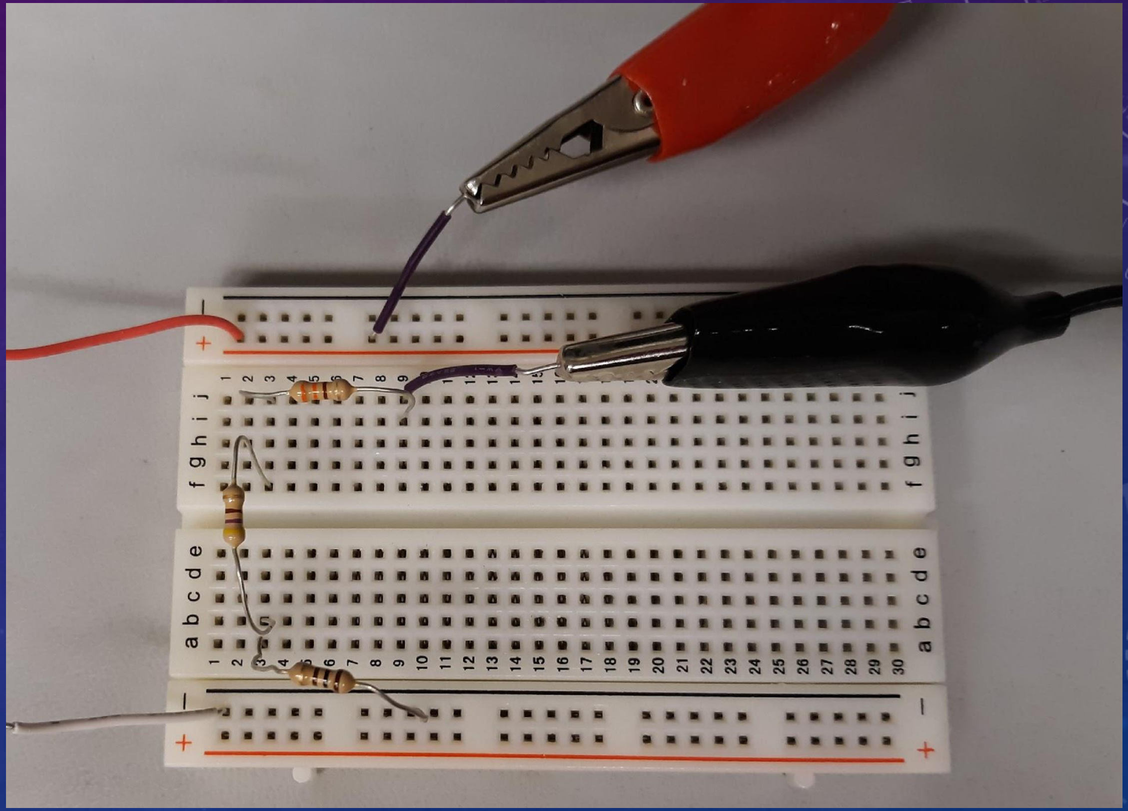


- To unsure this theory worked for the actual application, we built our black box in Multisim and, in fact, received the desired result.

LAB 4 – BLACK BOX DESIGN - SERIES



- Then finding the same result in the lab. As well as using Excel to verify the caculations.



LAB 4 – BLACK BOX DESIGN - RESULTS

- Observations:
  - Even though there were differences in our resistors from the design to the measured, we still were able to get 10mA through the circuit. In order to have the result of 10mA for the current this seemed to be the only combination that would work for standard resistor values.

	Design	Measured	Calculated	Simulated
V1 =	9V	9V	9V	9V
IT =	10mA	10mA	10mA	10mA
RT =	900Ω	885Ω	900Ω	900Ω
R1 =	100Ω	98Ω	100Ω	100Ω
R2 =	470Ω	464Ω	470Ω	470Ω
R3 =	330Ω	323Ω	330Ω	330Ω

LAB 6 – BLACK BOX DESIGN – 3 NOV 2018

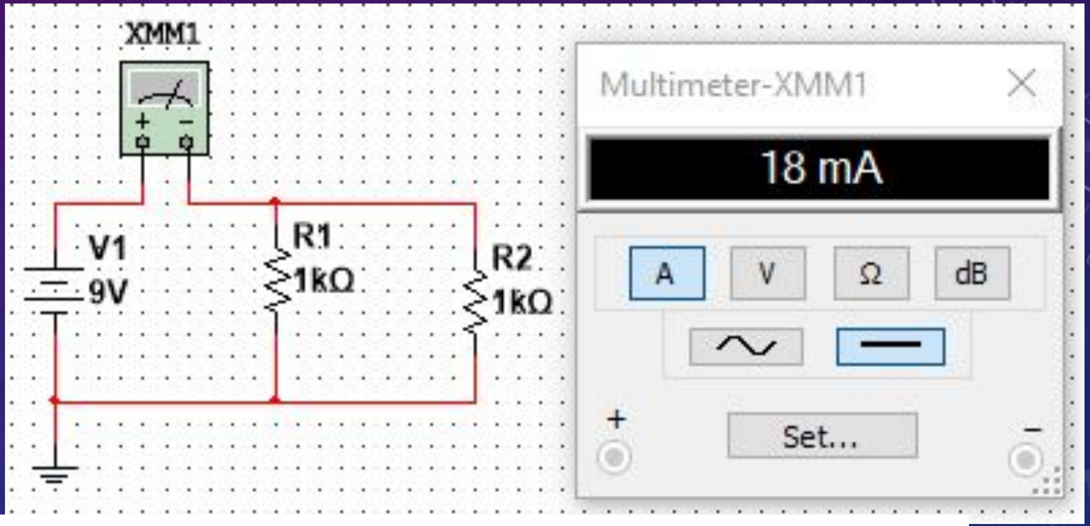
- Purpose:
  - Gain more knowledge on parallel circuits.
- Equipment used:
  - 1 – Digital Multi-meter
  - 1 – Elvis II
  - 3 – Standard resistors
  - MultiSim

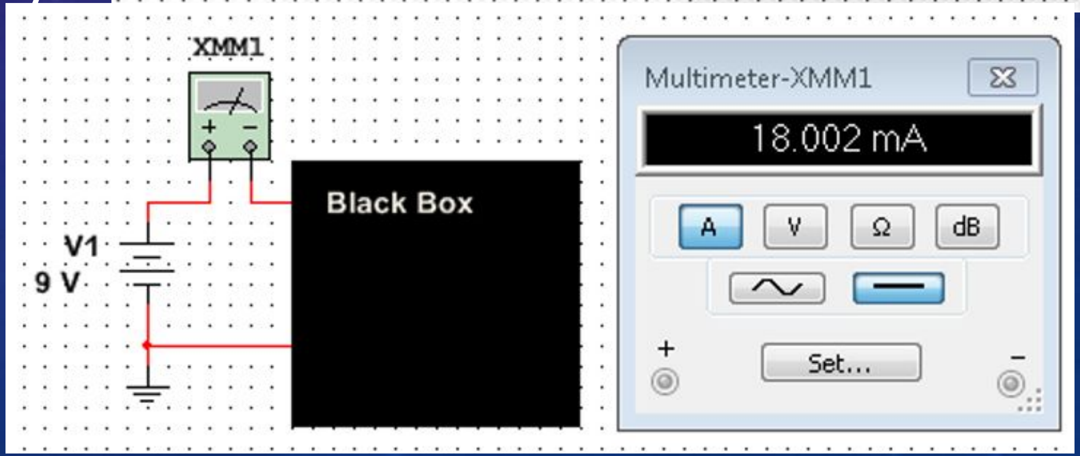
LAB 6 – BLACK BOX DESIGN - PARALLEL

- For this Black Box design the voltage is still 9 volts provided to the box but this time the given current is 18mA. The resistor included this time are only two standard in a parallel circuit. The total resistance can be found in the same way previously, giving us a total resistance of 500Ω. With this information we thought maybe the resistors could be the same value so using the same valued resistor formula multiplying the total resistance by 2 resulting in 1000Ω or 1kΩ. This did end up being the case as we moved forward with the lab.

