CMPE 460 Laboratory Exercise 7

Op Amp and Filter Design

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Lab Section: 1
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Colin Vo

Lecture Section: 1
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By submitting this report, you attest that you neither have given nor have received any assistance (including writing, collecting data, plotting figures, tables or graphs, or using previous student reports as a reference), and you further acknowledge that giving or receiving such assistance will result in a failing grade for this course.

Your Signature: ______________________________

Lab Description

This laboratory exercise involved using an op amp as as DC inverting amplifier, DC non-inverting amplifier, AC inverting amplifier, AC non-inverting amplifier, and a summing amplifier. Each circuit was tested at different voltages where the result was both measured and calculated.
The op amp was also used to create a low pass filter, a high pass filter, and a band pass filter. The values of the required components were calculated and the circuits were tested at different frequencies. The results were measured and then graphed to show the frequency response and phase shift of each filter.

Schematics

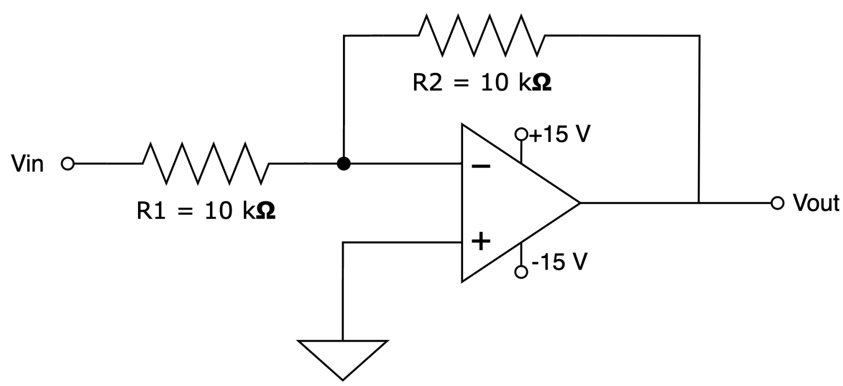

Figure 1: DC Inverting Amplifier

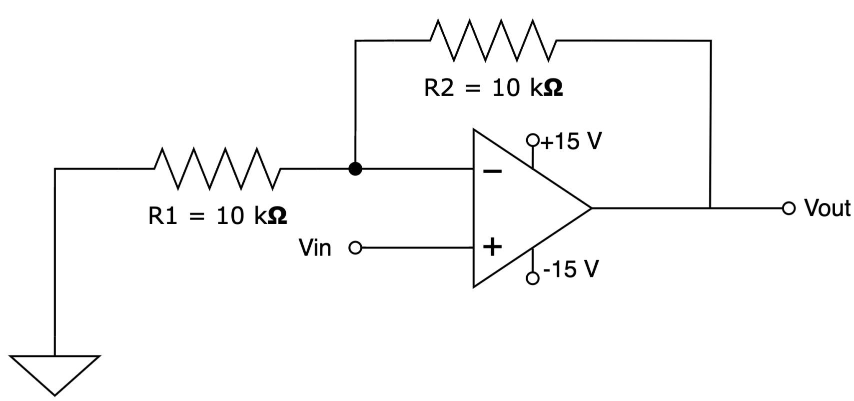

Figure 2: DC Non-Inverting Amplifier

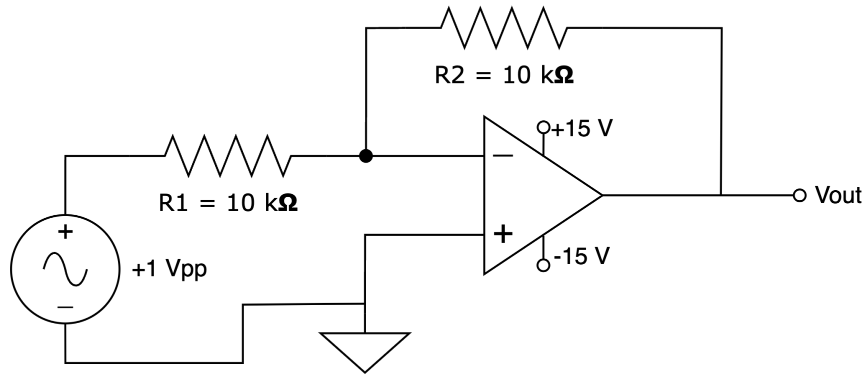

Figure 3: AC Inverting Amplifier

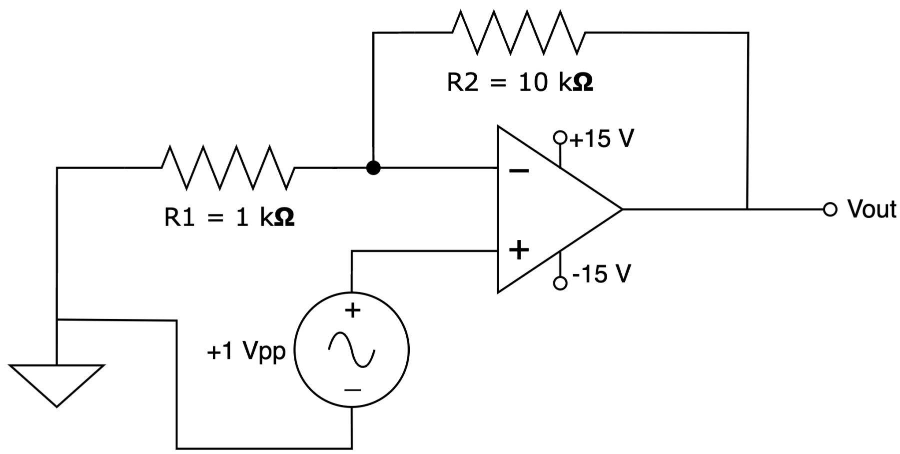

Figure 4: AC Non-Inverting Amplifier

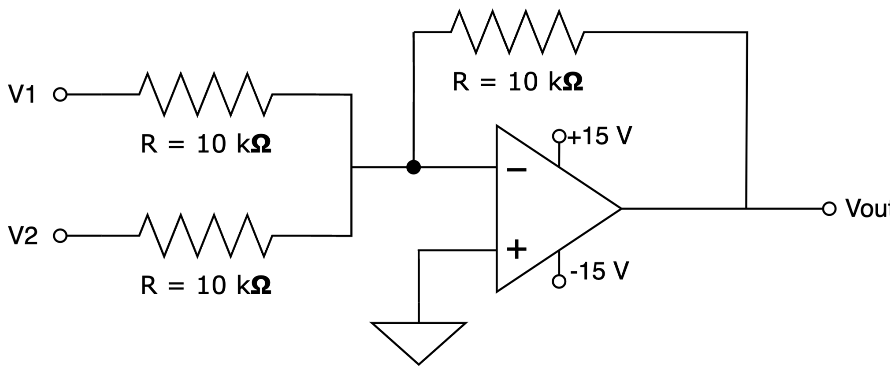

Figure 5: Summing Amplifier

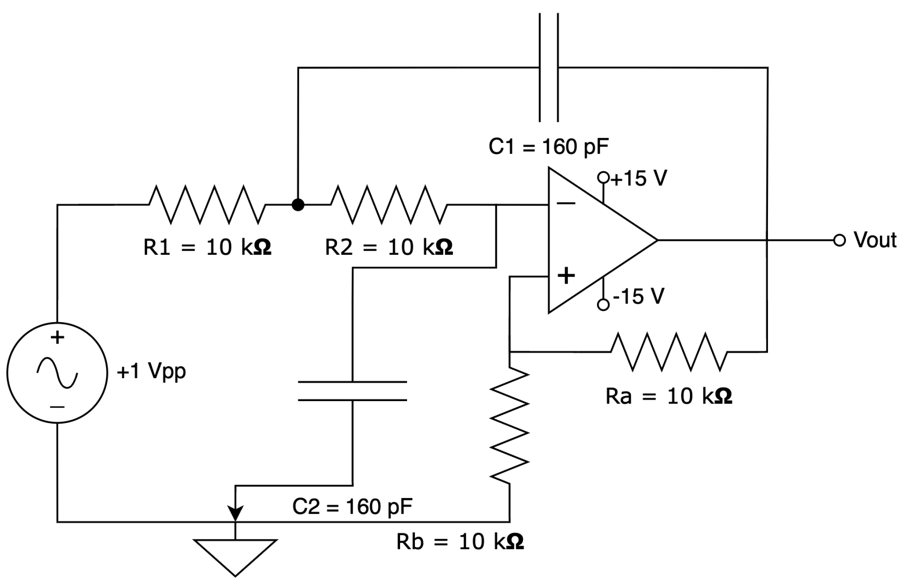

Figure 6: Low Pass Filter

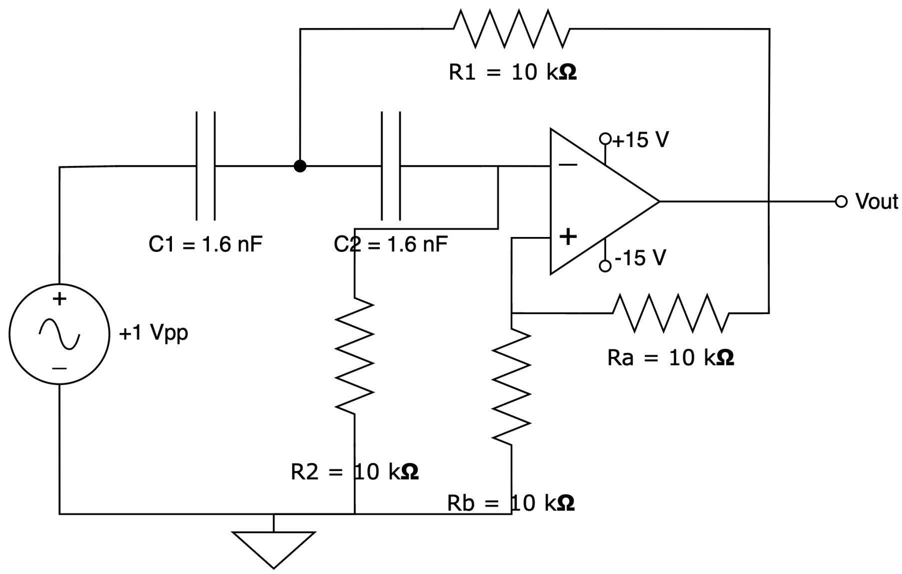

Figure 7: High Pass Filter

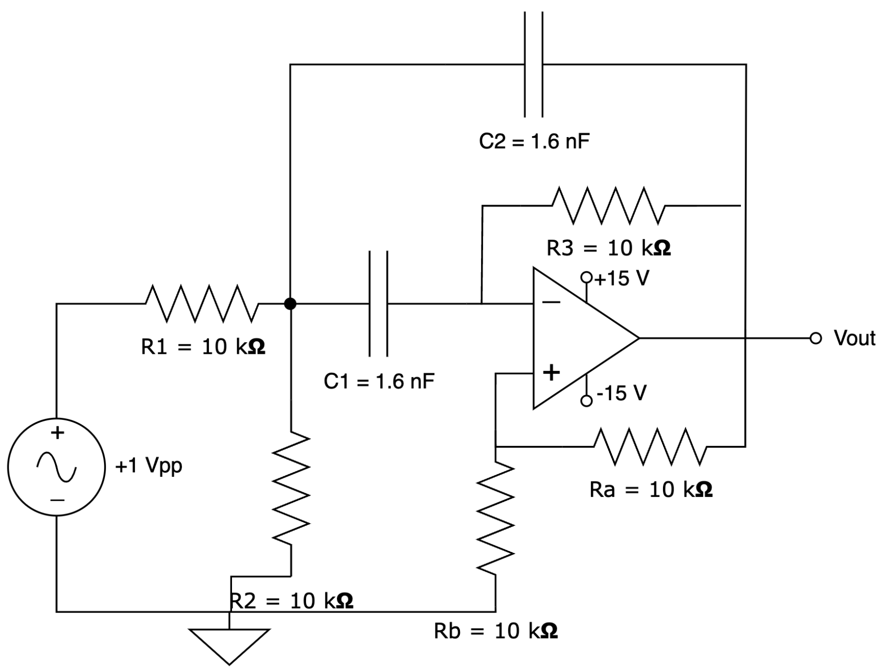

Figure 8: Band Pass Filter

Data Tables

Table 1: Results of Part 1

Vin (V)	Calculated Vout (V)	Measured Vout (V)
0.1	-0.2	-0.196
1.5	-3.0	-2.987
2.0	-4.0	-3.984
2.5	-5.0	-4.981
3.0	-6.0	-5.978
4.0	-8.0	-7.970
5.0	-10.0	-9.961

Table 2: Results of Part 2

Vin (V)	Calculated Vout (V)	Measured Vout (V)
