EE 230 Lab Lab 2 report

Report: **First-order filters**

Lab work done by __________Sean Gordon______________

and __________Tejas Agarwal________________

Lab work date: 2/13/2019

Report submission date:

Lab Section: E

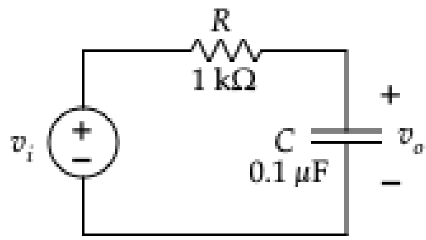
Graded by ____

Score __________________________________

Introduction

This lab works through the relationships of filter circuits and frequencies, giving a more hands on approach to the results we had seen in class. It focuses on a series of different filter types, gradually getting more complex until the design portion at the end.

A. RC low -pass

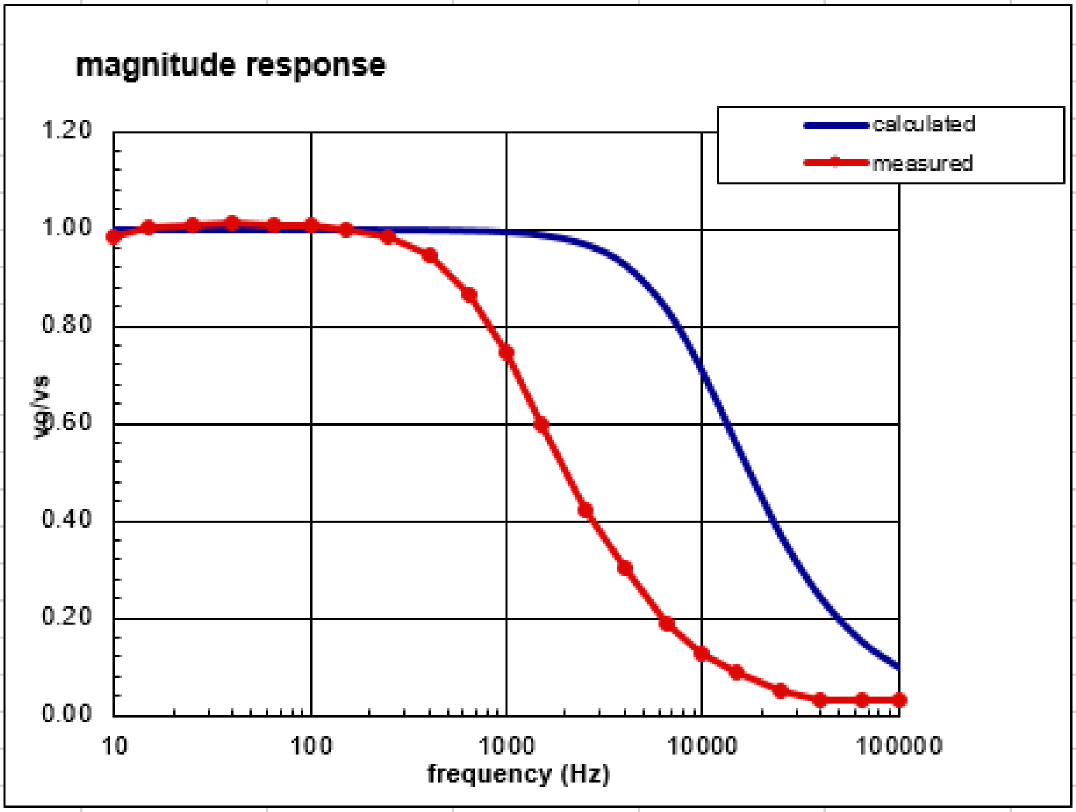


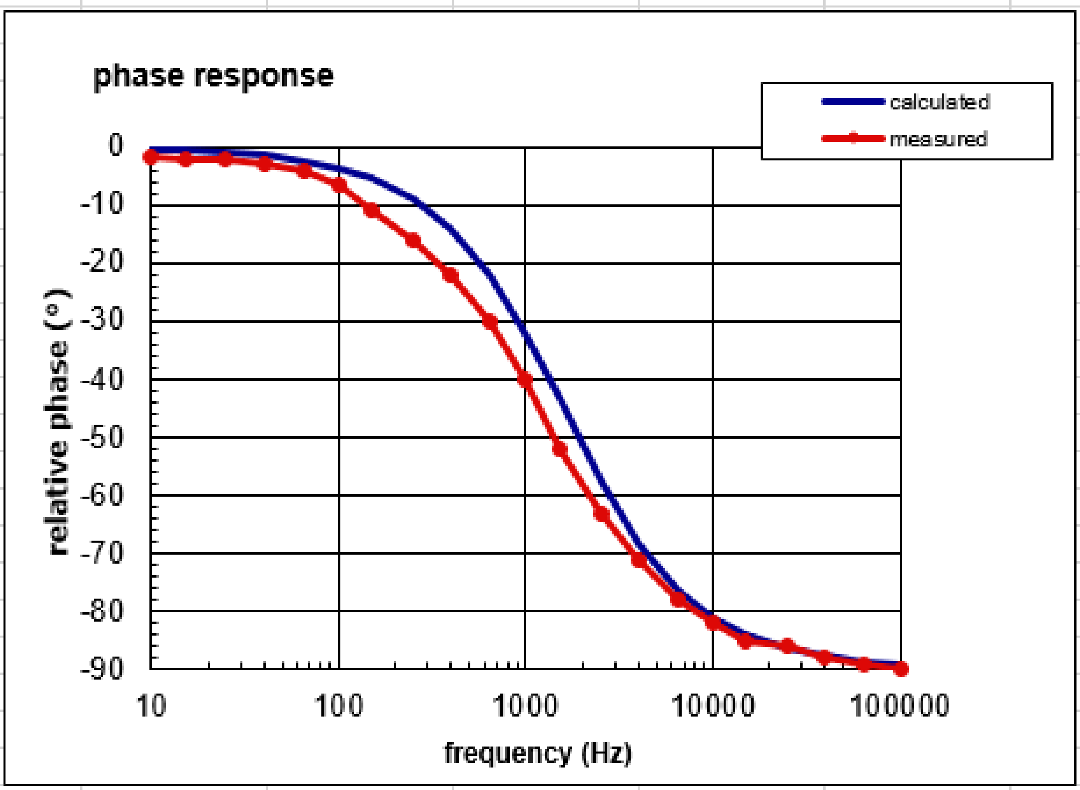
Include the calculation for the transfer function and corner frequency.

$V o = (1/sc)/(R_1+1/sc)$ => 1/(RSC+1) = T = 10,000/s

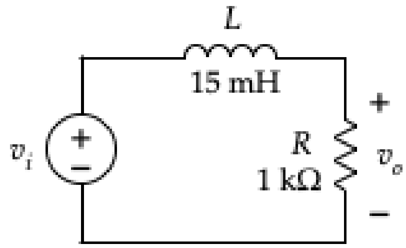
Figures: *Insert the magnitude and phase frequency response plots that you calculated and measured.*

	A	B	C	D	E	F	G
1	frequency (Hz)	Xc	predicted magnitude	Vo	measured magnitude	predicted phase	measured phase
2	10	159154.9431	0.999980261	2.46	0.98	-0.35999526	-1.9
3	15	106103.2954	0.999998875	2.51	1.00	-0.53998401	-2
4	25	63661.97724	0.999996875	2.52	1.01	-0.89992599	-2.1
5	40	39788.73577	0.999992	2.53	1.01	-1.43969692	-2.8
6	65	24485.37586	0.999978876	2.522	1.01	-2.33870029	-4.3
7	100	15915.49431	0.999950004	2.515	1.01	-3.59527378	-6.6
8	150	10610.32954	0.999887519	2.5	1.00	-5.38409592	-11
9	250	6366.197724	0.999687646	2.456	0.98	-8.92705487	-16
10	400	3978.873577	0.999200959	2.36	0.94	-14.1078024	-22
11	650	2448.537586	0.997894171	2.166	0.87	-22.2154504	-30
12	1000	1591.549431	0.99503719	1.86	0.74	-32.1419076	-40
13	1500	1061.032954	0.988936353	1.5	0.60	-43.3038073	-52
14	2500	636.6197724	0.9701425	1.05	0.42	-57.5183634	-63
15	4000	397.8873577	0.928476691	0.76	0.30	-68.303016	-71
16	6500	244.8537586	0.838443616	0.47	0.19	-76.2416041	-78
17	10000	159.1549431	0.707106781	0.32	0.13	-80.9569389	-82
18	15000	106.1032954	0.554700196	0.22	0.09	-83.9433894	-85
19	25000	63.66197724	0.371390676	0.13	0.05	-86.3573531	-86
20	40000	39.78873577	0.242535625	0.082	0.03	-87.7214753	-88
21	65000	24.48537586	0.152057184	0.083	0.03	-88.5973716	-89
22	100000	15.91549431	0.099503719	0.084	0.03	-89.0881863	-90


magnitude response
calculated
measured
1.20
1.00
0.80
0.60
0.40
0.20
0.00
vg/vs
10
100
1000
10000
100000
frequency (Hz)


phase response
calculated
measured
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
relative phase (°)
10
100
1000
10000
100000
frequency (Hz)