LAB 6 – BLACK BOX DESIGN - PARALLEL

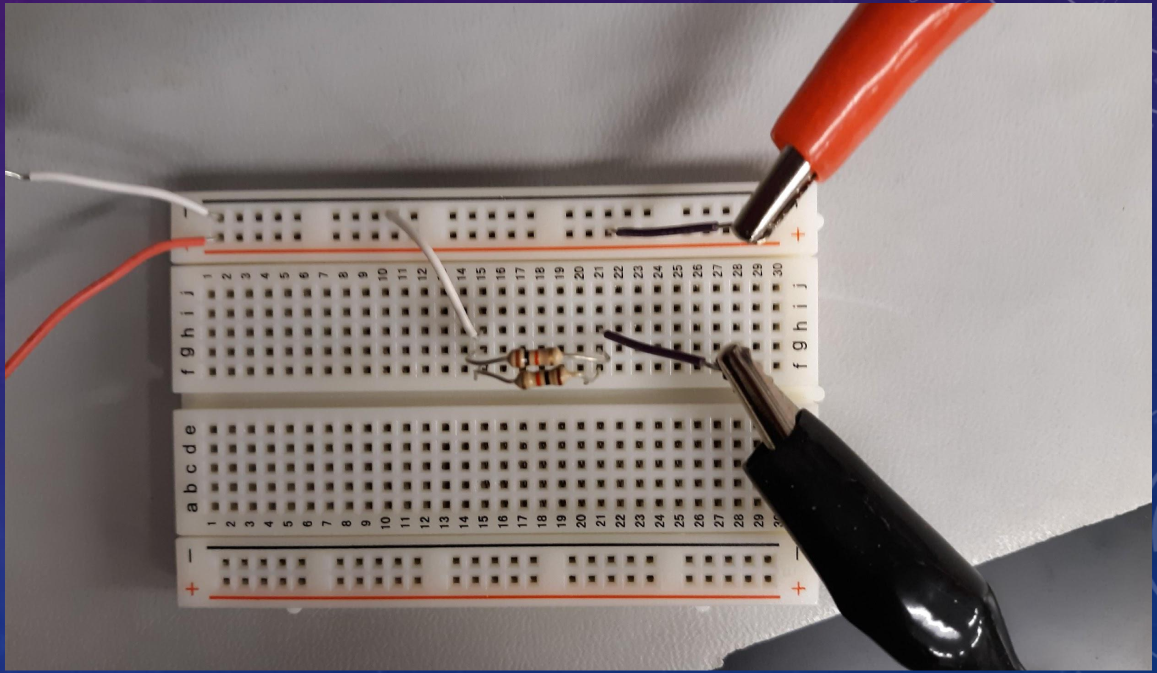
- To verify the information that we had gather we put this idea into MultiSim. Then used excel to verify the calculations.





LAB 6 – BLACK BOX DESIGN – PARALLEL

- Then we created our design in the lab to obtain the same results.



LAB 6 – BLACK BOX DESIGN - RESULTS

- Observations:
  - Using parallel within a black box would seem to be slightly more difficult than series just because if we would have had more that 2 resistors, the process would be more of a guessing game.

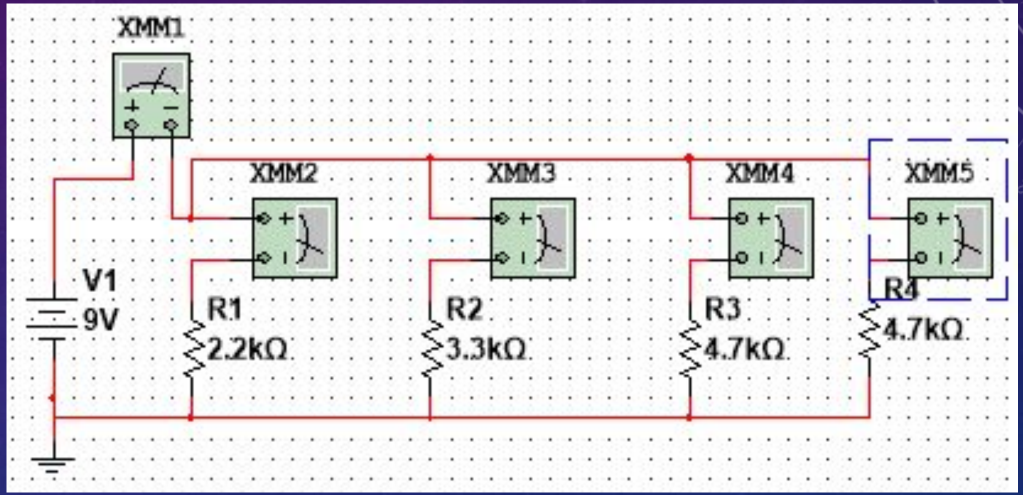
	Design	Measured	Calculated	Simulated
V1 =	9V	9V	9V	9V
IT =	18mA	17.7mA	18mA	18mA
RT =	500Ω	493 Ω	500 Ω	500 Ω
R1 =	1k Ω	0.99k Ω	1k Ω	1k Ω
R2 =	1k Ω	0.98k Ω	1k Ω	1k Ω

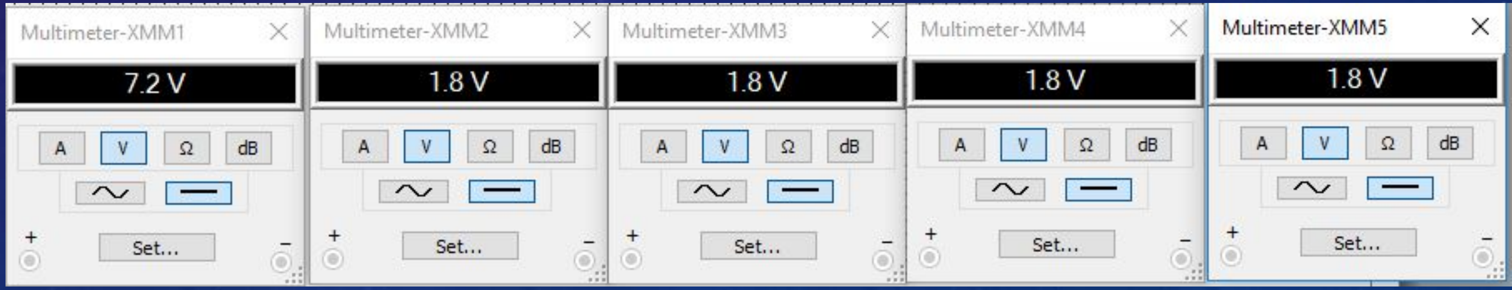
LAB 7 – 4 RESISTOR PARALLEL CIRCUIT – 3 NOV 2018

- Purpose:
  - To gain more knowledge about parallel circuits
- Equipment used:
  - 1 – Digital Multi-meter
  - 1 – Elvis II
  - 3 – Standard resistors
  - MultiSim

LAB 7 - 4 RESISTOR PARALLEL CIRCUIT

- First we built a MutiSim that applied 9 volts to 4 parallel resistors of various values while measuring the current of each branch. These resistors included: 2.2kΩ, 3.3k Ω, and two 4.7k Ω.





LAB 7 – 4 RESISTOR PARALLEL CIRCUIT

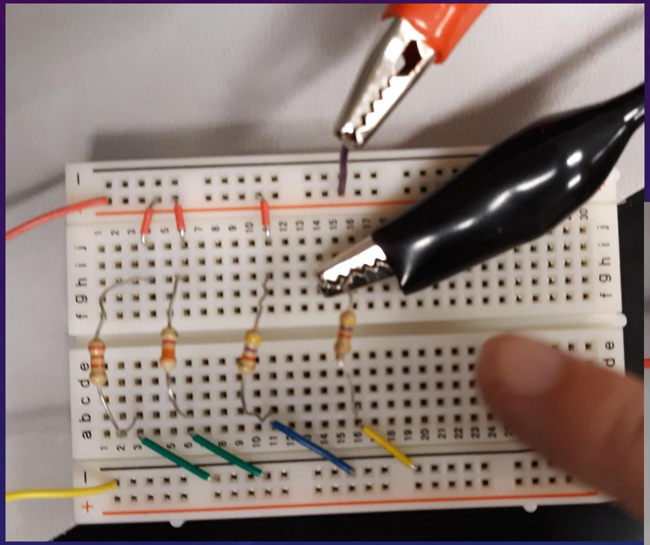
- We also created an excel to unsure we understood how to calculate the values for parallel circuits, and to verify we obtained the same values as simulated. This included dividing the voltage by the resistance of each branch and parallel resistance formula.

