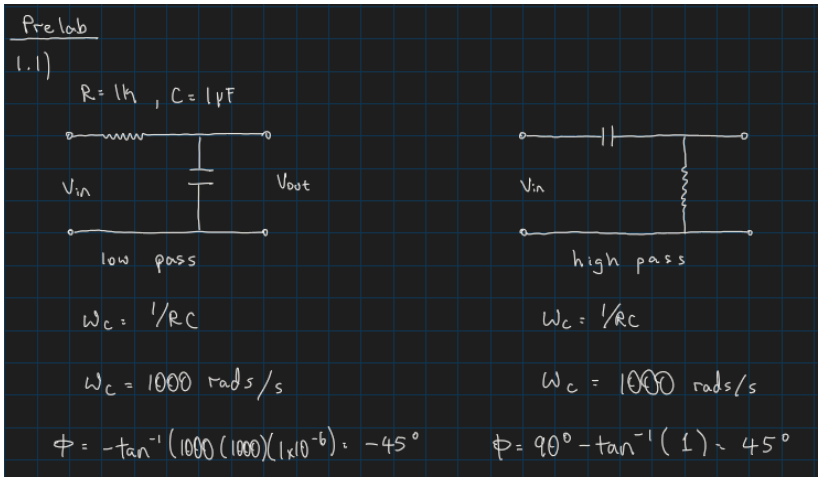
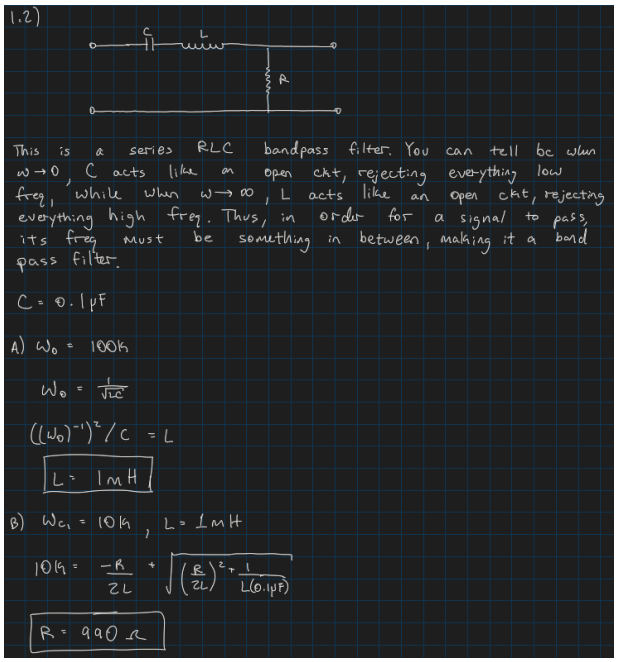
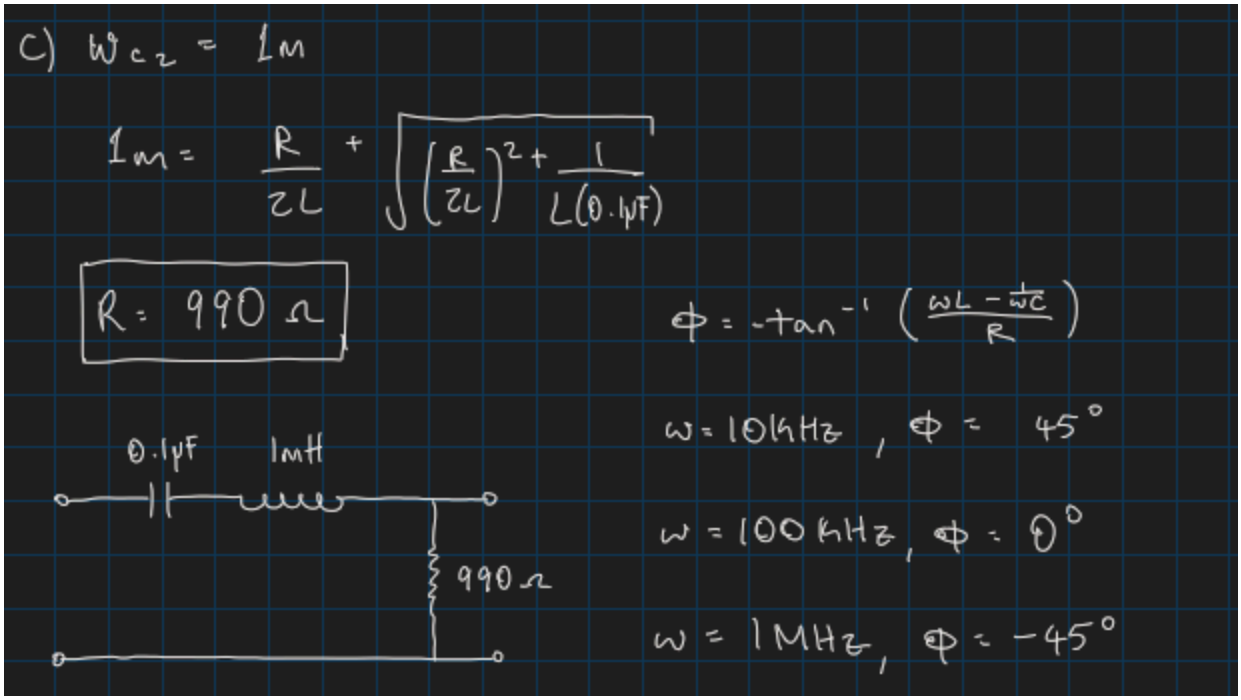
Justin Hsu
EEC 100 Lab 5
10/21/24

