Lab 3 Report | Frequency Filters | ECE 1000

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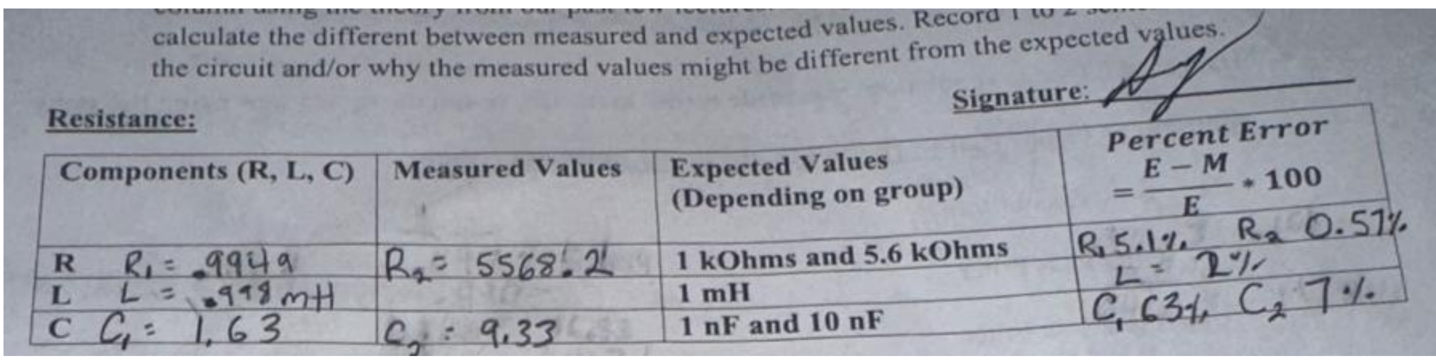
The purpose of this lab is to demonstrate the ability to read frequency through different types of filters (low and high pass as well as band pass). We build three types of filters using different components to show that you can get the same result, RC (capacitor) and RL (inductor) alongside a band pass filter. This lab also teaches the fundamentals of digital multimeters, LCR meters, function generators, and oscilloscopes. Landon Courtney, Miller Kites, and Duncan Killer were other students alongside me.

Part 1: Measuring Resistors and Capacitors as well as Inductor Values

Word table:

Components (R, L, C)	Measured Values	Expected Values	Percent Error
R1, R2 (kilo-ohms)	.994k, 5.568k	1k, 5.6k	5.1%, 0.57%
L (milli-henry)	.998mH	1mH	2%
C1, C2 (micro-farads)	1.63nF, 9.33	1nF, 10nF	63%, 7%

Report paper table:



calculate the different between measured and expected values. Record 1 to 2 ...
the circuit and/or why the measured values might be different from the expected values.

Signature:

Resistance:

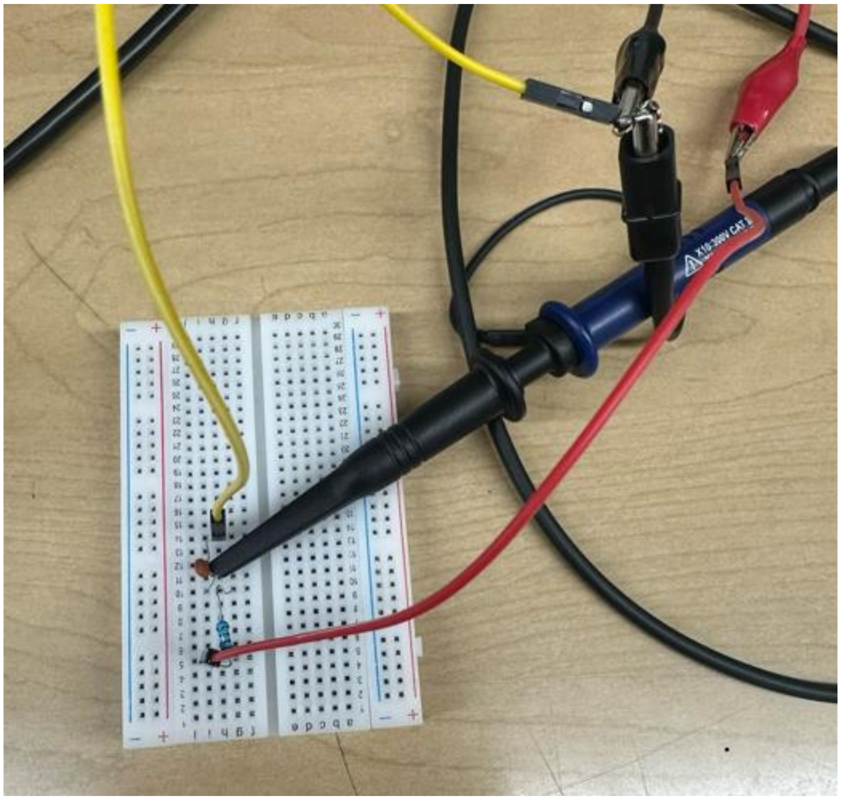
Components (R, L, C)	Measured Values	Expected Values (Depending on group)	Percent Error $= \frac{E-M}{E} * 100$
R $R_1 = .9949$	$R_2 = 5568.2$	1 kOhms and 5.6 kOhms	R_1 5.1% R_2 0.57%
L $L = .998$ mH		1 mH	$L = 2\%$
C $C_1 = 1.63$	$C_2 = 9.33$	1 nF and 10 nF	C_1 63% C_2 7%

Thoughts: What are my thoughts:

Not many thoughts here, just measuring the parts used in lab. Good to learn how to use the multimeter for measuring capacitor and the inductor. Calculated percent error and good to note that these have high percent error due to fewer quality parts.

Part 2: Low Pass Filter Circuits

Picture of Low Pass Filter with Capacitor:



Picture of Low Pass Filter with Inductor:

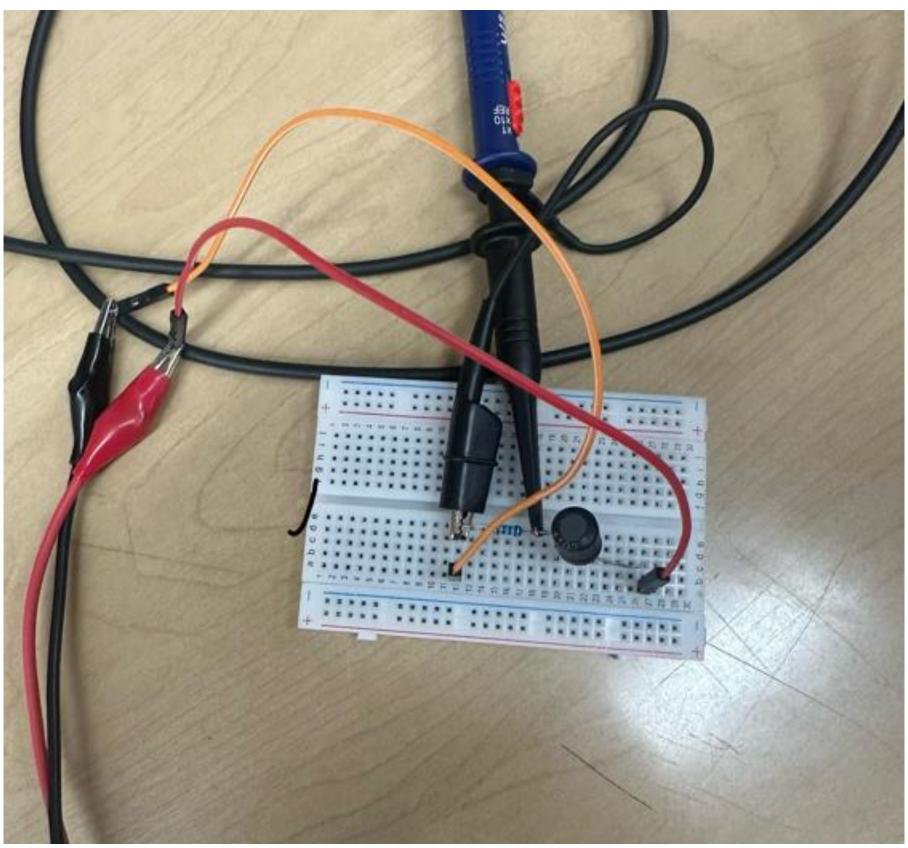


Table for Physical Circuit Values: (Low Pass)

Cutoff Frequencies	Expected Frequency (Prelab)	Voltage @ Cutoff (mV)	Measured Frequency (kHz)
RC LPF	98.14kHz	700mV	103kHz
RL LPF	158.66kHz	640mV	160kHz