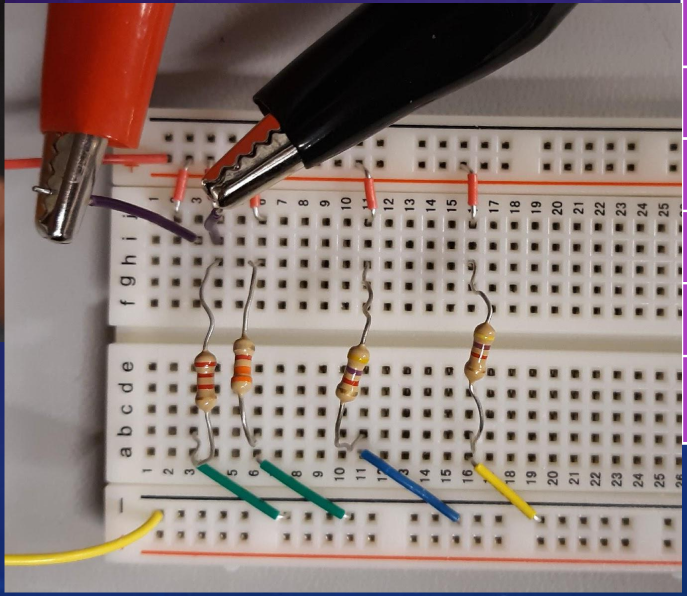
V1=	9
IT=	10.6E-3
I1=	4.091E-3
I2=	2.727E-3
I3=	1.915E-3
I4=	1.915E-3
R1=	2.200E+3
R2=	3.300E+3
R3=	4.700E+3
R4=	4.700E+3
RT=	845.23

	A	B
1	V1=	9
2	IT=	=B1/B11
3	I1=	=B1/B7
4	I2=	=B1/B8
5	I3=	=B1/B9
6	I4=	=B1/B10
7	R1=	2200
8	R2=	3300
9	R3=	4700
10	R4=	4700
11	RT=	=1/((1/B7)+(1/B8)+(1

LAB 7 – 4 RESISTOR PARALLEL CIRCUIT

Built in Lab





Results

	Measured	Calculated	Simulated
V1 =	9V	9V	9V
RT =	834.15Ω	845.23Ω	845.23Ω
I1 =	4.10mA	4.091mA	4.091mA
I2 =	2.68mA	2.727mA	2.727mA
I3 =	1.92mA	1.915mA	1.915mA
I4 =	1.92mA	1.919mA	1.919mA
IT =	10.62mA	10.648mA	10.648mA

	Design	Measured
R1 =	2.2k Ω	2.15 k Ω
R2 =	3.3k Ω	3.28k Ω
R3 =	4.7k Ω	4.74k Ω
R4 =	4.7k Ω	4.59 kΩ

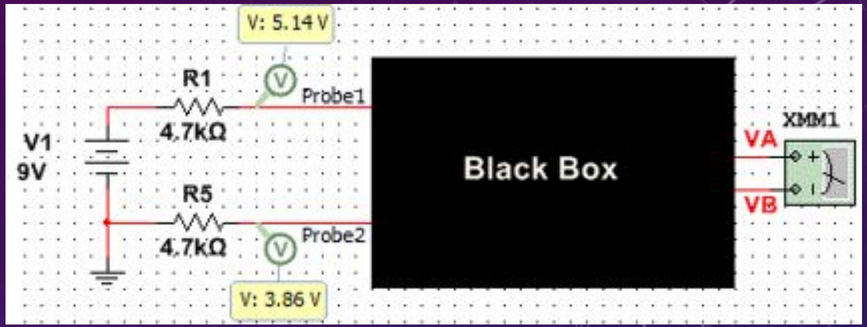
LAB 7 – 4 RESISTOR PARALLEL CIRCUIT - OBSERVATIONS

- Measuring current within a parallel circuit is different than measure current in series
- Each leg of the circuit pulled different current besides the two that had the same resistance
- Even with slight differences in out resistances our numbers still were pretty close to what we calculated and simulated

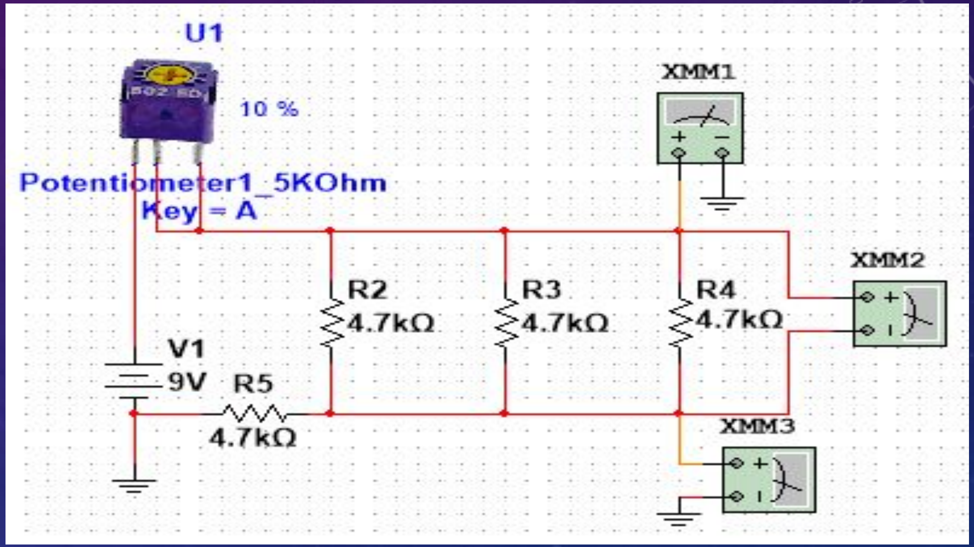
LAB 8 – BLACK BOX 3 DESIGN – 10 NOV 2018

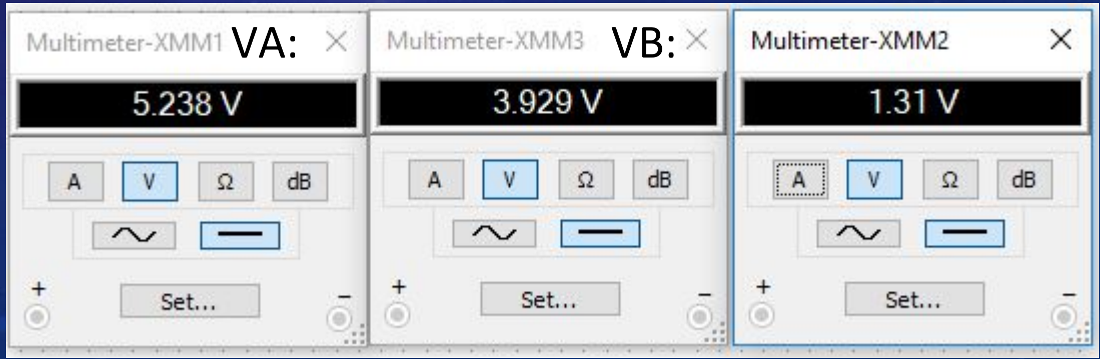
- Purpose:
  - Learning how to build a circuit that produces a set amount of voltage.
- Equipment Used:
  - 1 – Digital Multi-meter
  - 1 – Elvis II
  - MultiSim
  - 5 – Standard Resistors
  - 1 – 5k ohm Potentiometer