(1) Objective: Learn how to calculate, build, and simulate low pass, high pass, and band pass filter circuits. Then using the function generator see how different input frequencies are manipulated by each kind of filter. Finally using the data to create a bode plot to easily interpret at what frequencies the filters are attenuating the input.

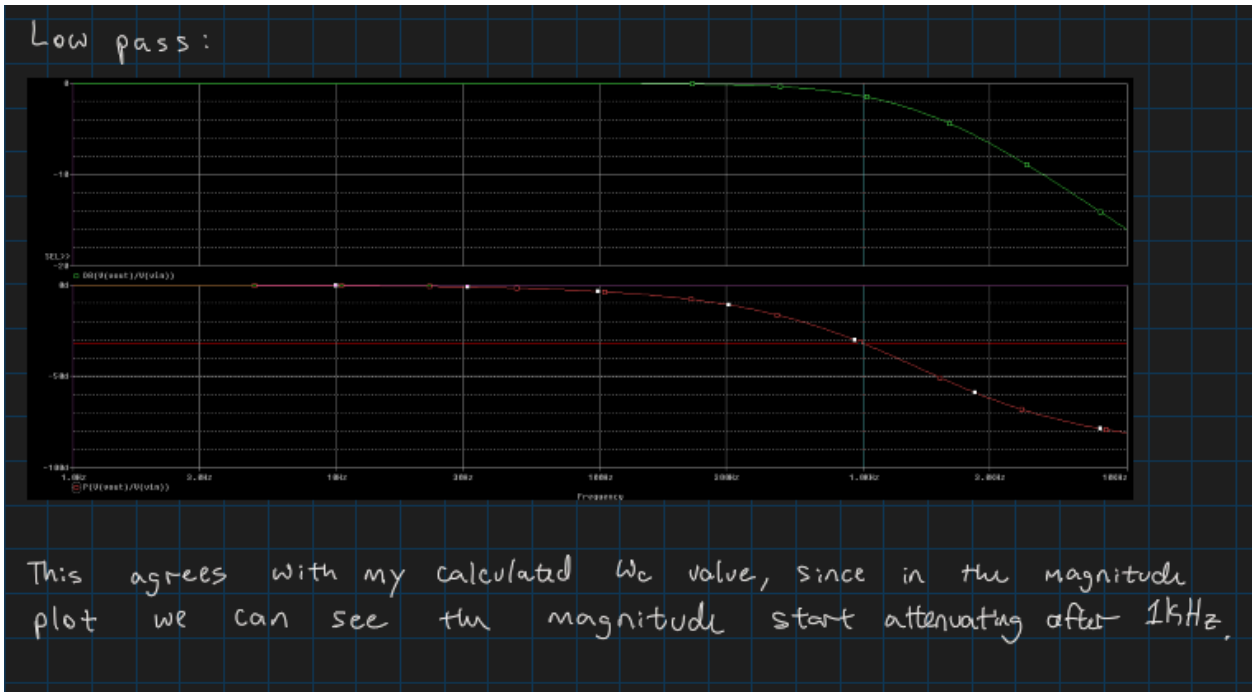
(2) Prelab:



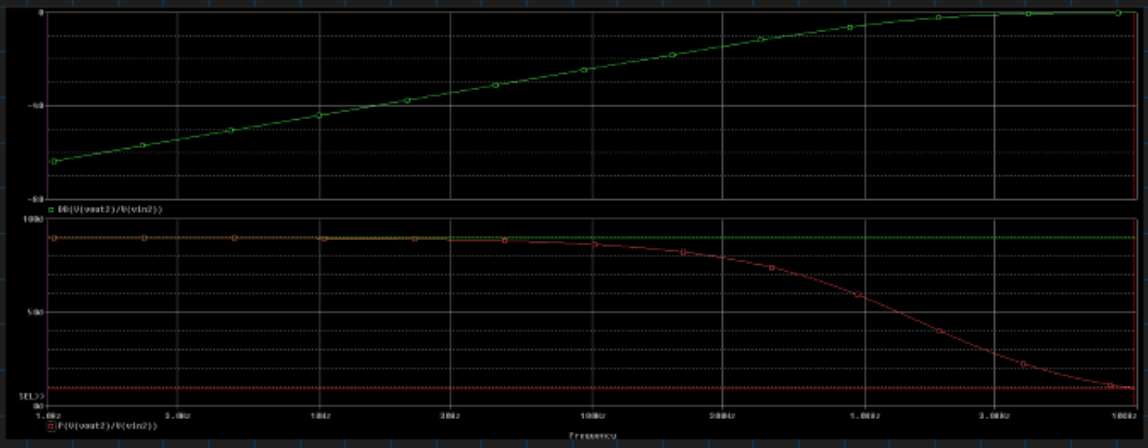




(3) Simulation:

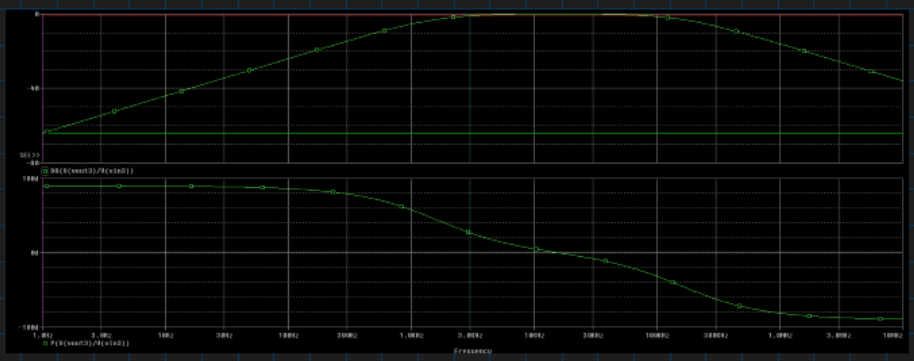


High pass:



The magnitude plot agrees with my calculations as we can clearly see before 10kHz there is attenuation of the signal.