B. RL low-pass



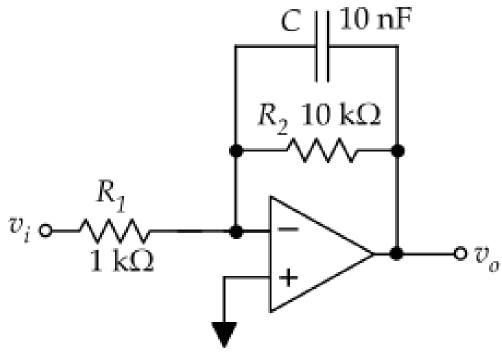
Include the calculation for the transfer function and corner frequency and your measurement of the low-frequency transfer-function magnitude and corner frequency.

T = R/(R+SL) = 1000/(1000+s.015)*
low-freq: 1/(1+(w(L/R))^2)^(½)

Calc. magnitude = 1/(1+(1000(.015/1000))^2)^(½) = .999
Meas. Voltage = 2.365 => V_o/2.5=.946

2.365/(2)^(½) = 1.672 freq = 11.47kHz

C. Active low-pass filter.

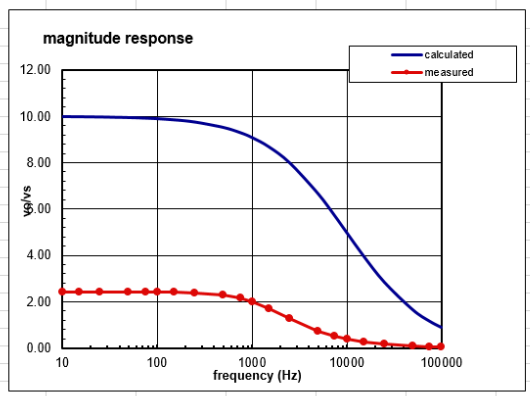


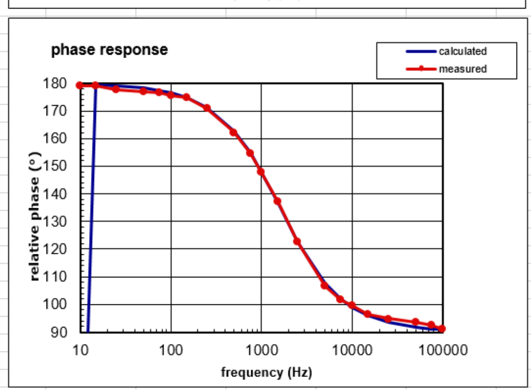
Include the calculation for the transfer function, the corner frequency, and the pass-band gain.

$T = \dfrac{-10}{(10^{-4}s + 1)}$ $\qquad w_c = 10000$ $\qquad$ PassBand = $T = \dfrac{-10}{(10^{-4}s + 1)}$

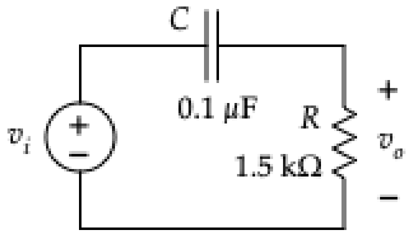
Figure: *Insert the magnitude frequency response that you measured.*

frequency (Hz)	predicted magnitude	measured magnitude	predicted phase	measured phase
10	9.99000999	2.414	z	179.2
15	9.985022466	2.414	179.460016	178.9
25	9.975062344	2.413	179.100074	177.7
50	9.950248756	2.412	178.2005918	176.9
75	9.925558313	2.409	177.3019959	176.4
100	9.900990099	2.406	176.4047262	175.5
150	9.852216749	2.397	174.6159041	174.7
250	9.756097561	2.374	171.0729451	171.0
500	9.523809524	2.276	162.5594055	162.2
750	9.302325581	2.144	154.7683628	154.7
1000	9.090909091	1.995	147.8580924	147.7
1500	8.695652174	1.702	136.6961927	137.1
2500	8	1.257	122.4816366	122.5
5000	6.666666667	0.715	107.6567872	106.7
7500	5.714285714	0.495	101.9808136	101.6
10000	5	0.376	99.04306108	99.7
15000	4	0.257	96.05661059	96.3
25000	2.857142857	0.162	93.64264689	94.8
50000	1.666666667	0.080	91.82316572	93.5
75000	1.176470588	0.054	91.21567175	92.6
100000	0.909090909	0.041	90.91181367	91.1