0.1	0.3	0.309
1.5	4.5	4.528
2.0	6.0	6.059
2.5	7.5	7.567
3.0	9.0	9.102
4.0	12.0	12.114
5.0	15.0	14.131

Table 3: Results of Part 3

Vin (Vpp)	Calculated Vout (V)	Measured Vout (V)
0.4	4.0	3.4
0.5	5.0	4.5
0.6	6.0	5.8
0.8	8.0	7.8
1.0	10.0	9.8

Table 4: Results of Part 4

Vin (Vpp)	Calculated Vout (V)	Measured Vout (V)
0.4	4.4	4.2
0.5	5.5	5.4
0.6	6.6	6.6
0.8	8.8	8.8
1.0	11.0	10.9

Table 5: Results of Part 5

V1 (V)	V2 (V)	Calculated Vout (V)	Measured Vout (V)
0	1	-1	-1
1	0	-1	-0.99
1	1	-2	-1.99
-1	1	0	0.02
3	2	-5	-4.99
-2	2	0	0.04
1	-3	2	2.27

Table 6: Results of Part 6

Frequency (Hz)	Gain (Vo/Vi)	Gain (dB)	Phase Angle
100	2.229	7.000	5.700
500	2.167	6.700	5.500
5000	2.083	6.400	9.000
10000	2.083	6.400	13.500
50000	1.800	5.100	148.200
80000	1.029	0.200	175.400
100000	0.829	-1.600	177.700
200000	0.314	-10.100	-169.000
300000	0.143	-16.900	-154.700
500000	0.057	-24.900	-123.000

Table 7: Results of Part 7

Frequency (Hz)	Gain (Vo/Vi)	Gain (dB)	Phase Angle
100	0.095	-20.470	-334.000
500	0.097	-20.279	-423.000
5000	0.526	-5.575	-140.000
10000	1.800	5.105	0.000