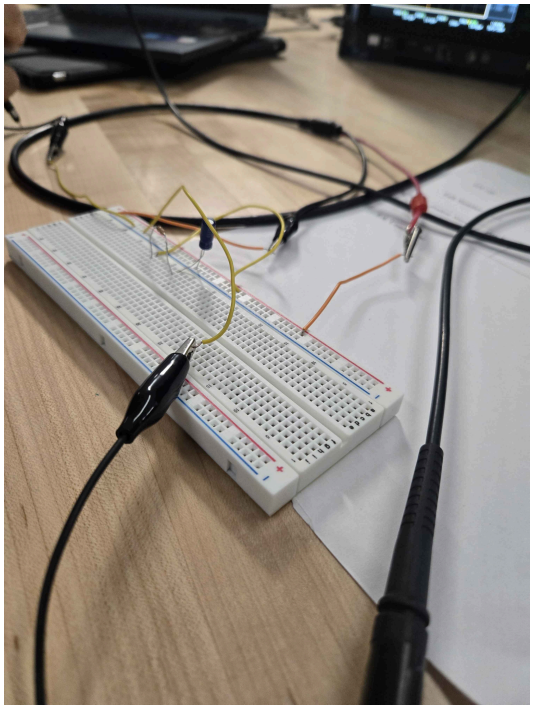
Bandpass:

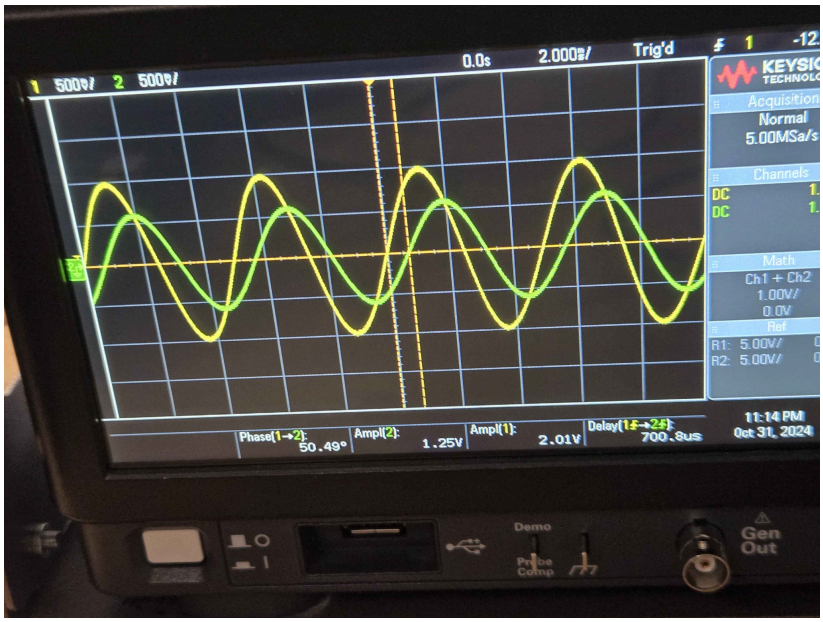


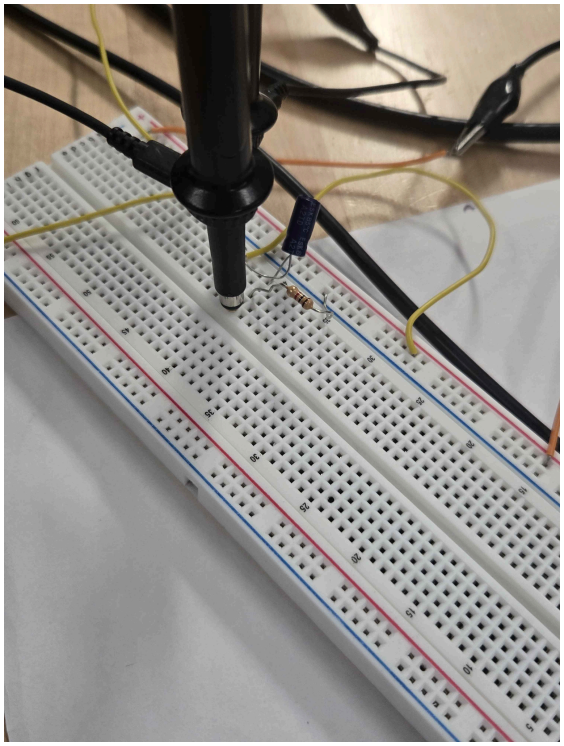
The magnitude plot agrees with my calculations as we can see that the signal with freq below 1.6kHz (10k rad/s) and above 160kHz (1M rad/s) is being attenuated. Furthermore, you can see that ω_r is ~ 16kHz since that is where the max magnitude is

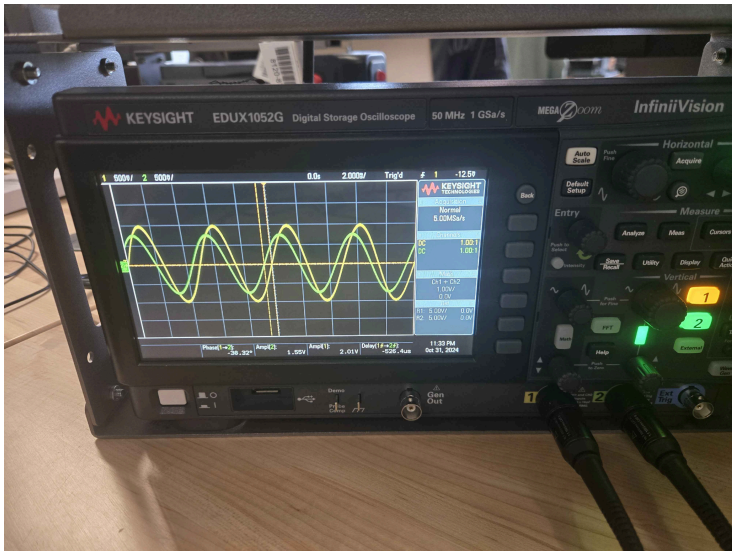
The phase shift does make sense as @ 1.6kHz (10k rad/s) there is a shift down to 45°, and @ 16kHz (100k rad/s) is another shift down to 0°, and finally @ 160kHz (1M rad/s) there is the final phase shift down to -45°, which agrees with my calculations

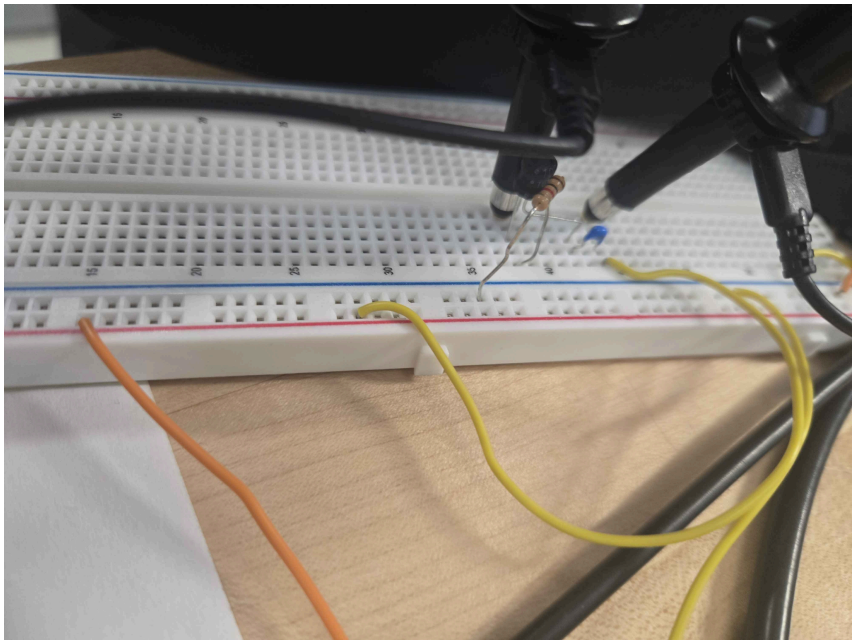
(4) Experiment:








KEYSIGHT
EDUX1052G
Digital Storage Oscilloscope
50 MHz 1 GSa/s
MEGAZoom
InfiniiVision
Horizontal
Vertical
Measure
Entry




KEYSIGHT
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Digital Storage Oscilloscope
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Horizontal
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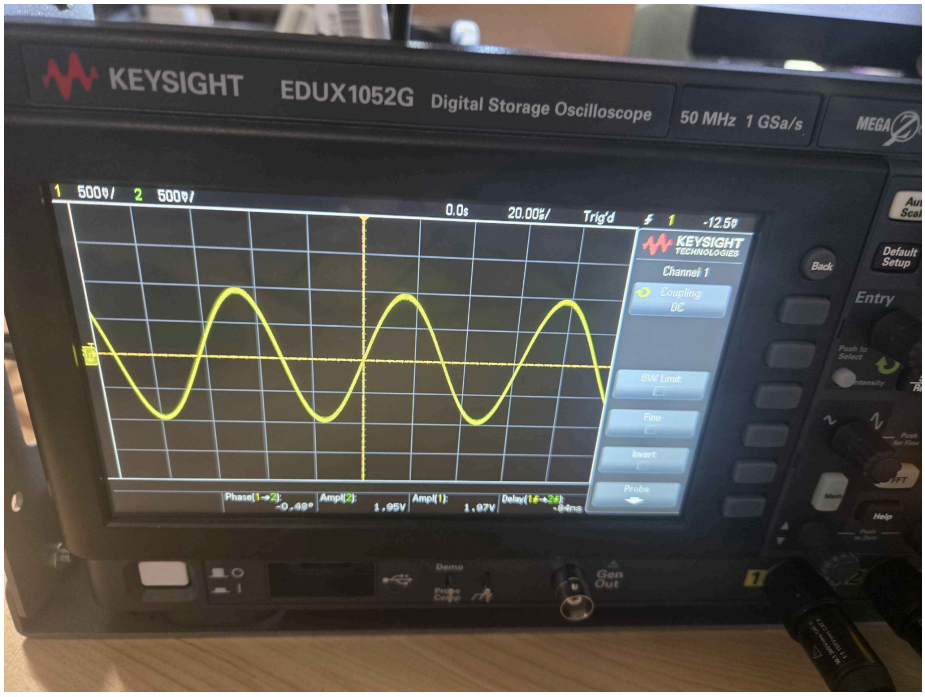
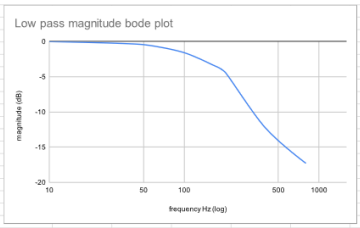
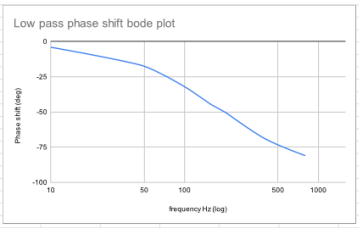
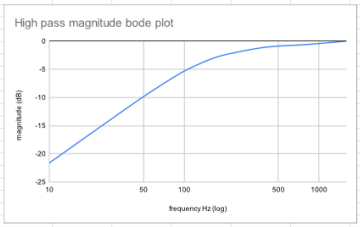
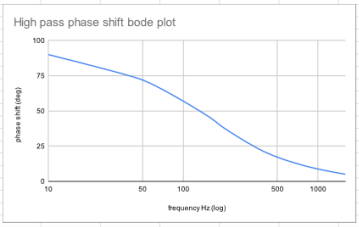