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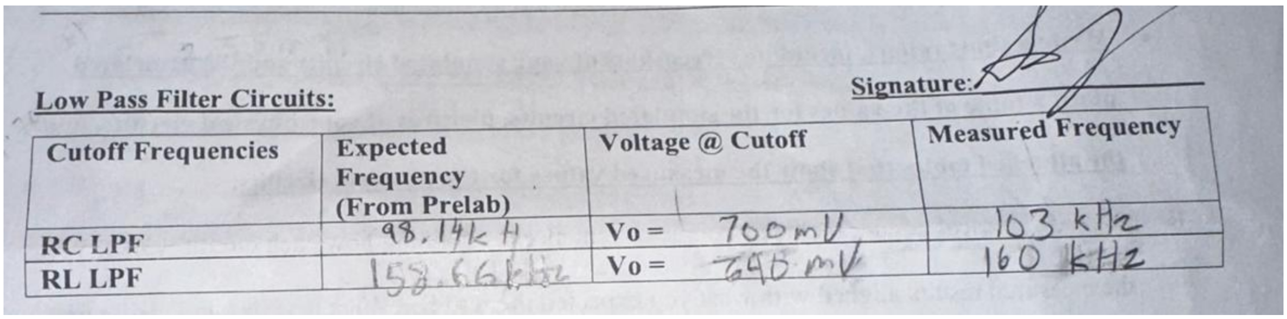

Low Pass Filter Circuits:

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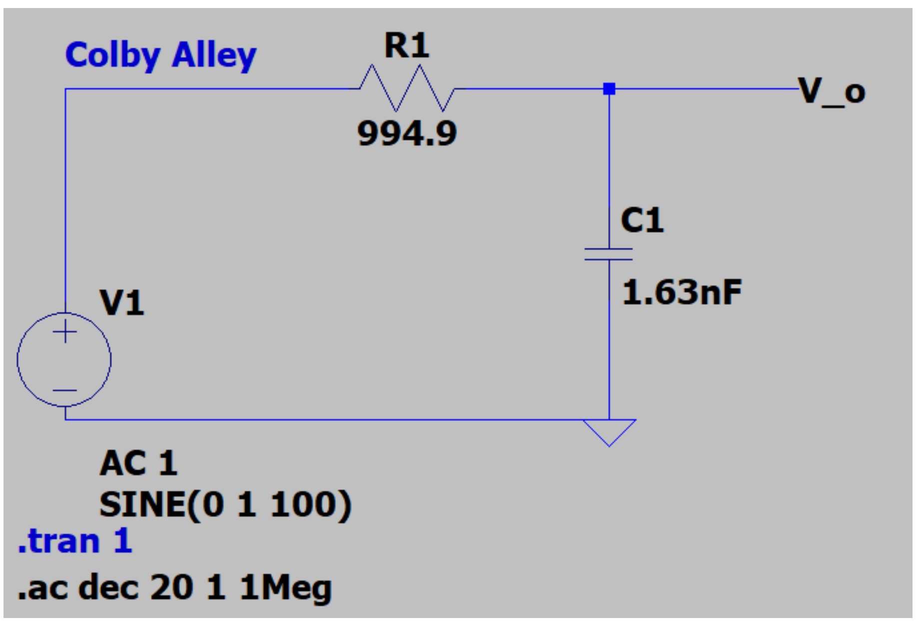
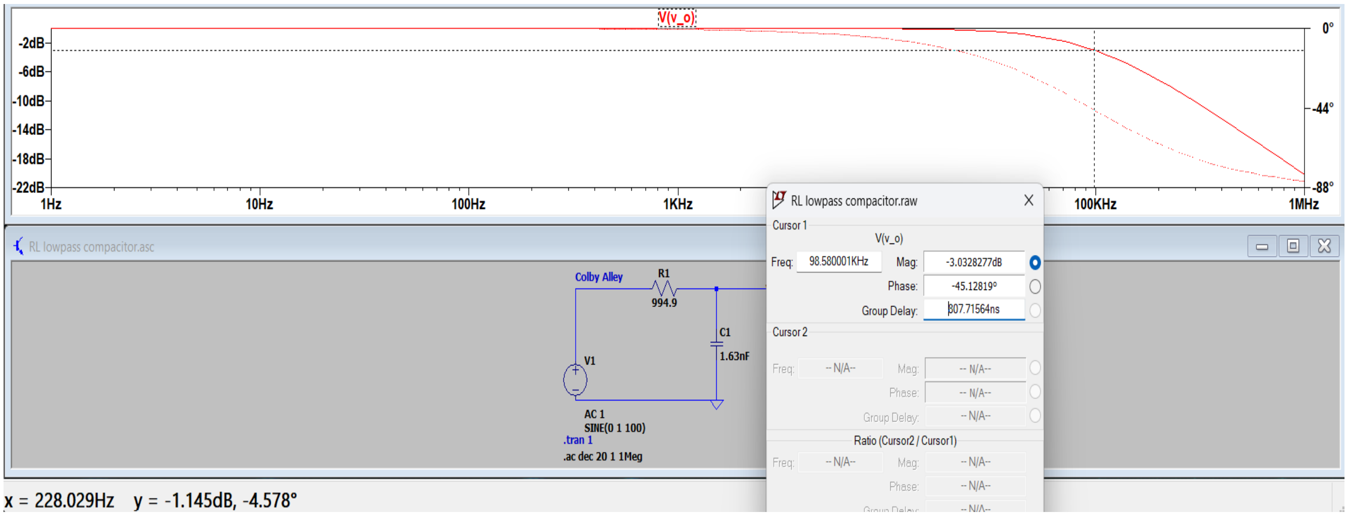
Cutoff Frequencies	Expected Frequency (From Prelab)	Voltage @ Cutoff	Measured Frequency
RC LPF	98.14k H	Vo = 700 mV	103 kHz
RL LPF	158.66kHz	Vo = 640 mV	160 kHz

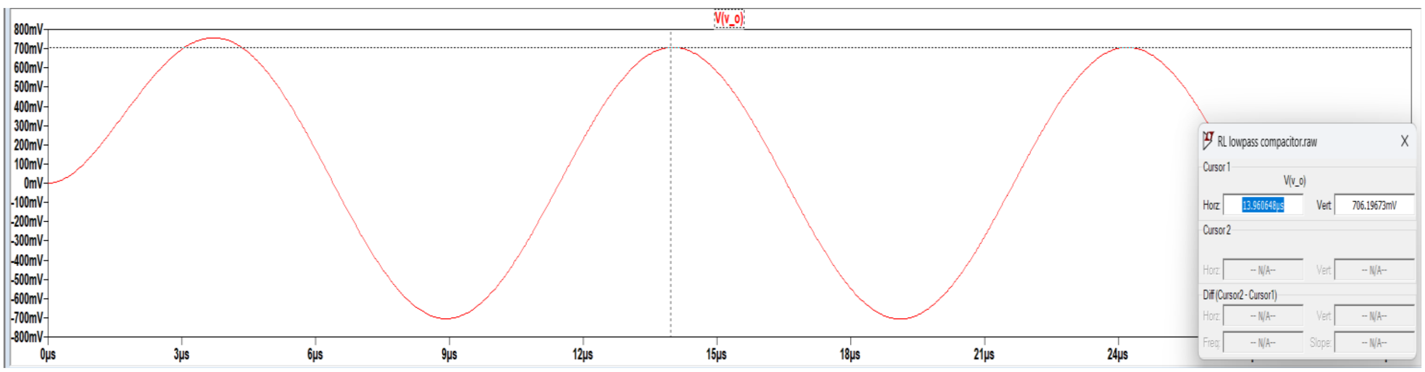
Picture of LTSpice Low Pass Capacitor Filter with Values:



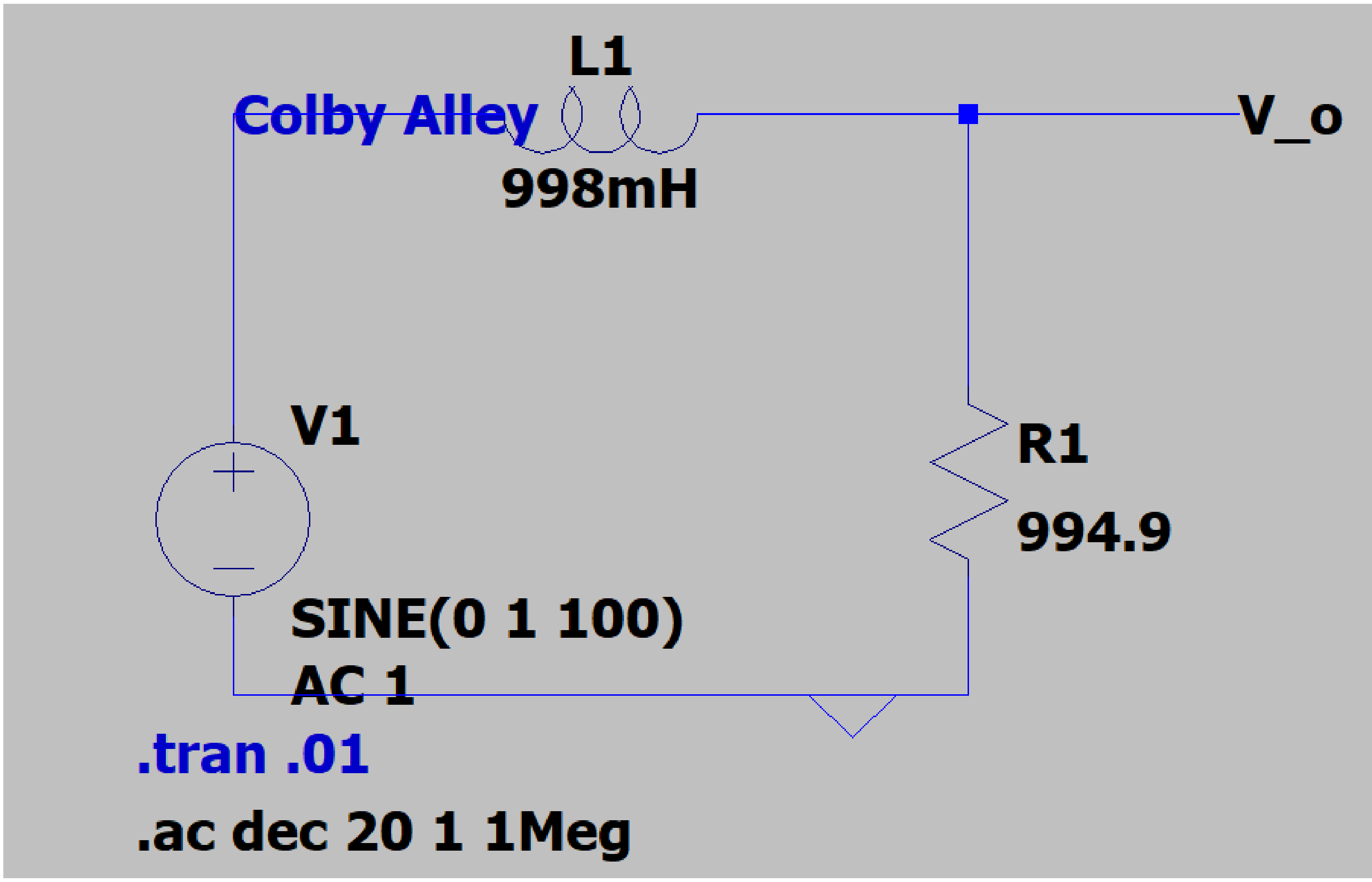
Picture of LTSpice Low Pass Capacitor Filter @ Freq Cutoff:



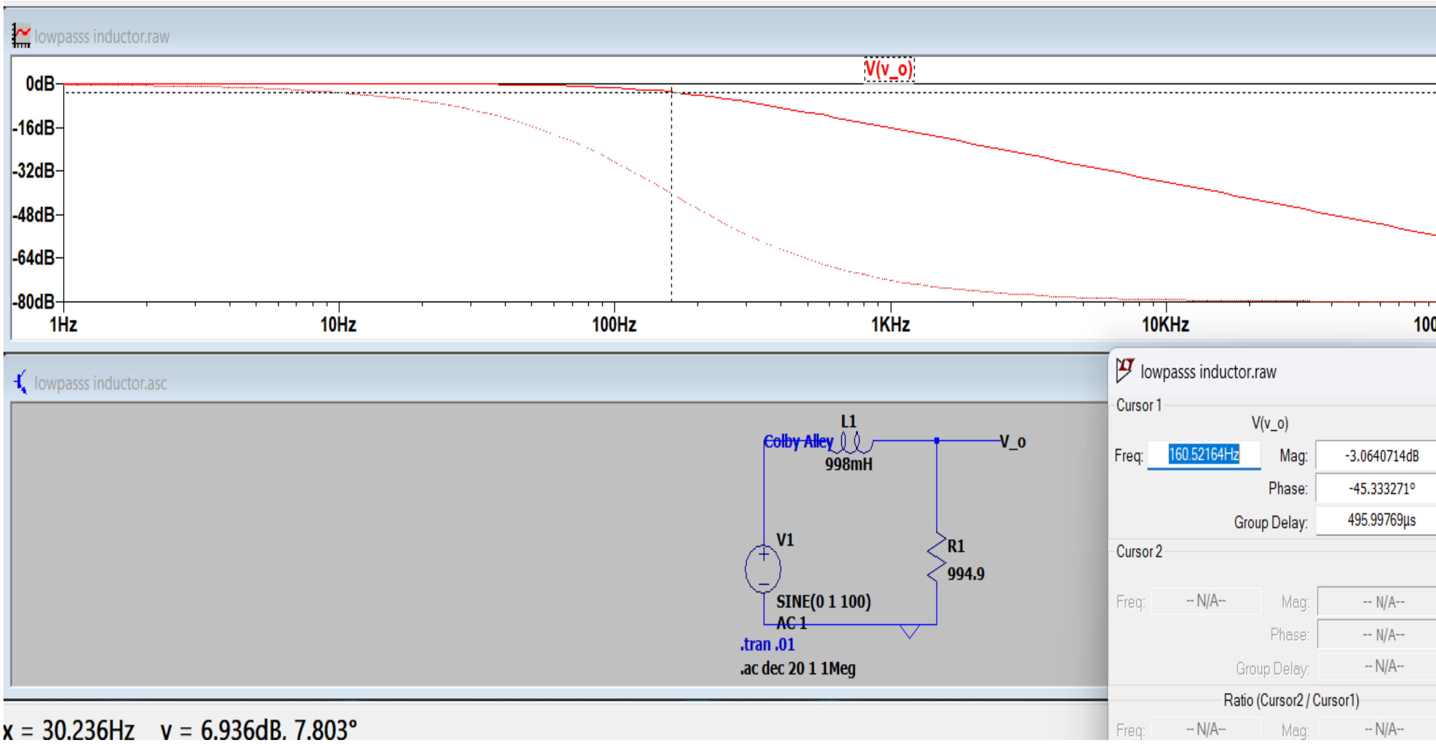
Picture of LTSpice Low Pass Capacitor Filter @ Voltage Cutoff:



Picture of LTSpice Low Pass Inductor Filter with Values:



Picture of LTSpice Low Pass Inductor Filter @ Freq Cutoff:



Picture of LTSpice Low Pass Inductor Filter @ Voltage Cutoff:

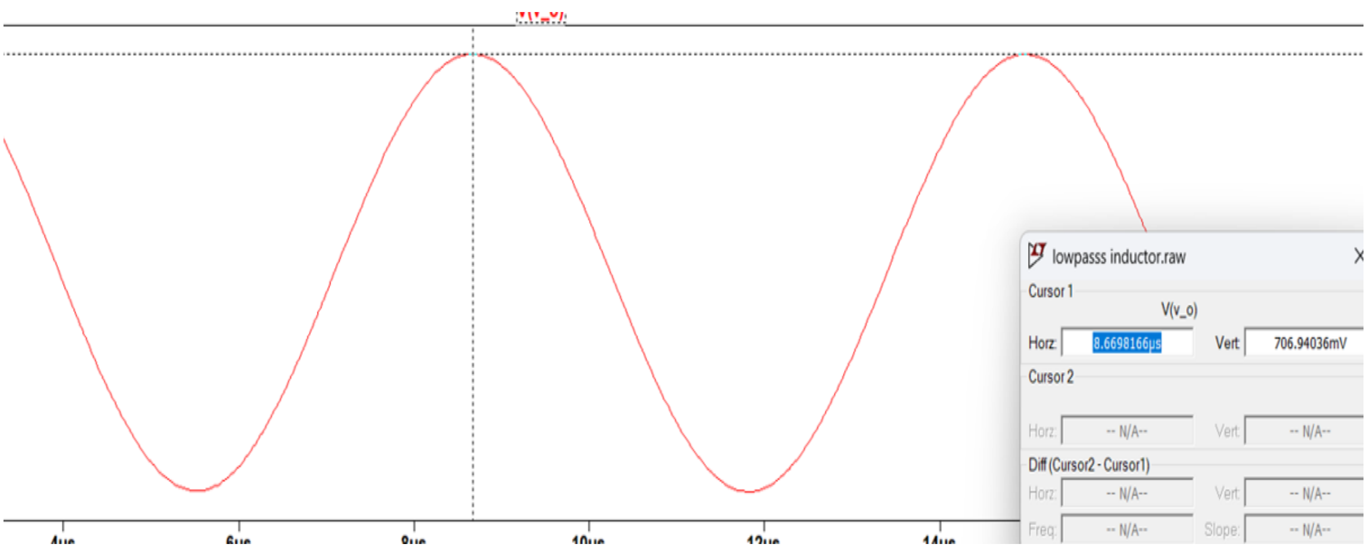


Table for Simulated Circuit Values (Low Pass)