50000	1.811	5.156	-10.000
80000	1.716	4.689	10.000
100000	1.674	4.473	20.000
200000	1.316	2.384	42.000
300000	1.032	0.270	54.000
500000	0.705	-3.033	72.000

Table 8: Results of Part 8

Frequency (Hz)	Gain (Vo/Vi)	Gain (dB)	Phase Angle
500	0.047	-26.620	134.000
1000	0.073	-22.694	130.000
10000	0.423	-7.466	120.000
20000	0.667	-3.522	140.000
50000	0.937	-0.568	180.000
80000	0.917	-0.756	-150.000
100000	0.833	-1.584	-140.000
200000	0.543	-5.299	-120.000
500000	0.270	-11.373	-80.000
1000000	0.147	-16.673	-50.000

Filters Calculations

Low Pass Filter

$$R_1 = R_2 = 10k\Omega$$

$$f_c = \frac{1}{2\pi\sqrt{R_1R_2C_1C_2}} = \frac{1}{2\pi(10k\Omega)C} = 100KHz$$

$$C = C_1 = C_2 = \frac{1}{2\pi(10k\Omega)(100KHz)} = 159.15pF$$

High Pass Filter

$$R_1 = R_2 = 10k\Omega$$

$$f_c = \frac{1}{2\pi\sqrt{R_1R_2C_1C_2}} = \frac{1}{2\pi(10k\Omega)C} = 10KHz$$

$$C = C_1 = C_2 = \frac{1}{2\pi(10k\Omega)(10KHz)} = 1.5915nF$$

Band Pass Filter

$$R_1 = R_2 = R_3 = 10k\Omega$$

$$f_r = \frac{1}{2\pi\sqrt{R_1R_2R_3C_1C_2}} = \frac{1}{2\pi(10k\Omega)C} = 10KHz$$