LAB 8 – BLACK BOX 3 DESIGN

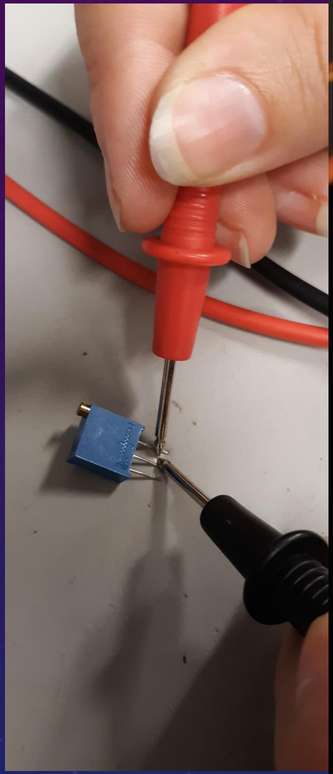


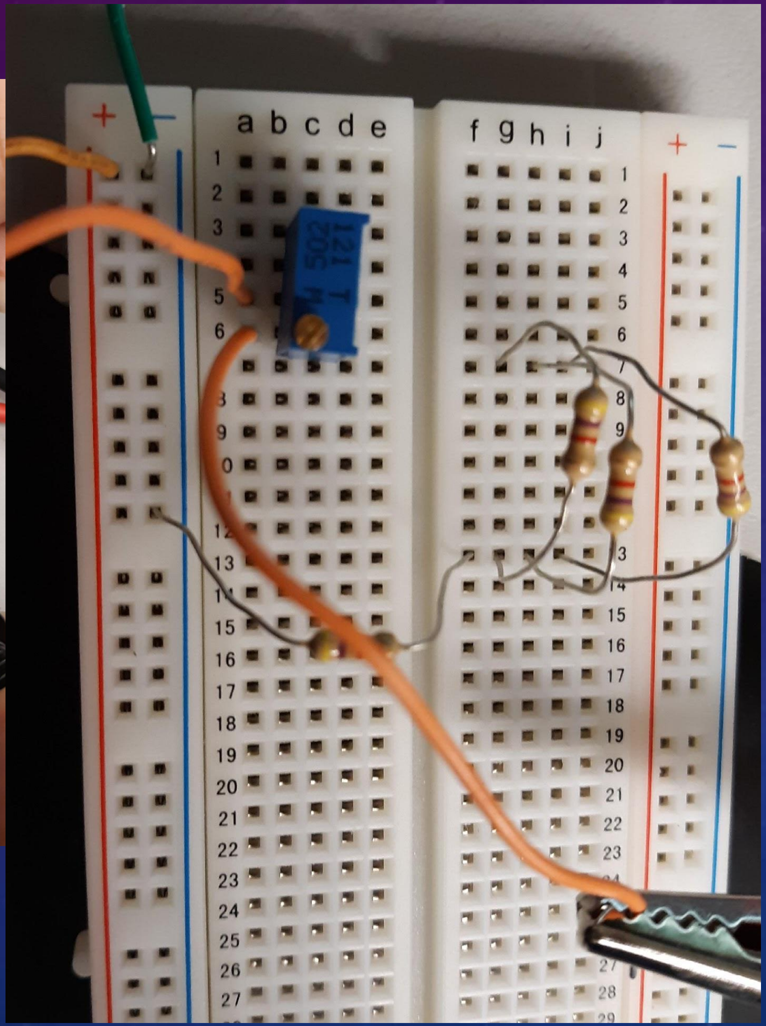
- First we designed a MutliSim to represent the black box using four 4.7k Ω resistors and a potentiometer as R1. Within the simulation the Pot is set at 10% so this would represent 4.5k Ω of resistance.





LAB 8 – BLACK BOX 3 DESIGN





- Then using a potentiometer as the variable resistor we created the schematic in the lab. We first measured the resistor to set it to 4.7k. Once everything was in place we adjusted the Pot until the output voltage was 1.3V. Then measured the pot again to find the adjusted voltage.

LAB 8 – BLACK BOX 3 DESIGN - OBSERVATIONS

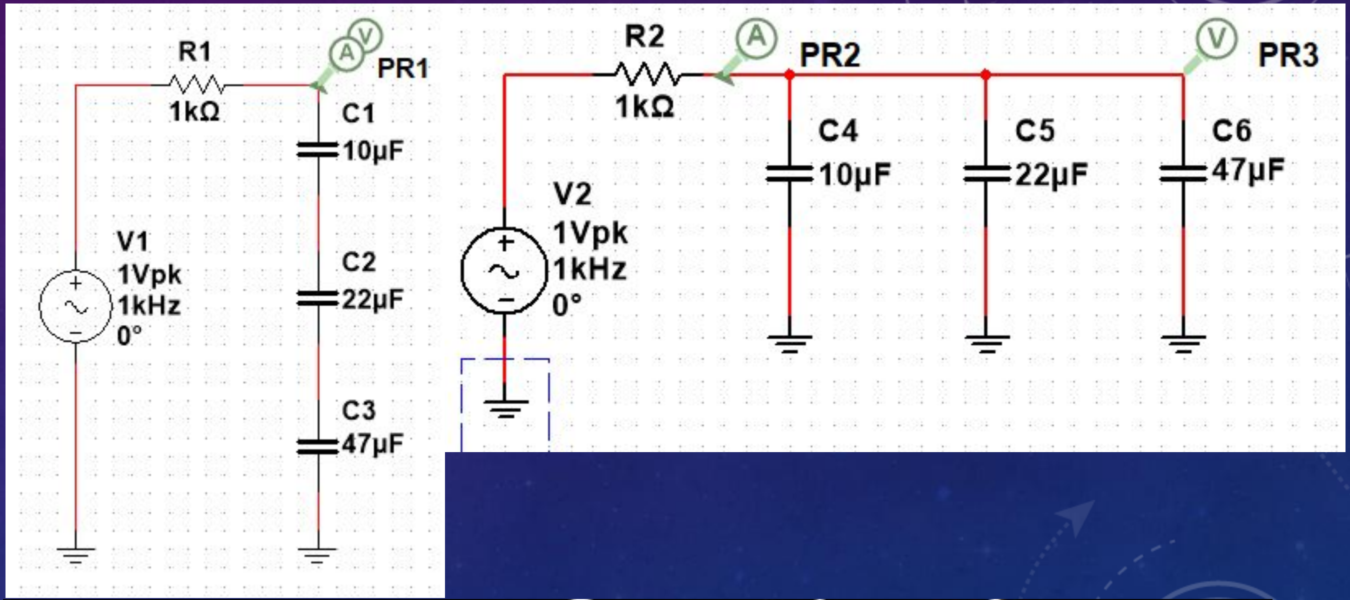
- The potentiometer is very useful when you need a very specific output value.
- Wiring the potentiometer was a little tricky at first because there are three pins total

LAB 10 – SERIES/PARALLEL – 7 NOV 2018

- Purpose:
  - To experiment and gain more knowledge on how capacitors work in the different type of circuits
- Equipment used:
  - LCR Meter
  - Elvis II
  - 10uF, 22uF, 47uF capacitors
  - MultiSim

LAB 10 – SERIES/PARALLEL CAPACITORS

- Created a schematic in MultiSim of both a series and a parallel circuit of capacitors. Using the Single Frequency AC function we were then able to find the capacitance by inserting the equation.