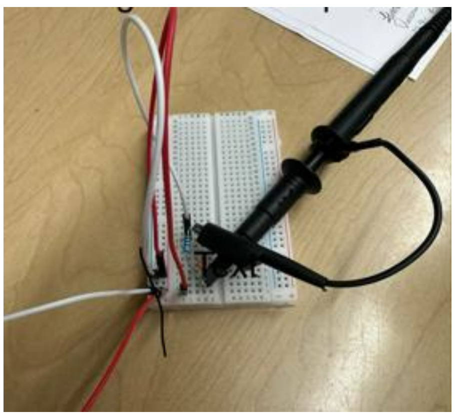
Cutoff Frequencies	Expected Frequency (Prelab)	Voltage @ Cutoff (mV)	Measured Frequency (kHz)
RC LPF	98.14kHz	706.20mV	98.58kHz
RL LPF	158.66kHz	706.94mV	160.52kHz

Thoughts: What are my thoughts: At first, it was confusing to understand how the oscilloscope worked, however, once you got the hand of it, it was ok. Still a learning curve for me, but important to see how to measure peak to peak as well as at certain time intervals. The biggest struggle for me was seeing exactly when the frequency was cutoff on the oscilloscope. However, once you notice it the waveform shrinking or lengthening, it corresponded correctly with the intended voltage cutoff of 700mV. Our values measured in the prelab were like those of in the actual test, so I would say it was a success.

The low pass filters use a resistor and a capacitor, or inductor, to allow low frequencies to pass through while blocking higher frequencies from passing. Low pass acts as a short circuit.

Part 3: High Pass Filter Circuits

Picture of High Pass Filter with Capacitor:



Picture of High Pass Filter with Inductor:

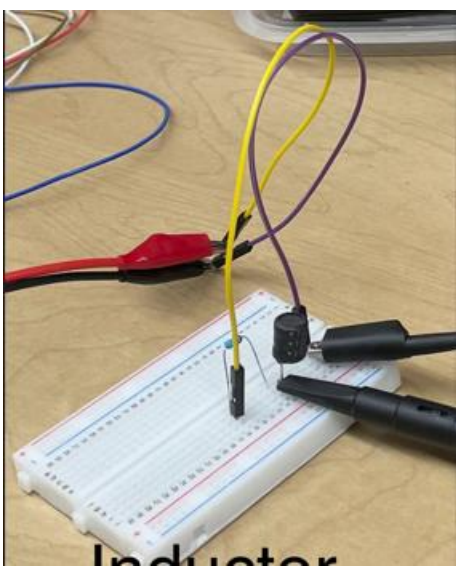


Table for Physical Circuit Values: (High Pass)

Cutoff Frequencies	Expected Frequency (Prelab)	Voltage @ Cutoff (mV)	Measured Frequency (kHz)
RC HPF	98.14kHz	700mV	100kHz
RL HPF	158.70kHz	700mV	160kHz

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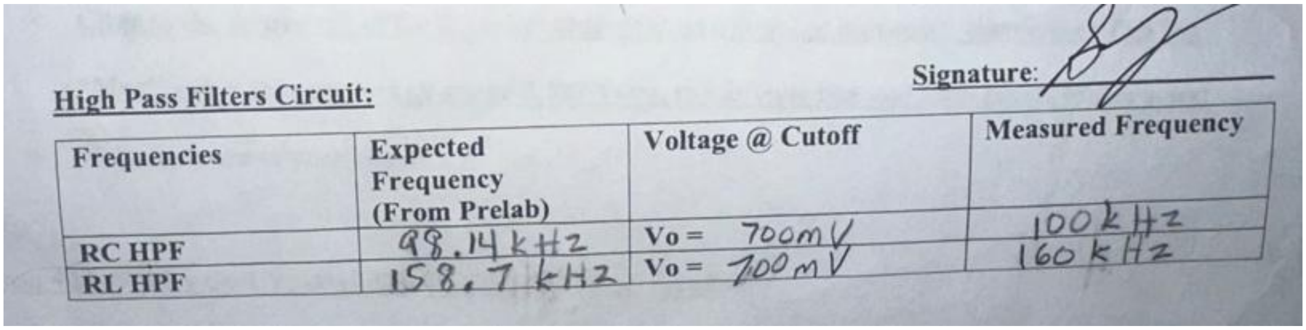

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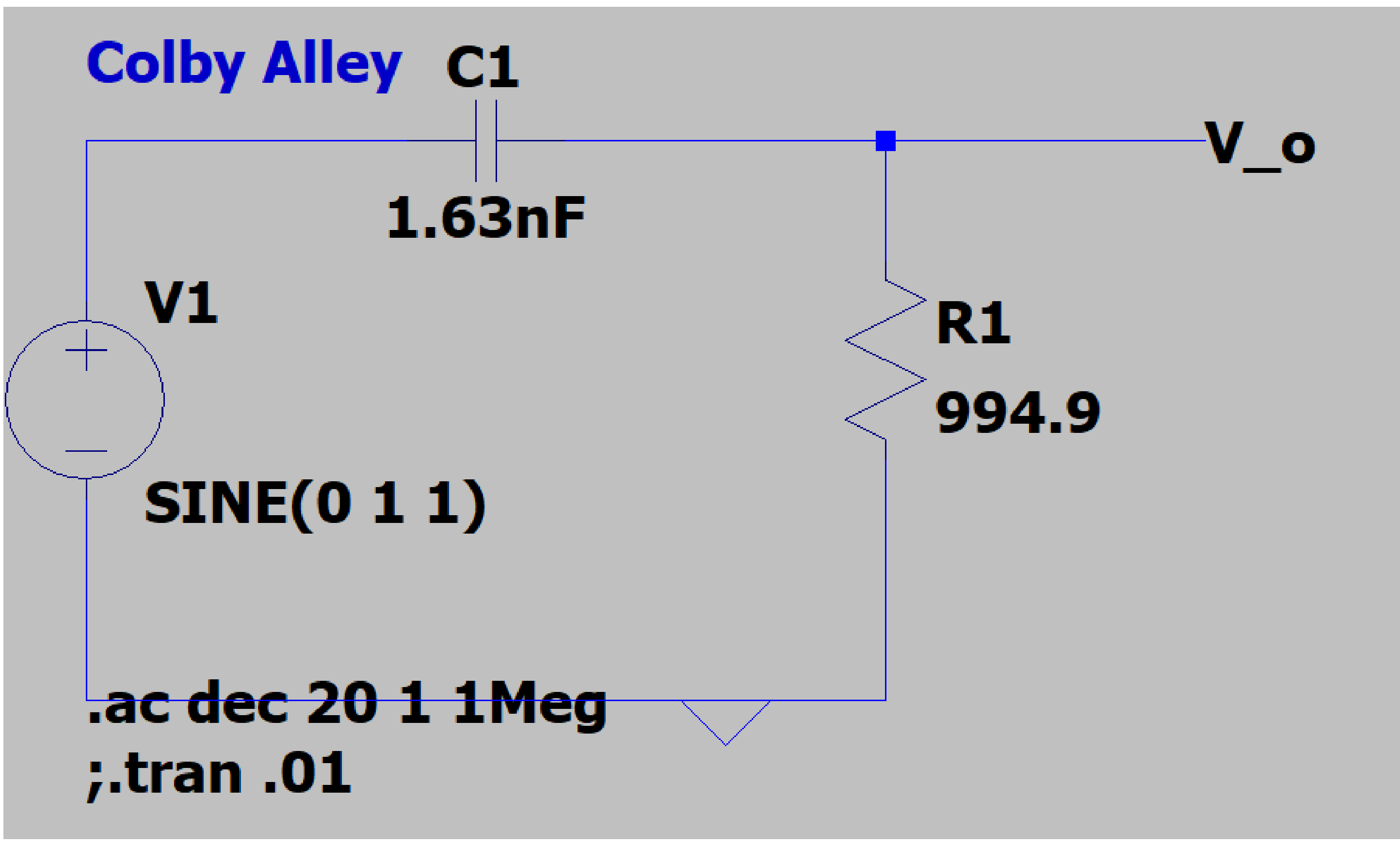
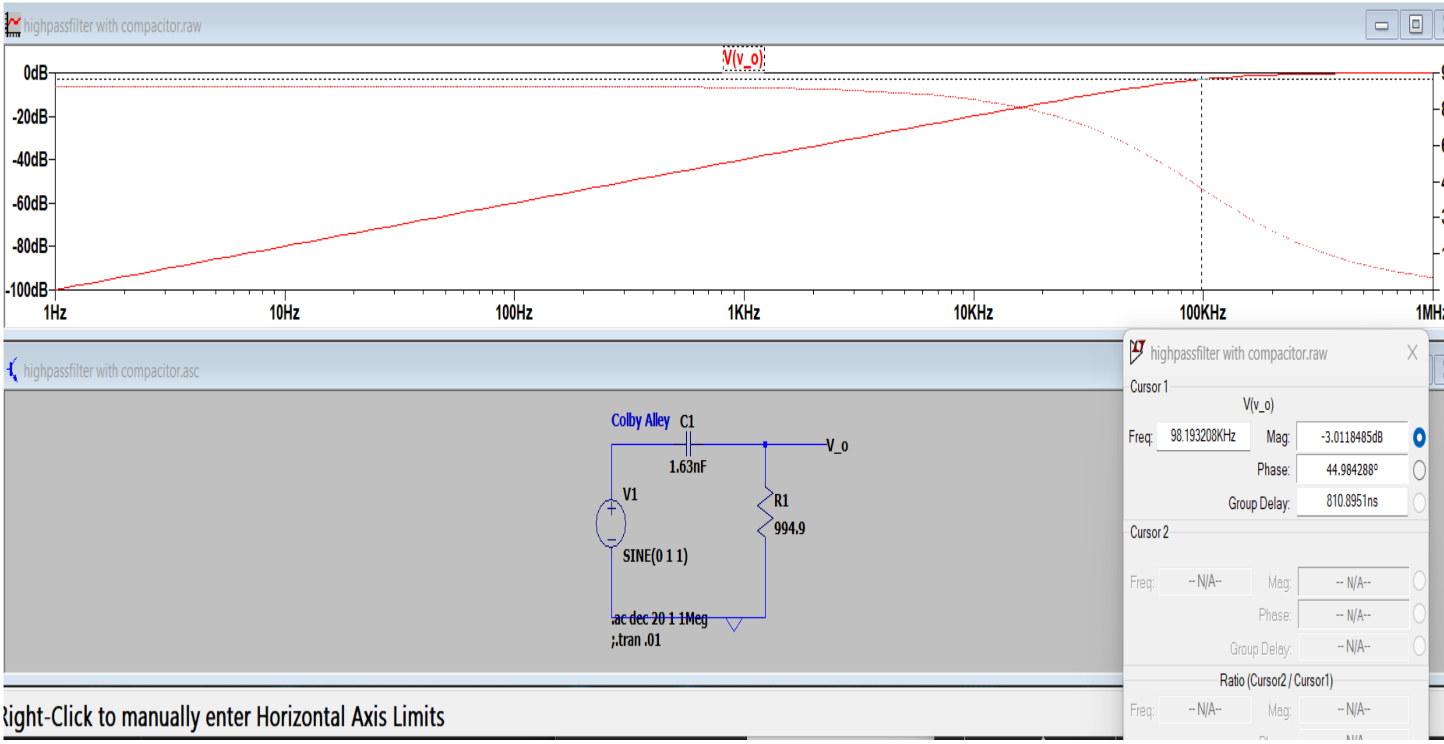
High Pass Filters Circuit:

Frequencies	Expected Frequency (From Prelab)	Voltage @ Cutoff	Measured Frequency
RC HPF	98.14 kHz	Vo = 700mV	100kHz
RL HPF	158.7 kHz	Vo = 700mV	160 kHz

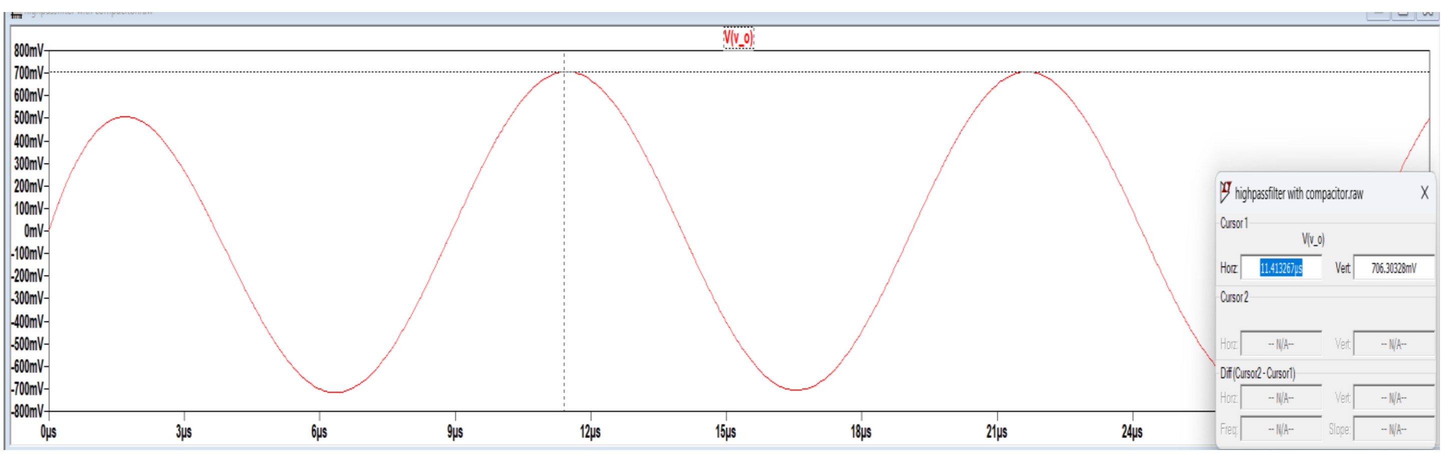
Picture of LTSpice High Pass Capacitor Filter with Values:



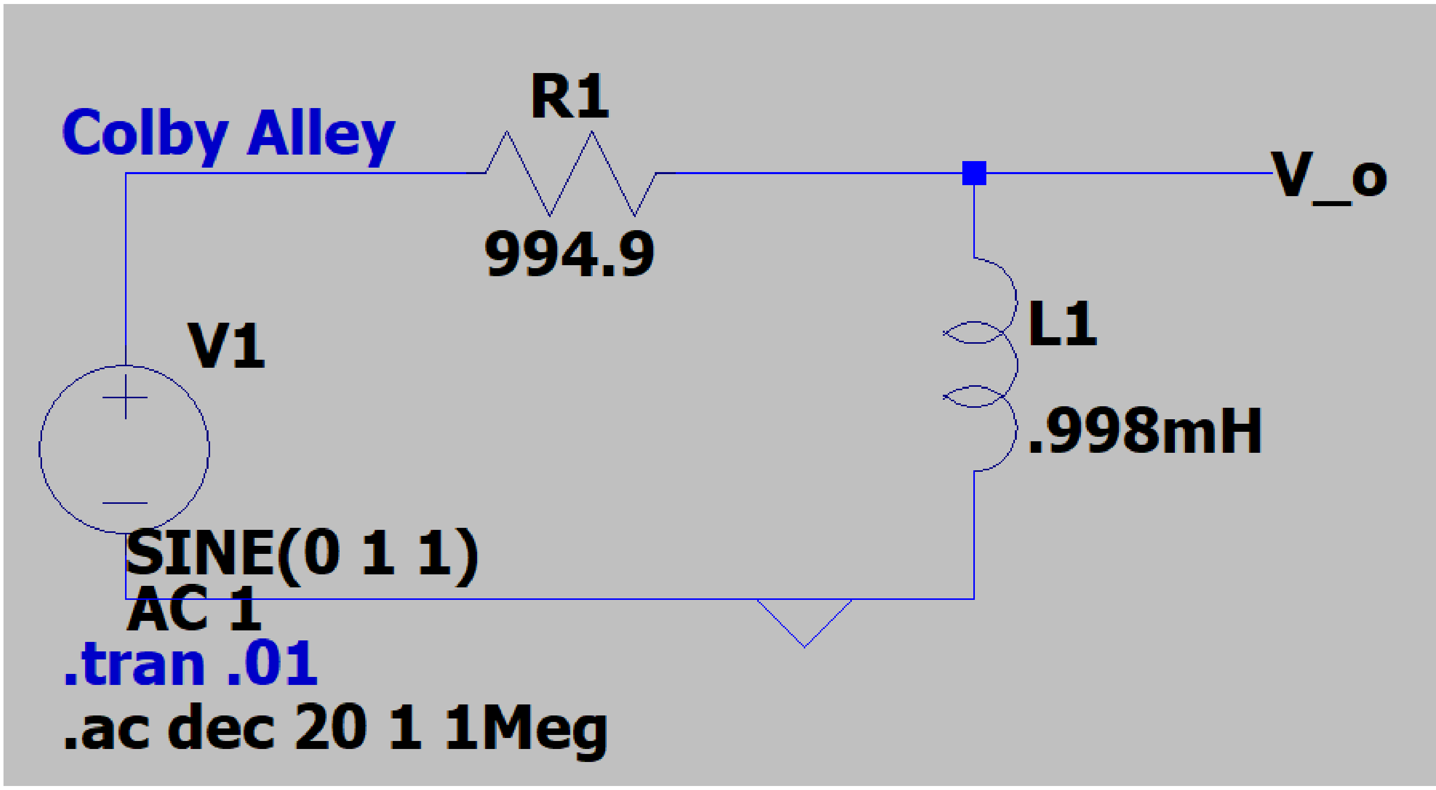
Picture of LTSpice High Pass Capacitor Filter @ Freq Cutoff:



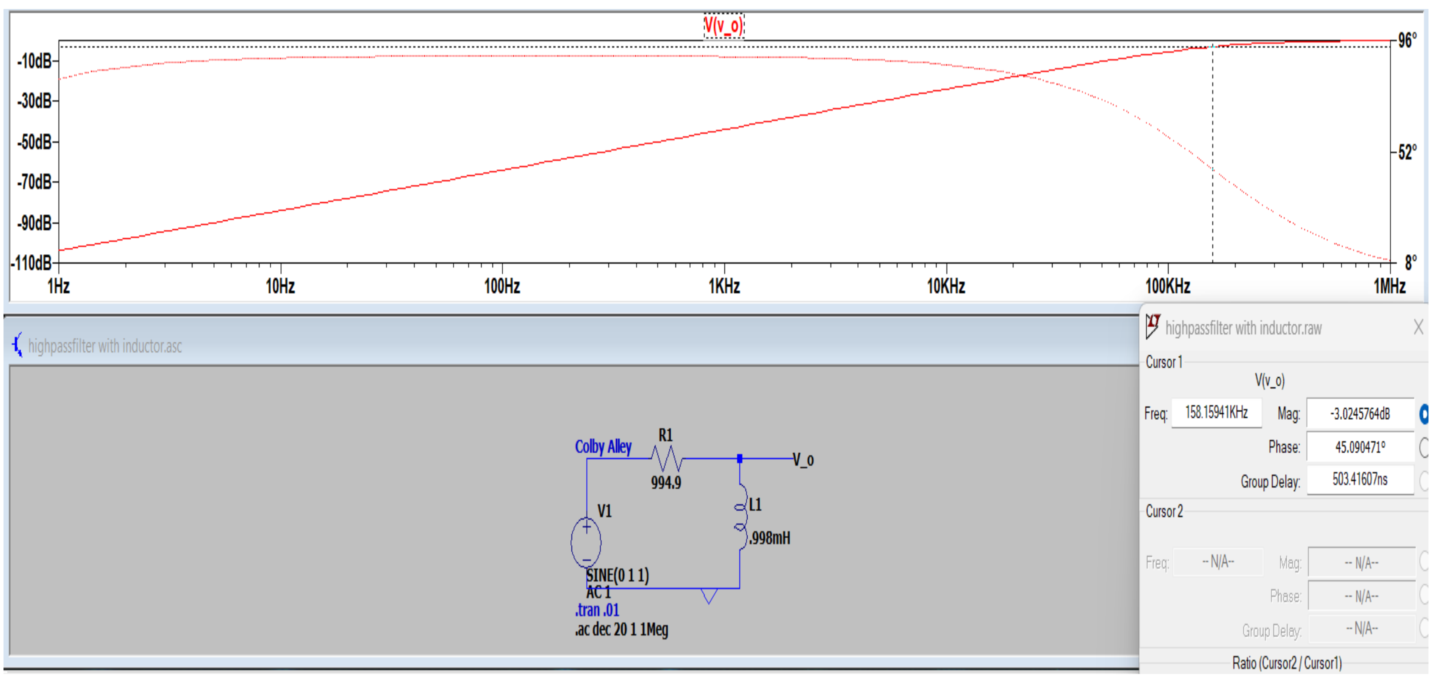
Picture of LTSpice High Pass Capacitor Filter @ Voltage Cutoff:



Picture of LTSpice High Pass Inductor Filter with Values:



Picture of LTSpice High Pass Inductor Filter @ Freq Cutoff:



Picture of LTSpice High Pass Inductor Filter @ Voltage Cutoff:

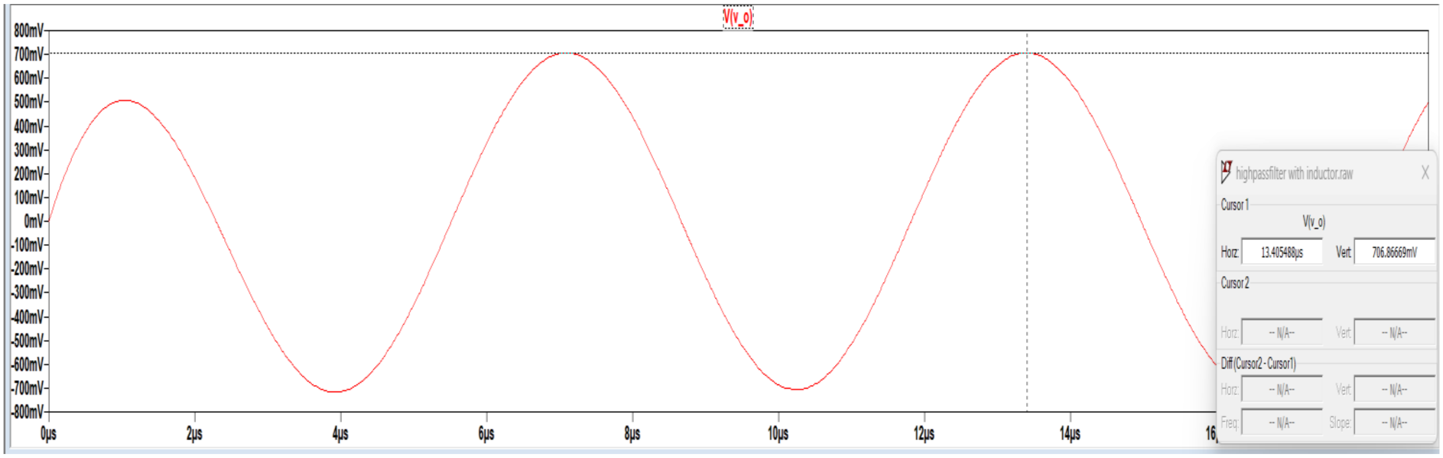


Table for Simulated Circuit Values (High Pass)

Cutoff Frequencies	Expected Frequency (Prelab)	Voltage @ Cutoff (mV)	Measured Frequency (kHz)
RC HPF	98.14kHz	706.30mV	98.19kHz
RL HPF	158.70kHz	706.87mV	158.16kHz

Thoughts: What are my thoughts: I think it was a little clearer when performing our high pass filters, but when we did ours, we did them out of order, so it was about the same level of difficulty when beginning. Our values are much like our measured prelab values, and finding the cutoff voltage was simpler here to me when measuring with the time on the oscilloscope. I did face some challenges on exactly where the place the oscilloscope probes to measure our cutoff frequencies during a few of these simulations, but assembling was easy. This is where we can notice how our values play off our low pass filter values and we can clearly see similarities in the measured and expected frequencies. Practice makes perfect.

The high pass filters use either a capacitor or inductor alongside a resistor to allow to pass high frequencies while blocking low frequencies at the same time. High pass acts as an open circuit.

Part 4: Band Pass Filter Circuit

Picture of Band Pass Filter:

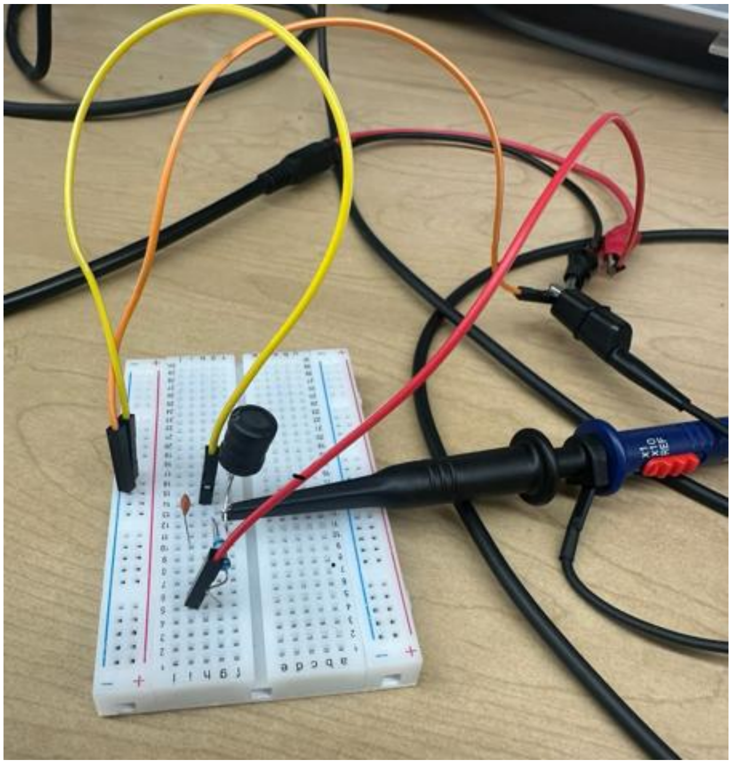
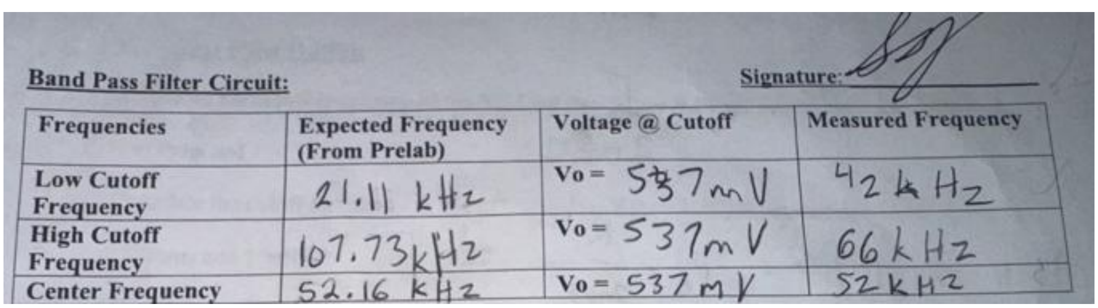


Table for Physical Circuit Values: (Band Pass)

Cutoff Frequencies	Expected Frequency (Prelab)	Voltage @ Cutoff (mV)	Measured Frequency (kHz)
Low Cutoff Frequency	21.11kHz	537mV	42kHz
High Cutoff Frequency	107.73kHz	537mV	66kHz
Center Cutoff Frequency	52.16kHz	537mV	52kHz

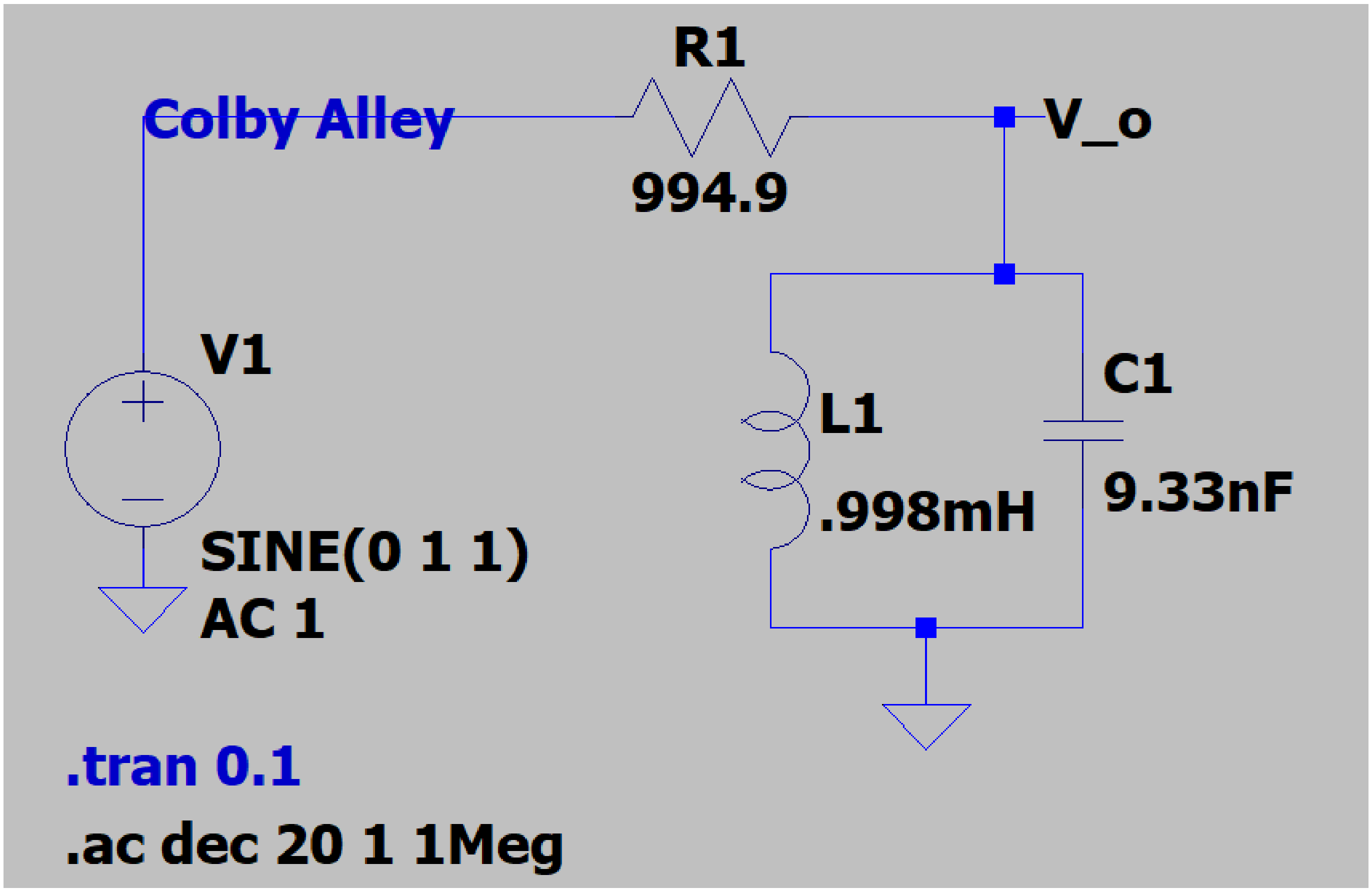
Report paper table with signature:



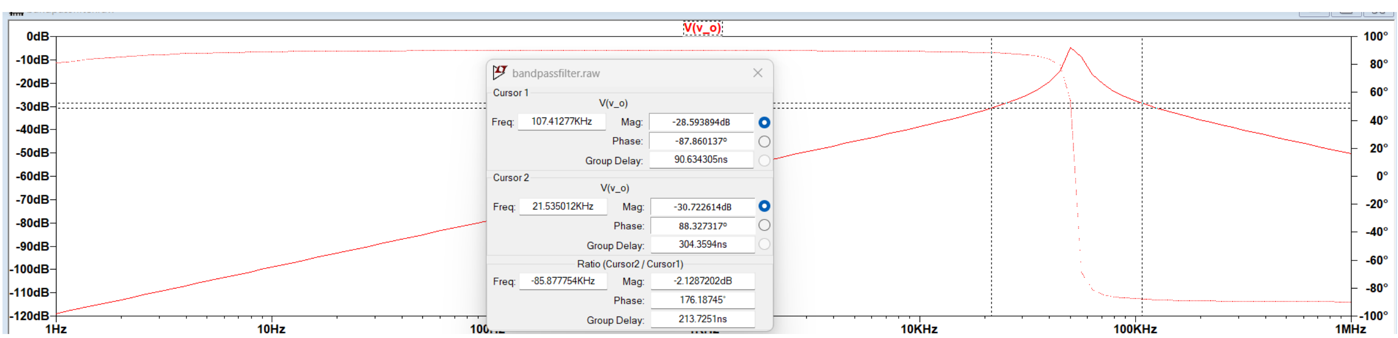
Band Pass Filter Circuit: Signature:

Frequencies	Expected Frequency (From Prelab)	Voltage @ Cutoff	Measured Frequency
Low Cutoff Frequency	21.11 kHz	Vo = ~~5~~37mV	42 kHz
High Cutoff Frequency	107.73kHz	Vo = 537mV	66 kHz
Center Frequency	52.16 kHz	Vo = 537 mV	52kHz