D. RC high-pass

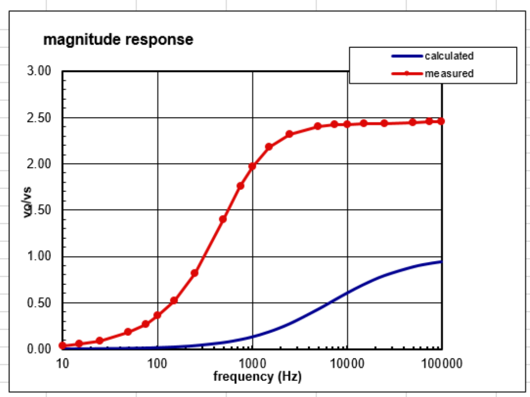


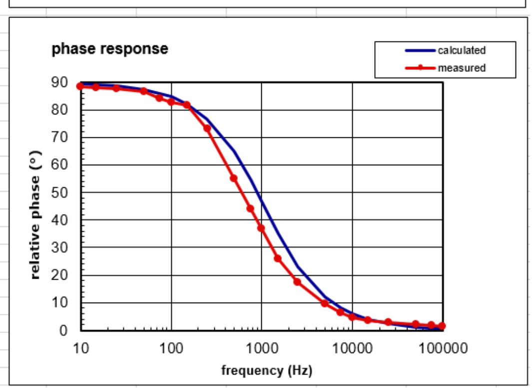
Include the calculation for the transfer function and corner frequency.

$$T = \frac{1.5 * 10^{-4}\, s}{(1.5 * 10^{-4})s + 1} = \frac{s}{s + 1/10^{-4}} \qquad w_c = 6666.6$$

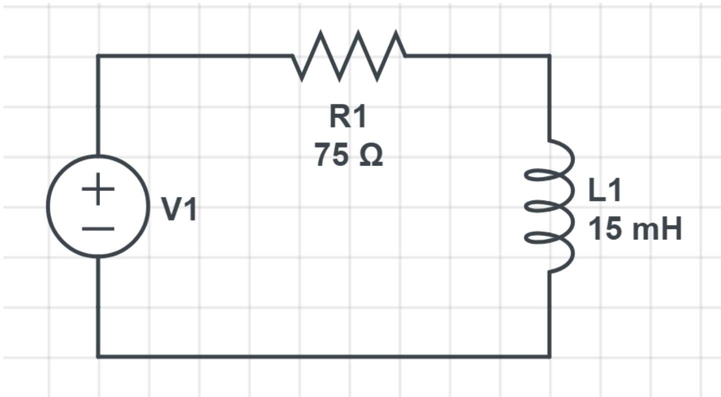
Figures: *Insert the magnitude and phase frequency response plots that you calculated and measured.*

frequency (Hz)	predicted magnitude	measured magnitude	predicted phase	measured phase
10	0.000999001	0.035	89.46001599	88.3
15	0.002244949	0.052	89.19005396	88.00
25	0.00373599	0.089	88.65024974	87.8
50	0.007444169	0.177	87.30199594	86.4
75	0.011124845	0.263	85.95672511	84.2
100	0.014778325	0.363	84.61590408	82.6
150	0.02200489	0.522	81.95332407	81.7
250	0.036144578	0.811	76.74181909	73.0
500	0.069767442	1.399	64.7683628	55.0
750	0.101123596	1.756	54.74510091	44.0
1000	0.130434783	1.972	46.69619269	36.9
1500	0.183673469	2.182	35.27388139	25.9
2500	0.272727273	2.322	22.99700767	17.3
5000	0.428571429	2.401	11.98081357	9.5
7500	0.529411765	2.419	8.052258962	6.5
10000	0.6	2.427	6.056610594	4.6
15000	0.692307692	2.433	4.046108072	3.5
25000	0.789473684	2.437	2.430249933	2.8
50000	0.882352941	2.447	1.215671747	2.2
75000	0.918367347	2.454	0.8105154	1.9
100000	0.9375	2.460	0.60790429	1.6



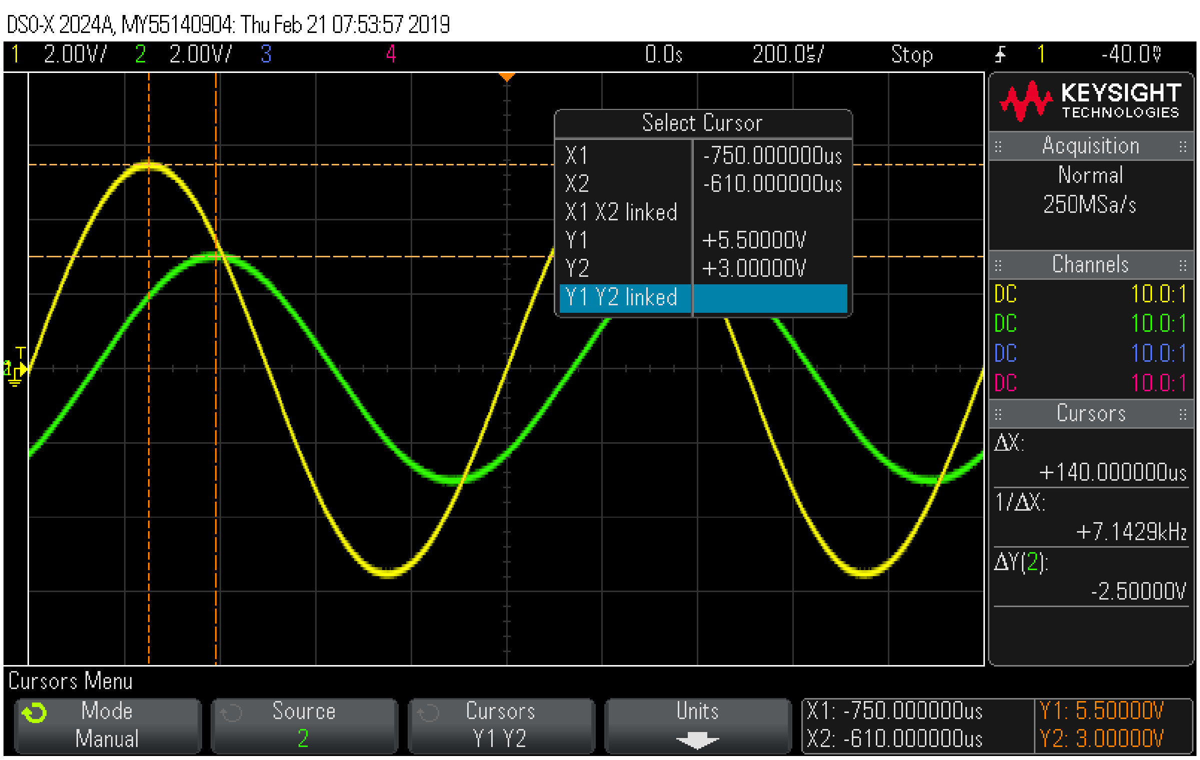


E. Passive low-pass design

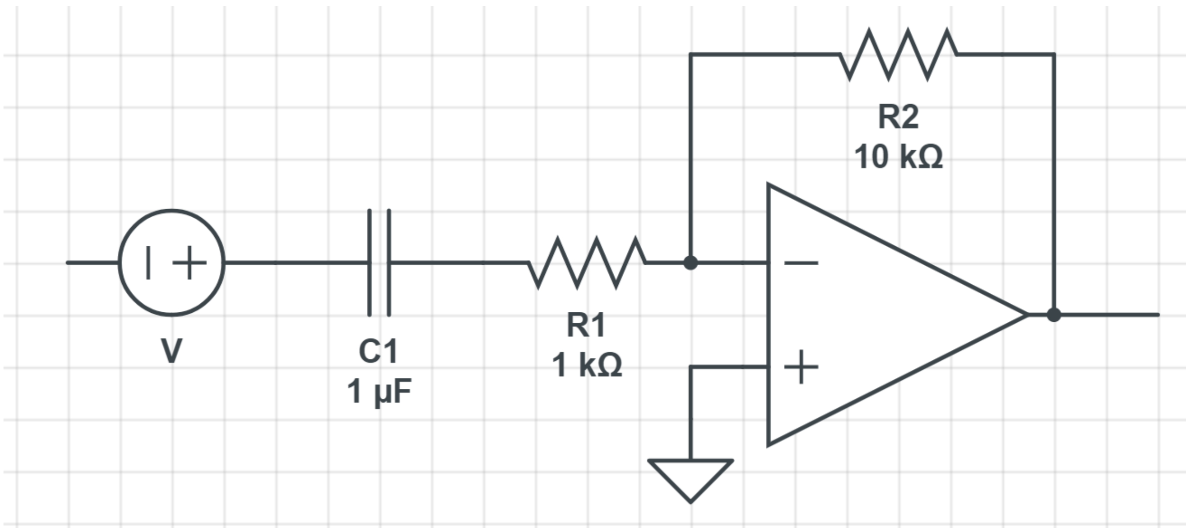


$T(s) = (R/L)/(R/L+s) = G_0 * w_c / (w_c + s)$

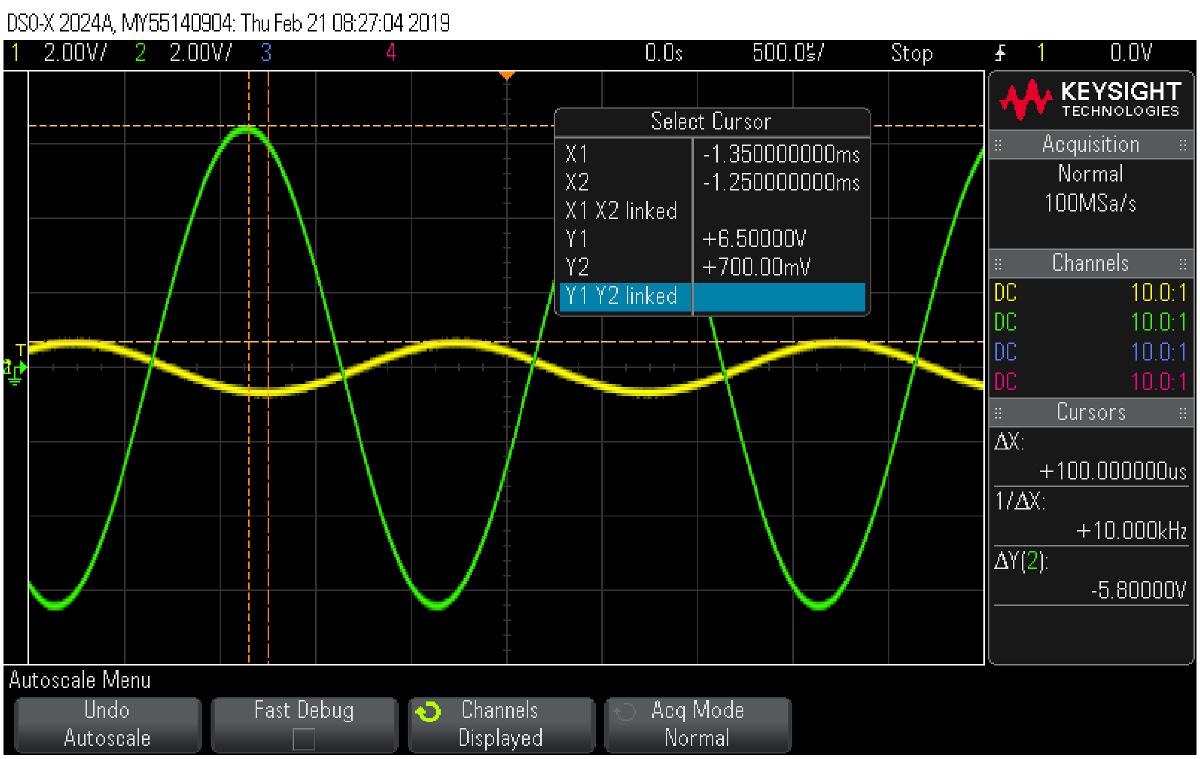
$w_c = R/L = 10$ kHz $\quad G_0 = 1/2$



F. Active high-pass design



$T(s)= (R_2)/(R_1+1/sC)= (R_2/R_1)(s/(s+1/CR_1) = G_0*s /(w_c +s)$
$w_c = 1/CR_1= 1000Hz$ $G_0 = -R_2/R_1= -10$



Conclusion

The lab focused on several different high and low pass circuits, with a design portion at the end. We had some issues with measurements in the beginning of the lab, but things smoothed out as we moved forward and exchanged some parts.