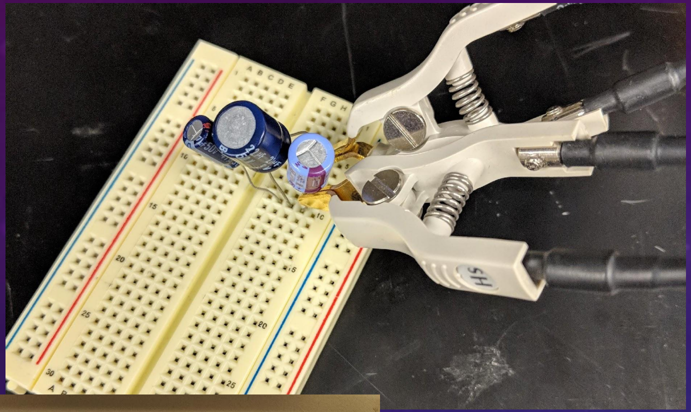
	Variable	Magnitude
1	1/(2*pi*1000*(V(PR1)/I(PR1)))	5.99768 u
2	1/(2*pi*1000*(V(PR3)/I(PR2)))	79.00000 u

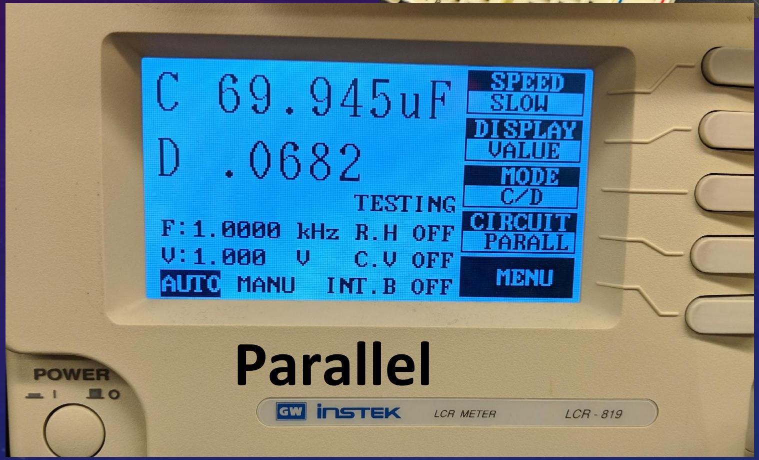
LAB 10 – SERIES/PARALLEL CAPACITORS

- In excel, we used similar techniques to calculating total resistance to calculate total capacitance.

Series	
C1=	10
C2=	22
C3=	47
CT=	5.99768
Parallel	
C1=	10
C2=	22
C3=	47
CT=	79

LAB 10 – SERIES/PARALLEL CAPACITORS





Parallel

Series

- Using the schematic that we used, we then created the same thing in the lab with 3 capacitors. First measuring each one then wring them together then measuring the total capacitance.

LAB 10 – SERIES/PARALLEL CAPACITORS

Observations

- Capacitors are much harder to measure and cannot be measured directly such as voltage and current.
- The series circuit was more accurately measured than the parallel. This could be due to the efficiency of the equipment.

Results

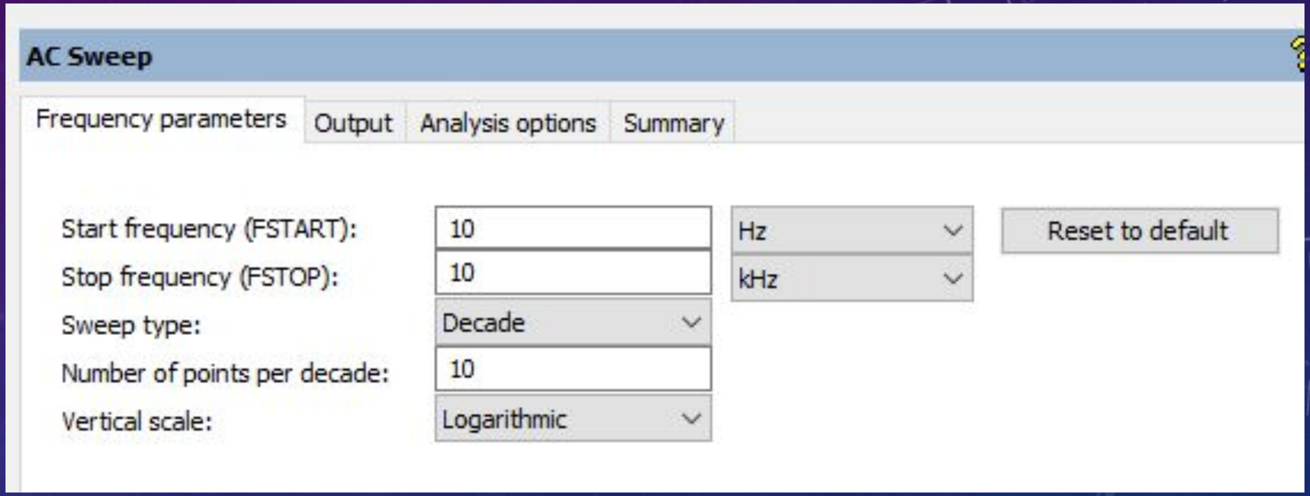
Series	Expected	Measured
C1 =	10uF	9.8uF
C2 =	22u	23.5uF
C3 =	47u	46.9uF
CT =	5.998uF	5.85uF
Parallel	**Expected**	**Measured**
C1 =	10uF	9.8uF
C2 =	22uF	23.5uF
C3 =	47uF	46.9uF
CT =	79uF	69.94uF

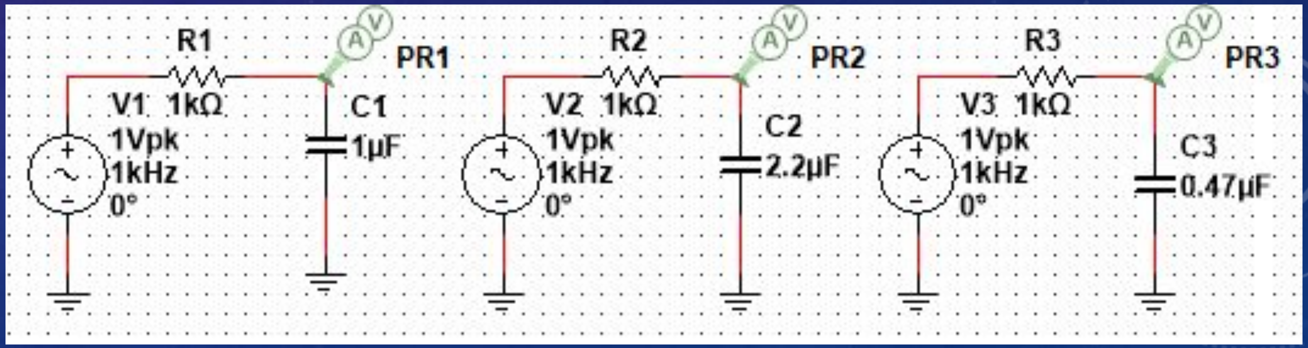
LAB 11 – RC LAB – 7 NOV 2018

- Purpose:
  - Experiment with resistance and capacitance
- Equipment Needed:
  - 1 – Digital Multimeter
  - 1 – LCR Meter
  - 1 – Oscilloscope
  - 1 – Function Generator
  - 1 – Elvis II
  - 0.47uF, 1uF, 2.2uF Capacitors
  - 1 – 1k Resistor

LAB 11 – RC LAB

- Created 3 circuits with the same value resistor and different valued resistors. Then used the AC sweep to measure the varying values at different frequencies. Then exported the information to an excel sheet (shown on next slide).





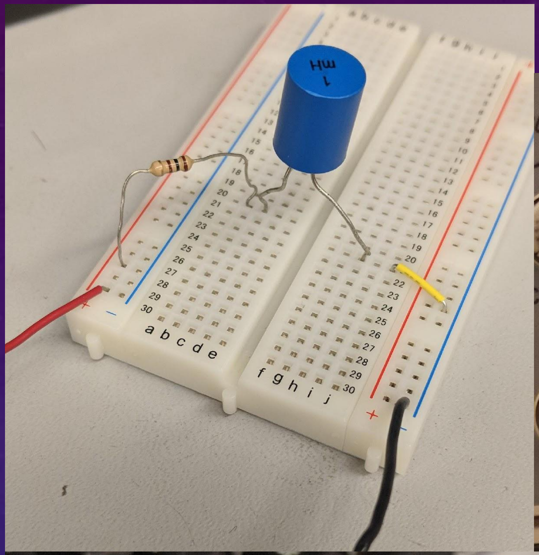
LAB 11 – RC LAB

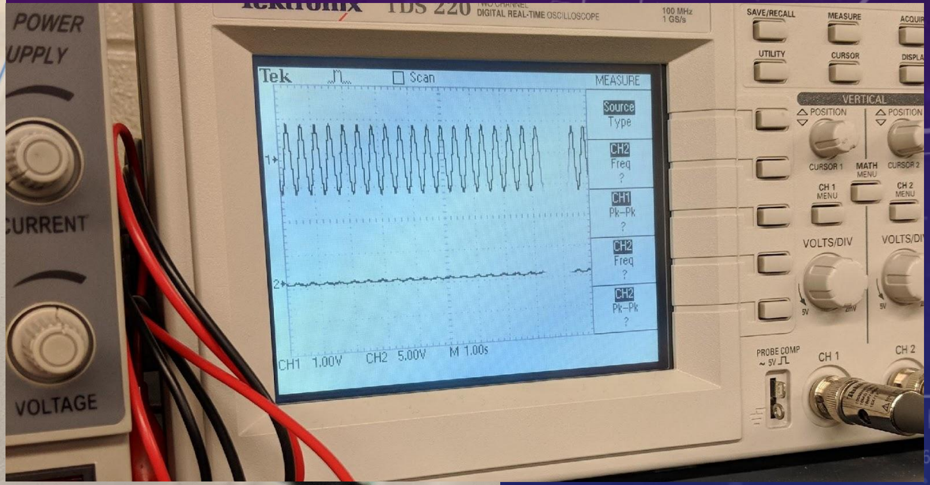
Excel

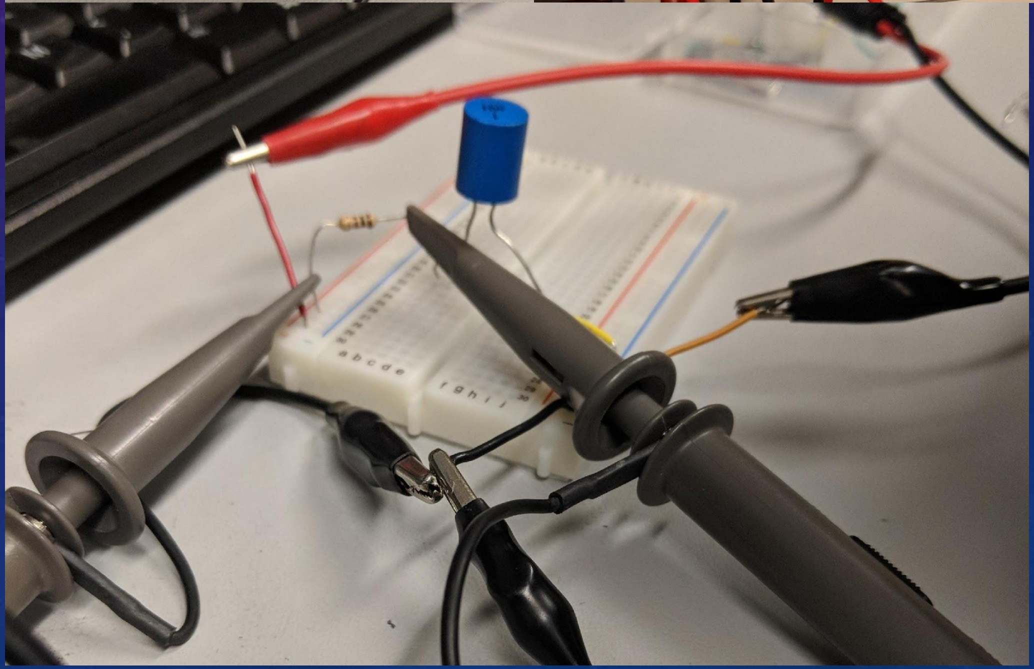
X--Trace 1::[V(1) | V(PR1)]	Y--Trace 1::[V(1) | V(PR1)]		X--Trace 2::[V(3) | V(PR2)]	Y--Trace 2::[V(3) | V(PR2)]		X--Trace 3::[V(6) | V(PR3)]	Y--Trace 3::[V(6) | V(PR3)]
10	0.998032		10	0.990581		10	0.999564
12.58925	0.996886		12.58925	0.985194		12.58925	0.99931
15.84893	0.995078		15.84893	0.976833		15.84893	0.998907
19.95262	0.992233		19.95262	0.964007		19.95262	0.998269
25.11886	0.987773		25.11886	0.944675		25.11886	0.99726
31.62278	0.980827		31.62278	0.916285		31.62278	0.995668
39.81072	0.970111		39.81072	0.876103		39.81072	0.99316
50.11872	0.953825		50.11872	0.822006		50.11872	0.989224
63.09573	0.929613		63.09573	0.753632		63.09573	0.98308
79.43282	0.894752		79.43282	0.673343		79.43282	0.973573
100	0.846733		100	0.586134		100	0.959055
125.8925	0.784298		125.8925	0.498238		125.8925	0.93732
158.4893	0.708587		158.4893	0.415242		158.4893	0.905708
199.5262	0.623581		199.5262	0.340861		199.5262	0.861563
251.1886	0.535217		251.1886	0.276754		251.1886	0.803156
316.2278	0.449565		316.2278	0.223008		316.2278	0.730866
398.1072	0.371214		398.1072	0.17879		398.1072	0.647911
501.1872	0.302662		501.1872	0.142863		501.1872	0.559843
630.9573	0.244583		630.9573	0.11391		630.9573	0.472888
794.3282	0.196459		794.3282	0.090699		794.3282	0.392159
1000	0.157177		1000	0.072155		1000	0.320737
1258.925	0.125423		1258.925	0.05737		1258.925	0.259749
1584.893	0.099917		1584.893	0.045598		1584.893	0.208944
1995.262	0.079514		1995.262	0.036234		1995.262	0.167323
2511.886	0.063234		2511.886	0.028788		2511.886	0.133601
3162.278	0.050266		3162.278	0.022871		3162.278	0.106475
3981.072	0.039946		3981.072	0.018169		3981.072	0.084753
5011.872	0.03174		5011.872	0.014433		5011.872	0.067411
6309.573	0.025216		6309.573	0.011465		6309.573	0.053592
7943.282	0.020032		7943.282	0.009107		7943.282	0.042592
10000	0.015913		10000	0.007234		10000	0.033843

LAB 11 – RC LAB

- Created the same thing in the lab and used the oscilloscope to measurements.







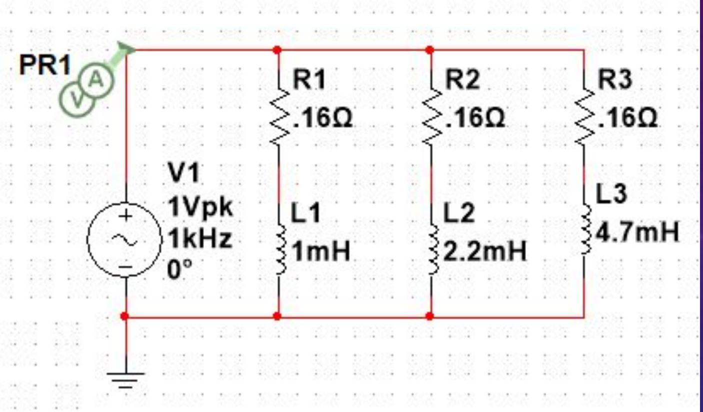
LAB 11 – RC LAB

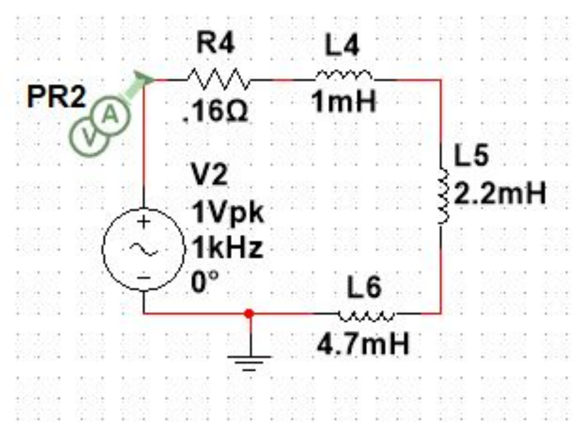
- Observations
  - Figuring out how to do the AC sweep to find the data points was an interesting task.
  - Although we do not have any measured data I remember when we were measuring data we realized half way though that we were set on the wrong voltage and had to get assistance from the other class to finish collecting the data that we lost.
  - We originally set up the wiring for the oscilloscope wrong creating inaccurate data and also not realizing we could adjust the voltage.

LAB 12 – SERIES/PARALLEL INDUCTORS – 28 NOV 2018

- Purpose:
  - Experiment and gain more knowledge of inductors in series and parallel circuits
- Equipment needed:
  - 1 – LCR Meter
  - 1 – Elvis II
  - 1mH, 2.2mH, 4.7mH Inductors

LAB 12 - SERIES/PARALLEL INDUCTORS

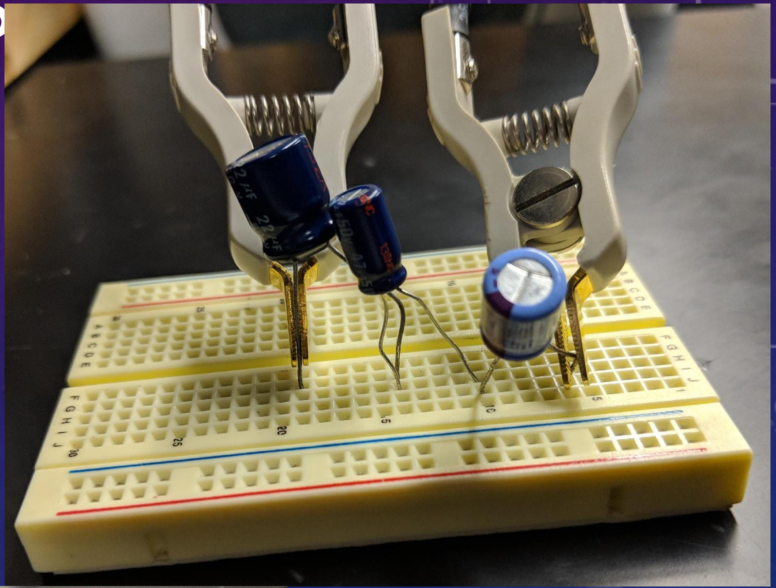




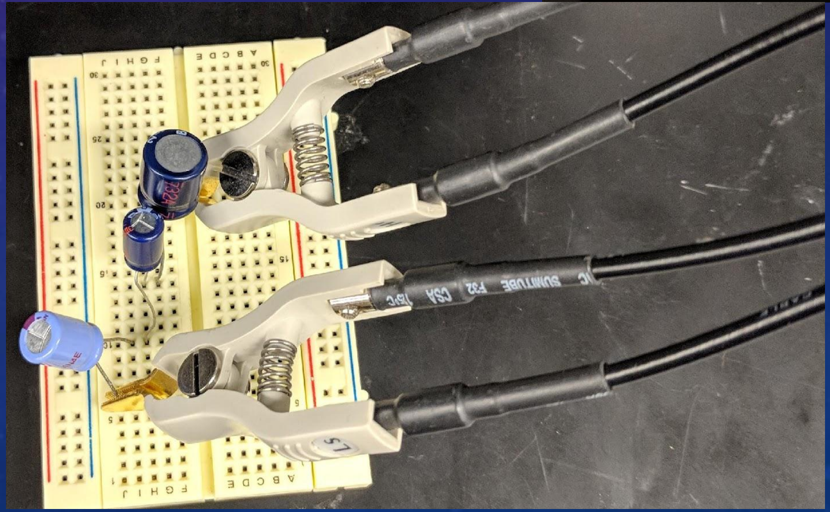
- Built inductors of the given values in series and in parallel in MultiSim. Then used Single Frequency function to obtain the total inductance.

	Variable	Magnitude	Phase (deg)
1	V(PR1)/(I(PR1)*2*pi*1000)	599.91573 u	88.90476
2	V(PR2)/(I(PR2)*2*pi*1000)	7.90004 m	89.81531

LAB 12 – SERIES/PARALLEL INDUCTORS



- We built our creation in the lab to obtain measured results using the LCR meter.



LAB 12 – SERIES/PARALLEL INDUCTORS

Results

Series	Expected	Simulated	Measured
L1 =	1m	1m	.98m
L2 =	2.2m	2.2m	2.1m
L3 =	4.7m	4.7m	4.52m
LT =	7.9m	7.9m	7.9m

Parallel	Expected	Simulated	Measured
L1 =	1m	1m	1m
L2 =	2.2m	2.2m	2.2m
L3 =	4.7m	4.7m	4.7m
LT =	600u	600u	599u

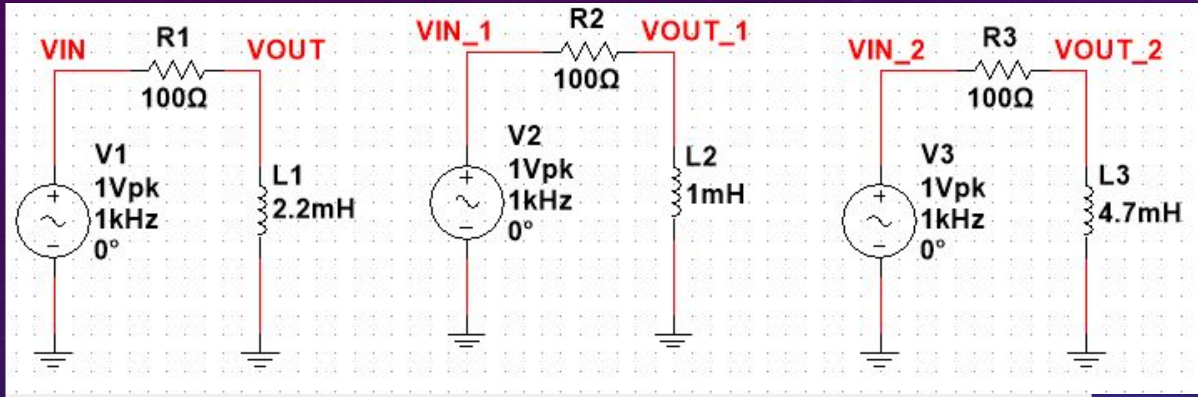
Observations

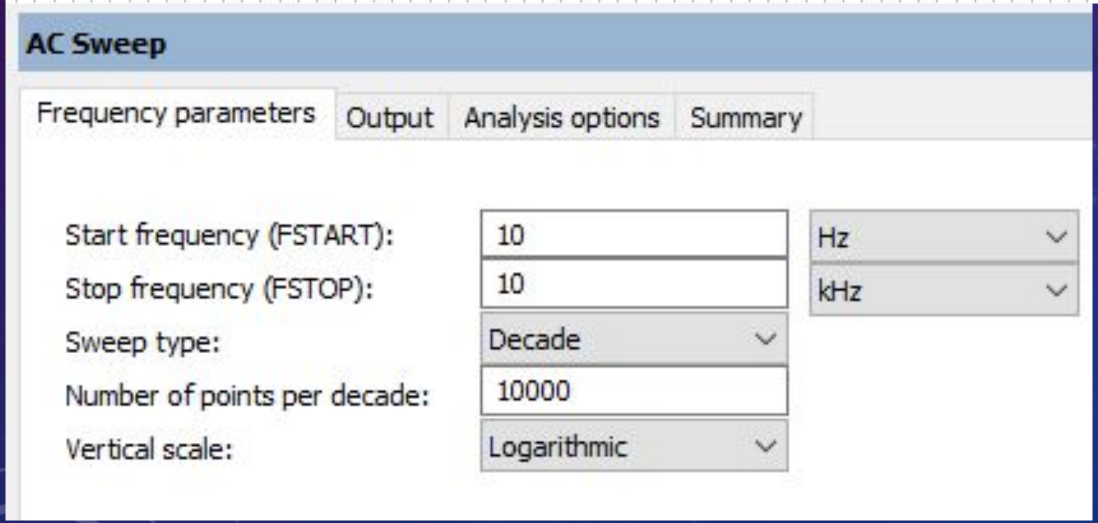
- Inductors work a lot like capacitors.
- The measured values are almost exactly like the expected values which made the measured inductance what we anticipated it to be.
- If the parallel inductors are not paired with resistors they do not work properly

LAB 13 – RL LAB – 5 DEC 2018

- Purpose
  - Experiment and gain more knowledge on circuit containing resistors and inductors
- Equipment Used:
  - 1 – Digital Multimeter
  - 1 – LCR Meter
  - 1 – Oscilloscope
  - 1 – Function Generator
  - 1 – Elvis II
  - 3 – inductors: 1mF, 2.2mF, 4.7mF
  - 1 – 100 ohm resistor

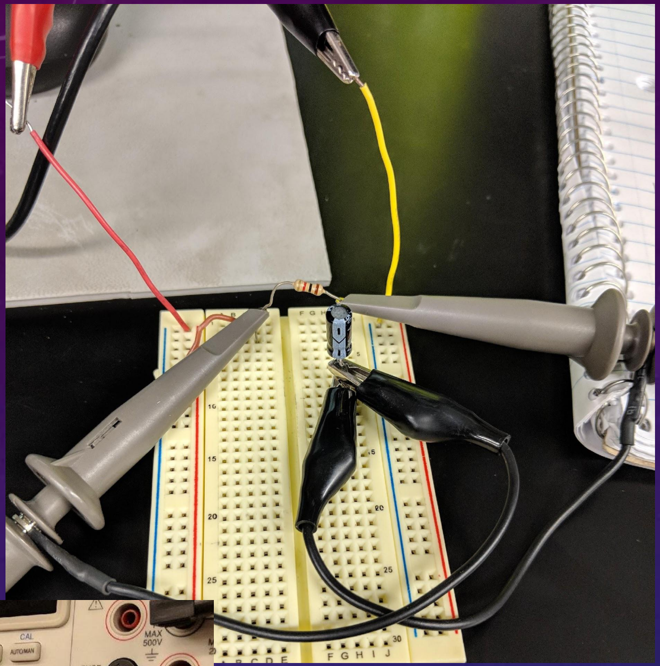
LAB 13 - RL LAB

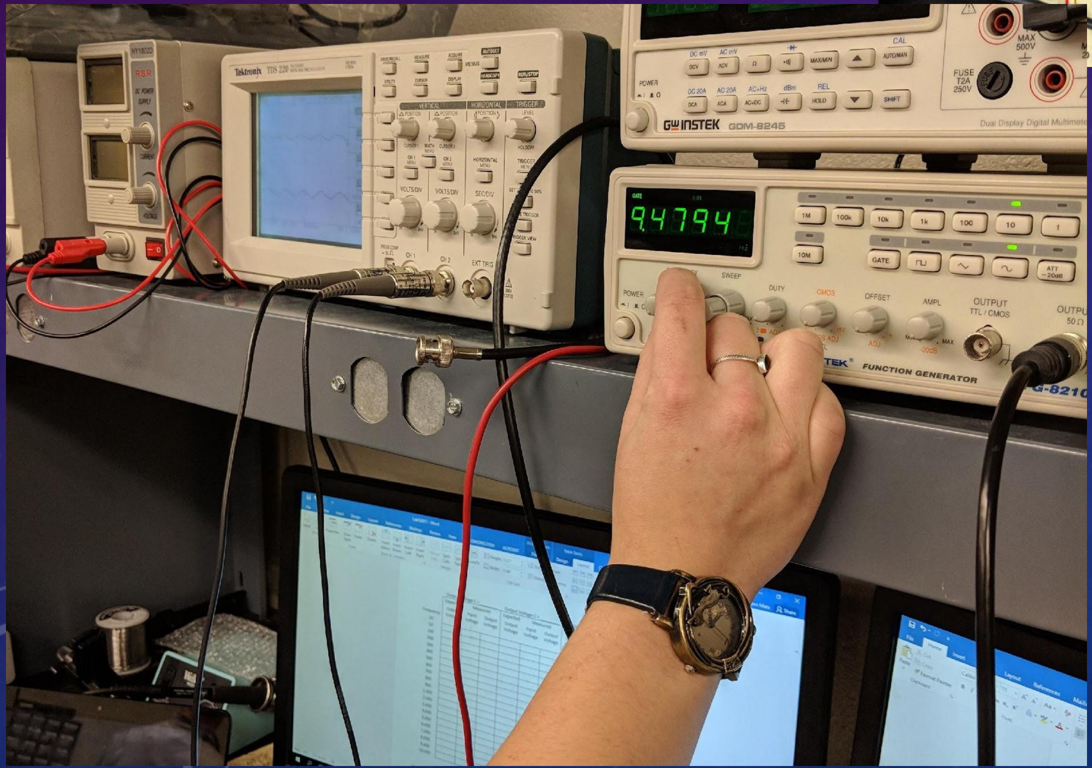




- MultiSim creation with the given inductors, using the AC Sweep function to gather data points at different frequencies. We ended up using 10,000 data point so that we could get an accurate measurement for the points needed.

LAB 13 – RL LAB





- Created the same thing in the lab using the function generator to change the frequency and the oscilloscope to gather the information.

LAB 13 – RL LAB Results

	Expected	Measured
L1 =	1m	1.19m
L2 =	2.2m	2.2m
L3 =	4.7m	4.3m
R1 =	100ohm	98.8ohm

	Output Voltage L = __1_____			Output Voltage L = __2.2___			Output Voltage L = __4.7___		
	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	.00063	1.12	.032	.00138	1.16	.063	.00295	1.18	.112
50	.00314	1.44	.0336	.00691	1.44	.062	.0147	1.44	.114
100	.00628	1.44	.0344	.0138	1.46	.064	.0295	1.46	.118
200	.0125	1.44	.0384	.0276	1.44	.072	.0589	1.48	.132
300	.0188	1.46	.0448	.0414	1.44	.084	.0882	1.48	.154
400	.0251	1.46	.0504	.0552	1.52	.098	.1172	1.52	.184
500	.0313	1.46	.0568	.0689	1.52	.114	.1460	1.52	.208
600	.0376	1.46	.0624	.0826	1.48	.130	.1744	1.52	.240
700	.0439	1.46	.0704	.0962	1.48	.144	.2024	1.52	.272
800	.0502	1.48	.082	.1099	1.5	.164	.2299	1.52	.296
900	.0564	1.52	.088	.1234	1.5	.178	.2568	1.54	.328
1,000	.0627	1.52	.98	.1369	1.52	.2	.2832	1.54	.360
2,000	.1246	1.5	.176	.2664	1.52	.376	.5085	1.6	.7
3,000	.1852	1.5	.256	.3830	1.54	.528	.6631	1.68	.980
4,000	.2437	1.5	.336	.4838	1.6	.696	.7632	1.8	1.2
5,000	.2997	1.54	.432	.5685	1.68	.920	.8279	1.8	1.36
6,000	.3527	1.54	.504	.6383	1.72	1.02	.8708	1.92	1.6
7,000	.4026	1.56	.576	.6953	1.76	1.12	.9002	1.96	1.68
8,000	.4490	1.58	.640	.7416	1.8	1.26	.9209	2	1.8
9,000	.4921	1.6	.712	.7793	1.84	1.32	.9359	2.04	1.84
10,000	.5320	1.68	.840	.8102	1.8	1.4	.9472	2.08	1.92

LAB 13 – RL LAB

- Observations:
  - There was only a slight increase for the input voltage in the lab whereas there was no increase at all for the simulated input voltage, this is partly due to the equipment’s inability for precision. Although the difference between the simulation and the actually measured values is great, they still stay on similar increasing trend lines. The higher input voltage and the abilities of the capacitors factor in these differences.