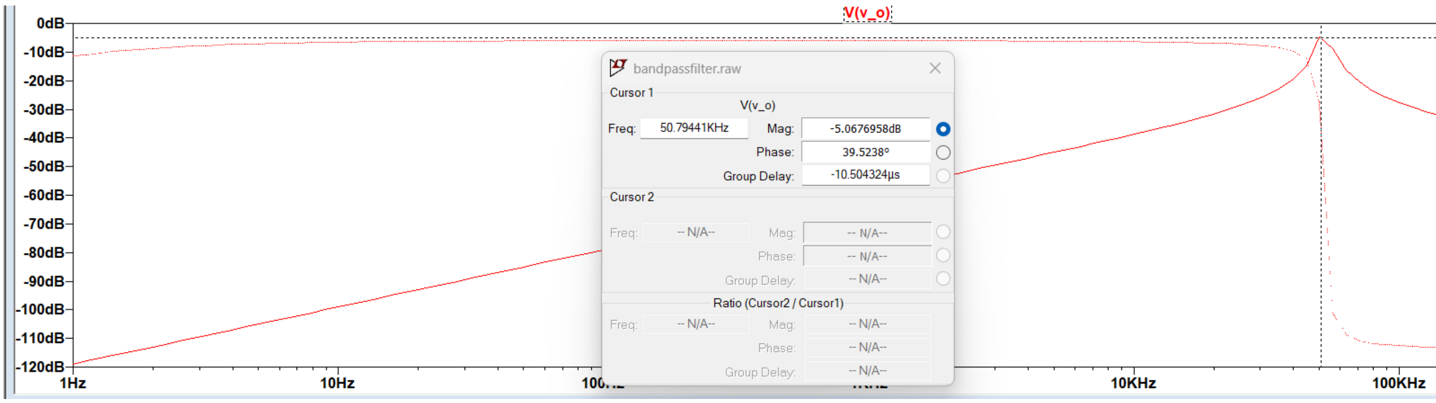
Picture of LTSpice Band Pass Filter with Values (*Used 10nF capacitor*):



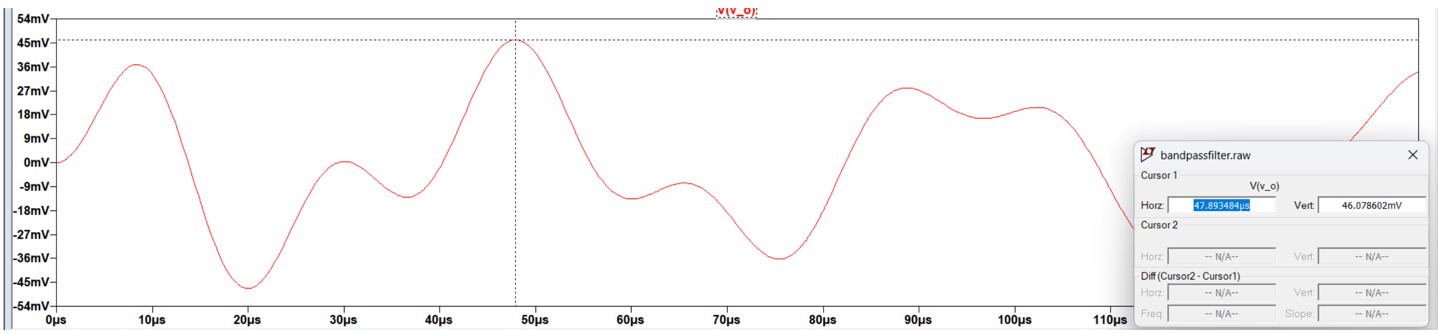
Picture of LTSpice Band Filter @ Low Cutoff Freq and @ High Cutoff Freq:



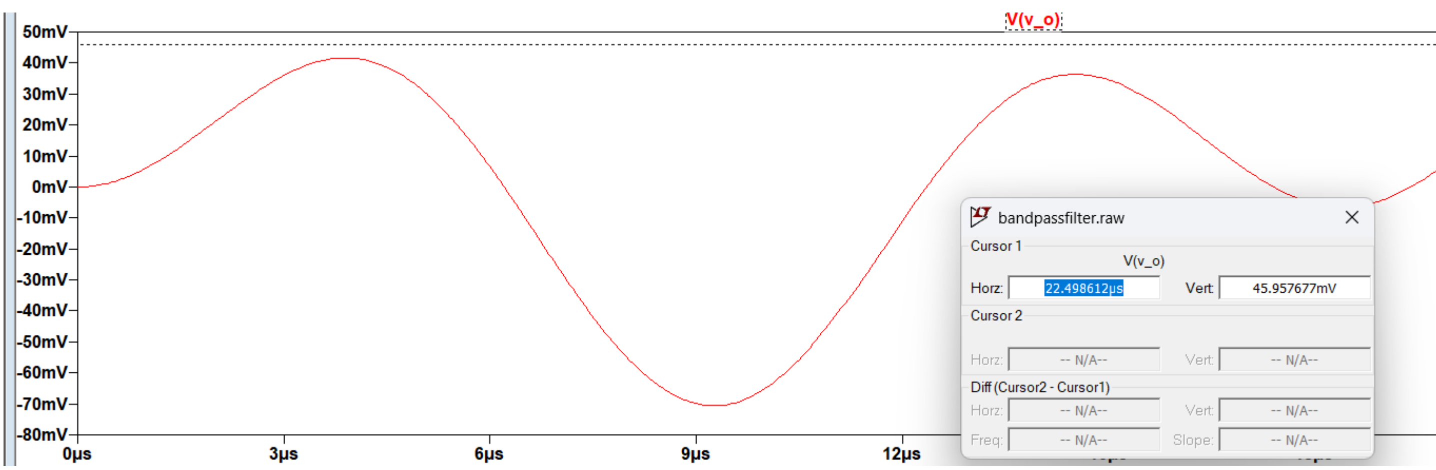
Picture of LTSpice Band Filter @ Center Cutoff Freq:



Picture of LTSpice Band Filter @ Voltage Cutoff (Low Freq):



Picture of LTSpice Band Filter @ Voltage Cutoff (High Freq):



Picture of LTSpice Band Filter @ Voltage Cutoff (Center Freq):

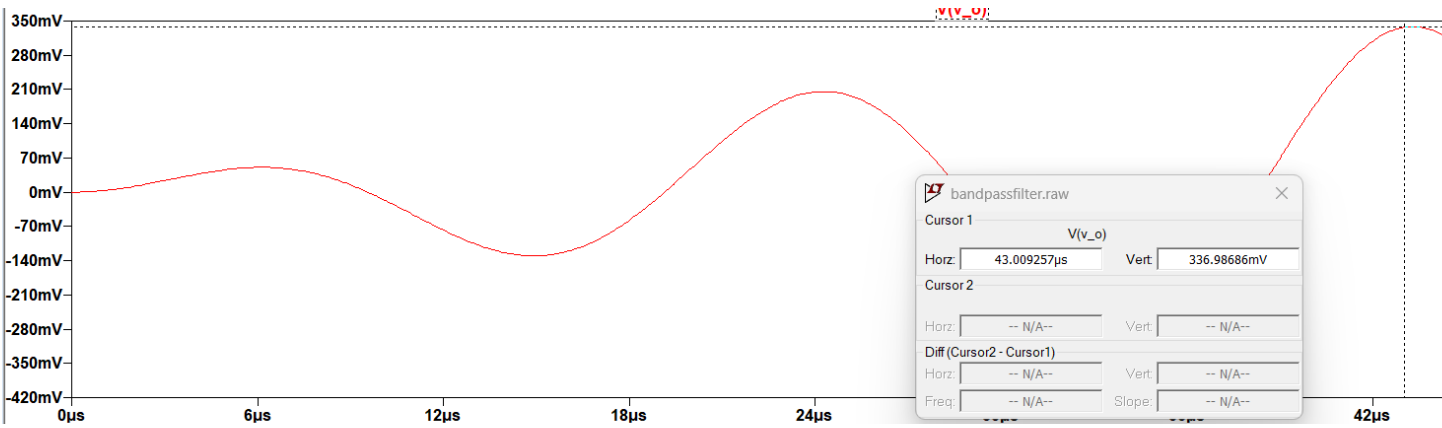


Table for Simulated Circuit Values (Band Pass) (*Voltage Cutoffs will be off in Simulation*)

Cutoff Frequencies	Expected Frequency (Prelab)	Voltage @ Cutoff (mV)	Measured Frequency (kHz)
Low Cutoff Frequency	21.11kHz	46.08mV	21.54kHz
High Cutoff Frequency	107.73kHz	45.96mV	107.41kHz
Center Cutoff Frequency	52.16kHz	336.99mV	50.79kHz

Thoughts: What are my thoughts: Like the high pass filters, I was unsure exactly where to place the oscilloscope probes to measure the frequencies in this simulation. It was helpful to use our expected frequencies from our prelab to find our measured frequencies when using the oscilloscope. It is still slightly challenging for me when looking at the oscilloscope what to see exactly where the high, low, or center frequency is and how to see where it the high or low cutoff is. I think that was my biggest challenge in this lab was seeing where the frequency begins to cutoff for both the low and high involving all the simulations in this lab.

A band pass filter uses both an inductor, capacitor, and resistor to allow high and low frequencies to pass through, depending on the range that is wanted. The inductor and capacitor are placed in parallel when building a band pass filter circuit (in this case).

Lab Conclusion

I would like to say I learned a lot in this lab since this is my first ECE class, as I am not in the intro to digital systems or other classes yet. This is all new to me still, hoping to grasp these concepts even better once my college career continues. I find it interesting how different components in circuits act depending on the order and how they are used. I am excited for future labs/activities with filters. Even though it was a simple lab, I would say it was my favorite one so far.