KEYSIGHT
EDUX1052G
Digital Storage Oscilloscope
50 MHz 1 GSa/s
MEGA
1 500mV/ 2 500mV/
0.0s
20.00ns/
Trig'd
-12.5mV
KEYSIGHT TECHNOLOGIES
Channel 1
Coupling
DC
BW Limit
Fine
Invert
Probe
Phase(1→2):
-0.48°
Ampl(2):
1.95V
Ampl(1):
1.97V
Delay(1→2):
-84ns
Back
Default Setup
Entry
Help
Gen Out
Demo

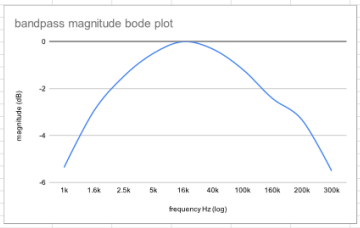
Low pass					Input to output	Input to output
Hz	Vout	Vin	H(jw)	H(jw) dB	time delay	phase shift (deg)
10	2.05	2.05	1	0	1ms	-4
50	1.95	2.05	0.9512195122	-0.434384939	940u	-17.5
100	1.71	2.05	0.8341463415	-1.575155013	900u	-32
150	1.41	2.05	0.6878048878	-3.250894988	775u	-45
200	1.25	2.05	0.6097560976	-4.29937681	700u	-50
400	0.5	2.05	0.243902439	-12.25567713	485u	-69
800	0.28	2.05	0.1365853659	-17.29191659	280u	-81
1600	0	2.05	0	infinity	no out	no out
High pass						
10	0.17	2.05	0.0829268927	-21.62609879	-25ms	90
50	0.66	2.05	0.3219512195	-9.84419851	-4ms	72
100	1.11	2.05	0.5414634146	-5.328617645	-1.6ms	57
150	1.43	2.05	0.6975609756	-3.128356472	-770u	45
200	1.55	2.05	0.756097561	-2.428443258	-530u	38
400	1.81	2.05	0.8829268293	-1.081505724	-151u	21
800	1.91	2.05	0.9317073171	-0.6144098752	-40u	11
1600	2.05	2.05	1	0	-10u	5
Bandpass						
1k	1.07	1.98	0.5404040404	-5.34682825	163u	58
1.5k	1.41	1.98	0.7121212121	-2.948921552	80u	45
2.5k	1.67	1.98	0.8434343434	-1.479974382	37u	33
5k	1.87	1.98	0.9444444444	-0.4964716745	10u	17
16k	1.98	1.98	1	0	0	0
40k	1.91	1.98	0.9646464646	-0.3126364603	-800n	-12
100k	1.73	1.98	0.8737373737	-1.172381743	-880n	-33
160k	1.5	1.98	0.7575757576	-2.411478624	-800n	-45
200k	1.35	1.98	0.6818181818	-3.326628435	-720n	-52
300k	1.05	1.98	0.5303030303	-5.509517824	-640n	-69

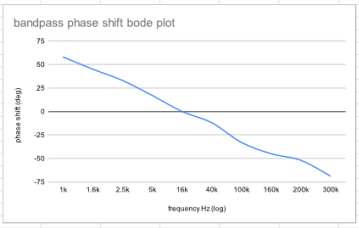












[Link to spreadsheet]

The experimental cut off values in the low pass filter matched our calculated results. It deviated slightly due to the inherent variance in resistor and capacitor values. Furthermore, the graphed bode plot from our experimental values matched the general shape of the simulated bode plot (there is a deviation because the x axis scaling did not match and there are not enough data points to create a smooth curve).