$$C = C_1 = C_2 = \frac{1}{2\pi(10k\Omega)(10KHz)} = 1.5915nF$$

Filters Plots

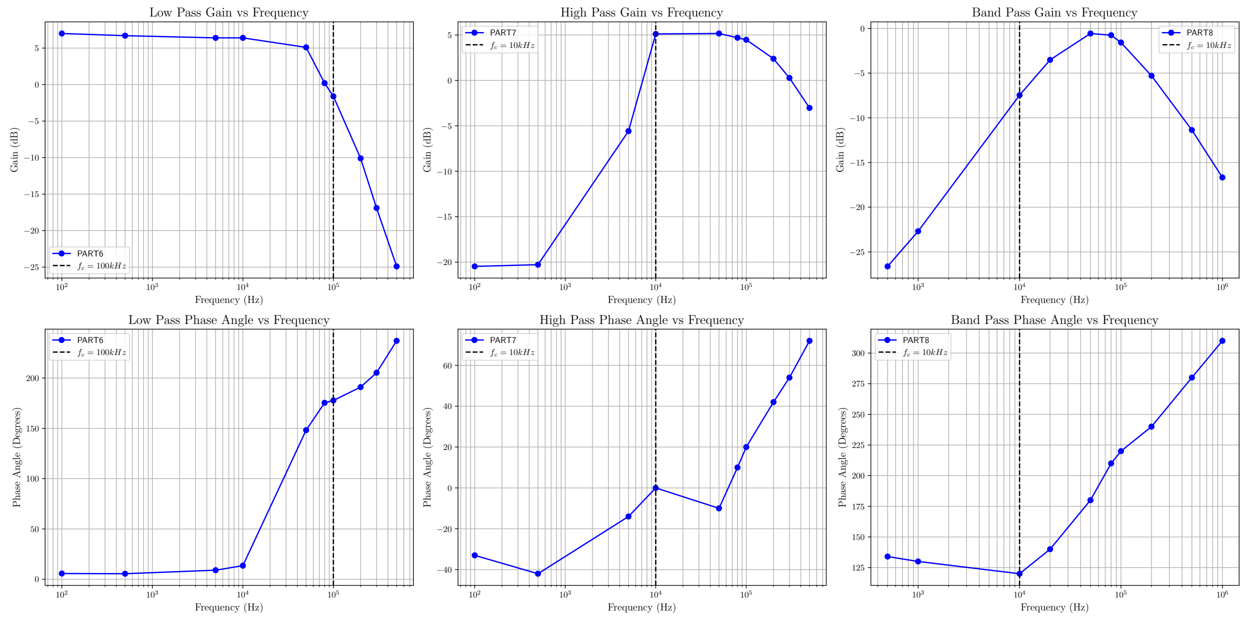

Figure 9: Filters Plots

Questions

Part 3: *Repeat step 2 for the following frequencies: 10 Hz, 100 Hz and 10 KHz. What conclusions can be drawn about voltage gain and phase shift?*
The voltage gain increases as the frequency increases. The phase shift also increases as the frequency increases. The gain instead by a factor of 10 and the phase shift increased by pi.

Exercise 6: Motor Control

Student's Name: Mohammed Fareed Trent Wesley Section: 1

PreLab		Point Value	Points Earned	Comments
PreLab	Motor Calculations	10	10	AJT 10/17
	H-Bridge Questions	10	10	AJT 10/17

Demo		Point Value	Points Earned	Date
Demo	20% Duty Cycle at 10kHz	10	10	AJT 10/25
	DC Motor Functionality	5	5	MT 10/30
	Stepper Motor Functionality	5	5	MT
	Servo Motor Functionality	5	5	MT 10/30
	Simultaneous TI Car Motors-Servo Motor	15	15	AJT 11/1

To receive any grading credit students must earn points for both the demonstration and the report.