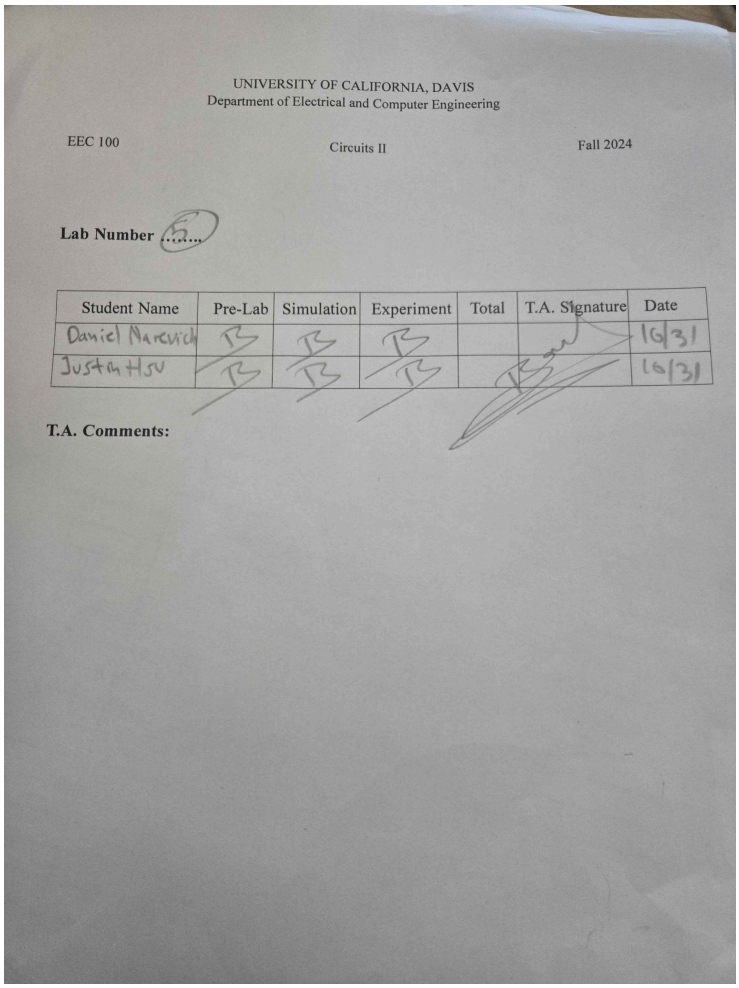
The experimental cut off values in the high pass filter matched our calculated results. It deviated slightly due to the inherent variance in resistor and capacitor values. Furthermore, the graphed bode plot from our experimental values matched the general shape of the simulated bode plot (there is a deviation because the x axis scaling did not match and there are not enough data points to create a smooth curve).

The experimental cut off values in the band pass filter matched our calculated results. It deviated slightly due to the inherent variance in resistor and capacitor values. Furthermore, the graphed bode plot from our experimental values matched the general shape of the simulated bode plot (there is a deviation because the x axis scaling did not match and there are not enough data points to create a smooth curve).

(5) Conclusion:

Our calculated values and simulated values matched the experimental values found in lab. While there is deviation due to the deviation in resistance and capacitance values, the general shape of the bode plots matched, and the cut off values were within an acceptable margin of error. By inputting a signal of various frequencies into the filter circuits, we were able to see just how the various frequencies were manipulated by the filter-whether they were let through or attenuated. Through this experiment my understanding of how filter circuits work improved, and I can intuitively predict how a certain input signal will be affected by the filter circuit.

(6) Checkoff:



UNIVERSITY OF CALIFORNIA, DAVIS
Department of Electrical and Computer Engineering

EEC 100 Circuits II Fall 2024

Lab Number 5

Student Name	Pre-Lab	Simulation	Experiment	Total	T.A. Signature	Date
Daniel Marcuch	✓	✓	✓			10/31
Justin Hsu	✓	✓	✓			10/31

T.A. Comments: