EE 230 Lab

lab 1 report

Report: **Basic op-amp circuits**

Lab work done by ________________Sean Gordon____________________

and ______________Tejas Agarwal______________________

Lab work date: 1/23/2019

Report submission date:

Lab Section: E

Graded by ____________________________________

Score ______________________________

Introduction

This lab acts as an initial review of op-amps, eventually sprinkling in newer concepts that use op amps in their implementations. The lab ensures experimentation with each device, and adds several questions for contemplation throughout the lab.

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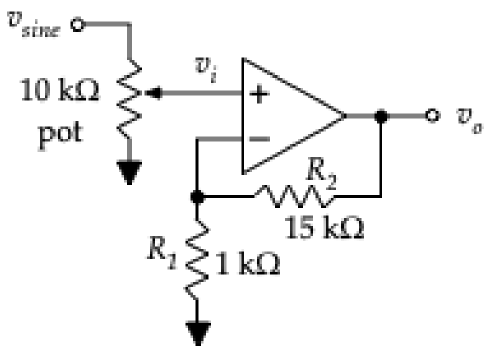
A. Non-inverting amp



(Don't forget units in all the right places!)
Using 324 Amp
$G = 1 + R_2/R_1 = 1 + 15/1 = 16$

Expected gain : G = _______16__________

Measured v_i = _________1.44V_{rms}______________

Measured v_o = ___________12.78V___________

Measure gain : G = _________14__________

Figure 1: Insert an image of the oscilloscope trace of undistorted v_o and v_i together.

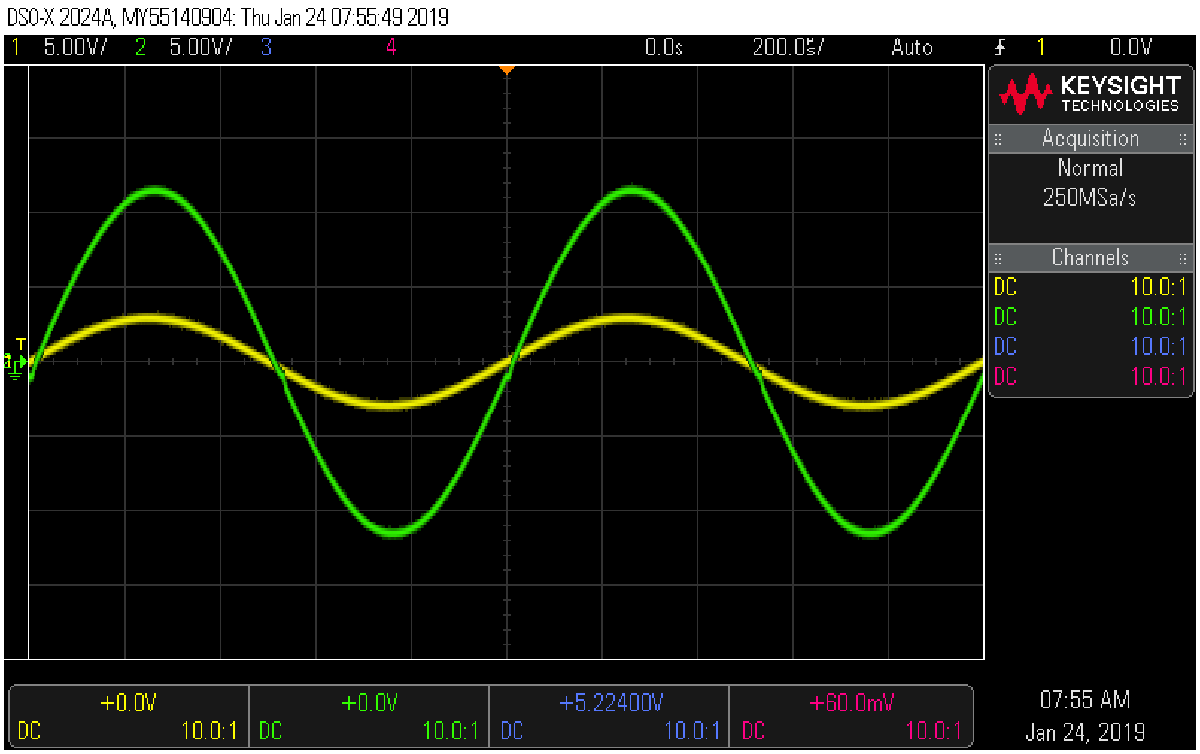
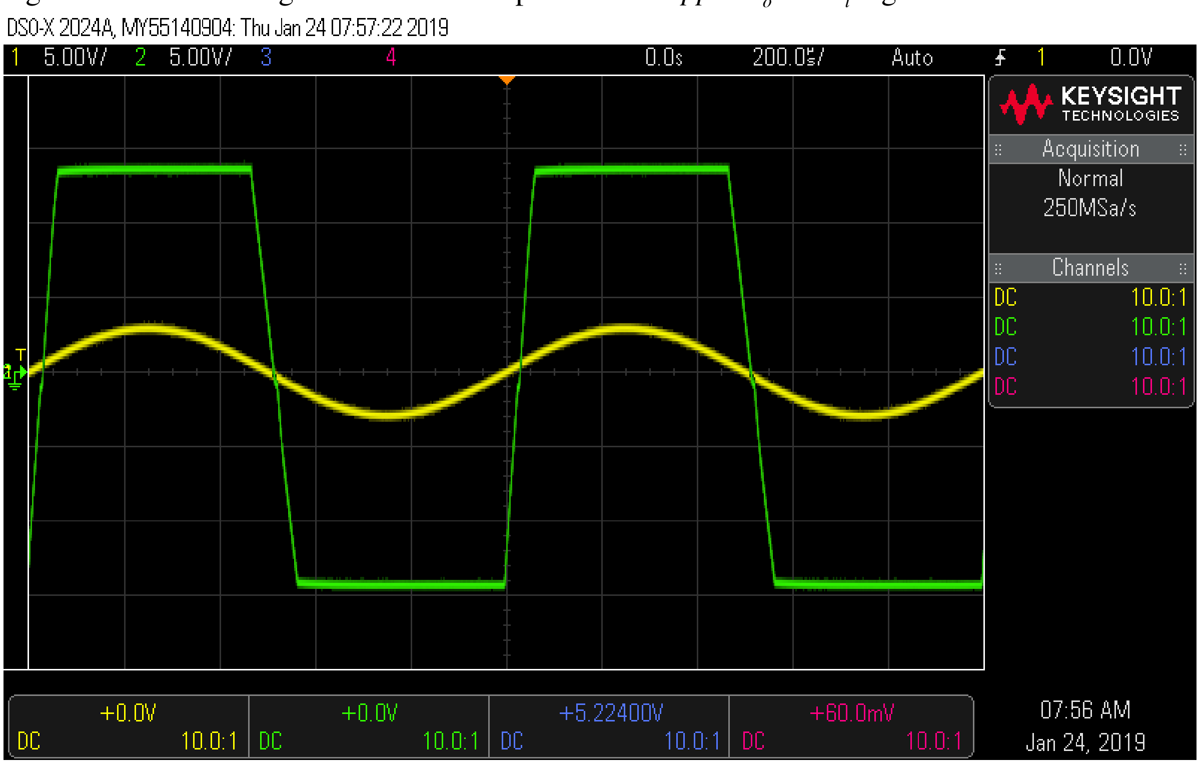


Figure 2: Insert an image of the oscilloscope trace of *clipped* v_o and v_i together.



Maximum output without clipping: v_o (max) = __________13V_________________

B. Transfer characteristic

Figure 3: Insert an oscilloscope image of the transfer characteristic when the output *is not* clipped.
/++

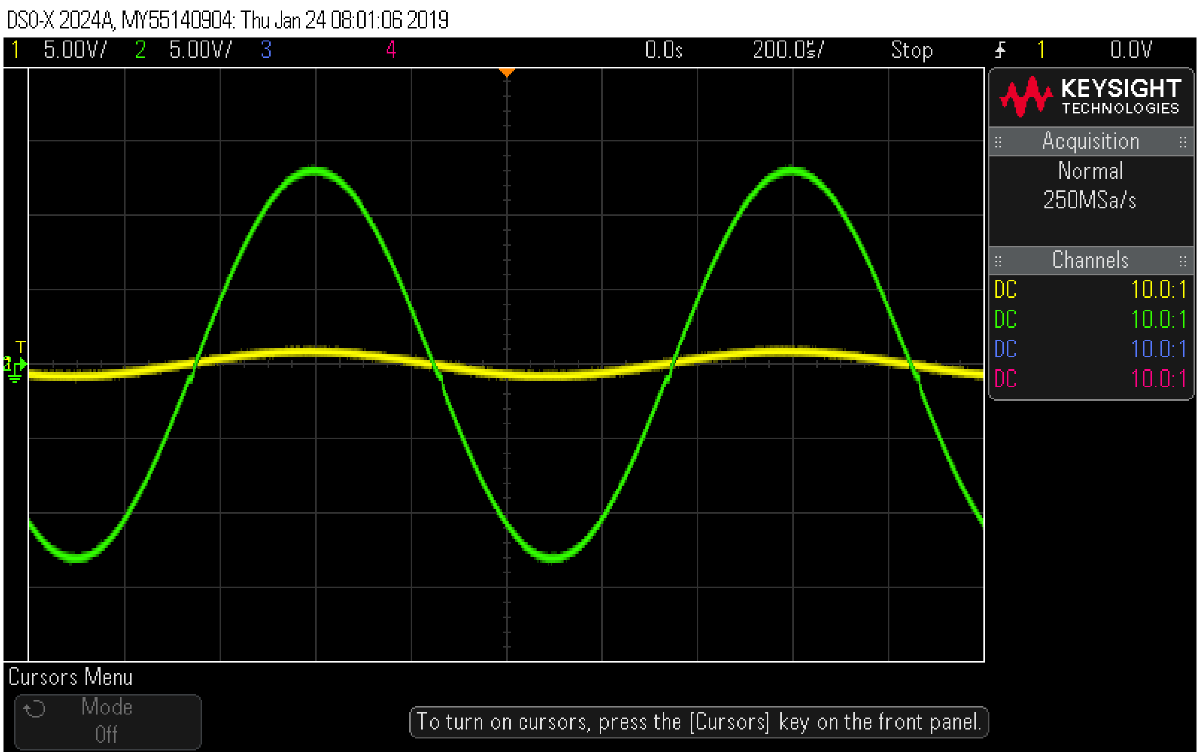
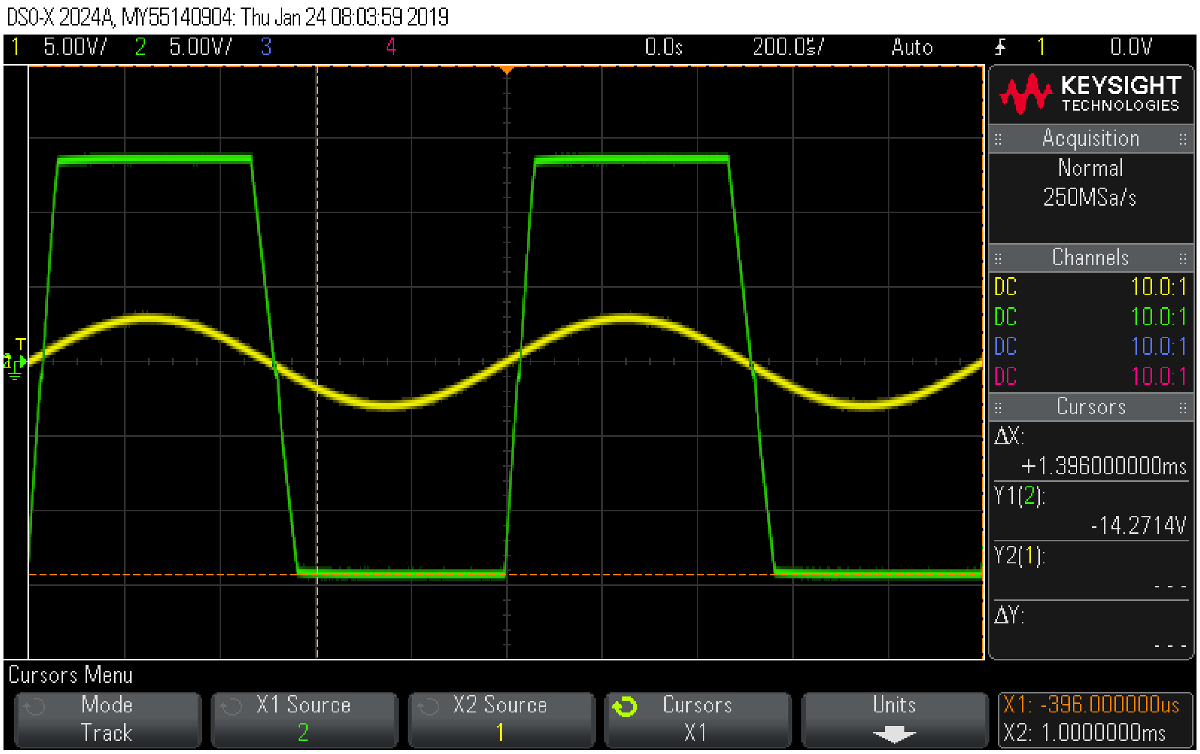


Figure 4: Insert an image of transfer characteristic when the output *is* clipped.



C. Unity-gain buffer

pot. position	*a-calculated*	*a-measured*	*b - calculated*	*b - measured*	*c - measured*
25%	11.25v	9.5	4.32	7.7	12.3
50%	7.5	5.27	2.57	4.06	7.55
75%	3.75	3.6	1.67	3.25	2.55

Write a paragraph explaining how the buffer amplifier works and how that leads to the results seen here.

The buffer amplifier uses negative feedback to provide an electrical impedance transformation. This buffers the output from anything the load may produce, driving the load as an ideal voltage source.

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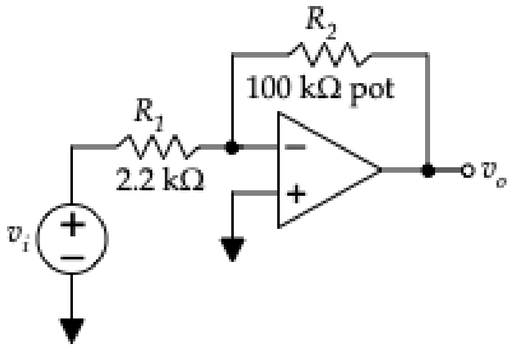
D. Inverting amplifier



$G = -R_2/R_1 = -50k/2.2k = -45.45$

Using 324 Amp

Expected gain : G = _______-22.72_________

Measured v_i = ________-13.67v________

Measured v_o = _______4.5v_________

Measure gain : $|G|$ = ________-3______

Figure 5: Insert an image of the oscilloscope trace of undistorted v_o and v_i together.

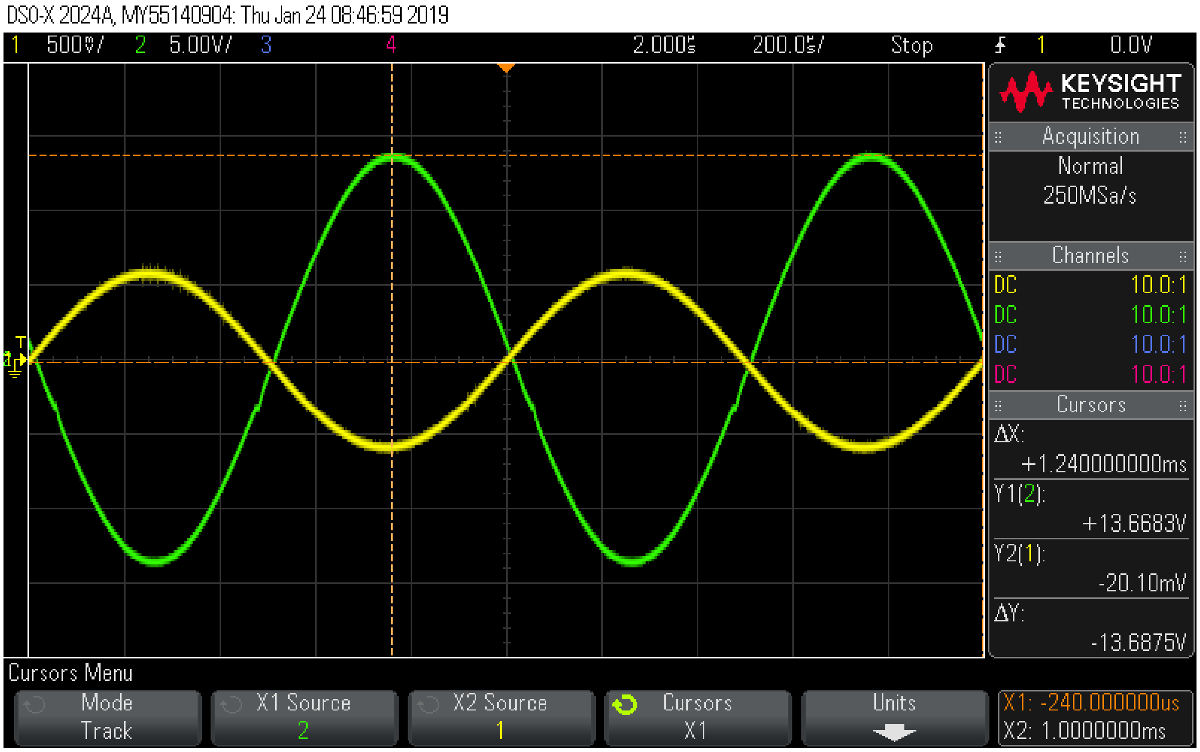
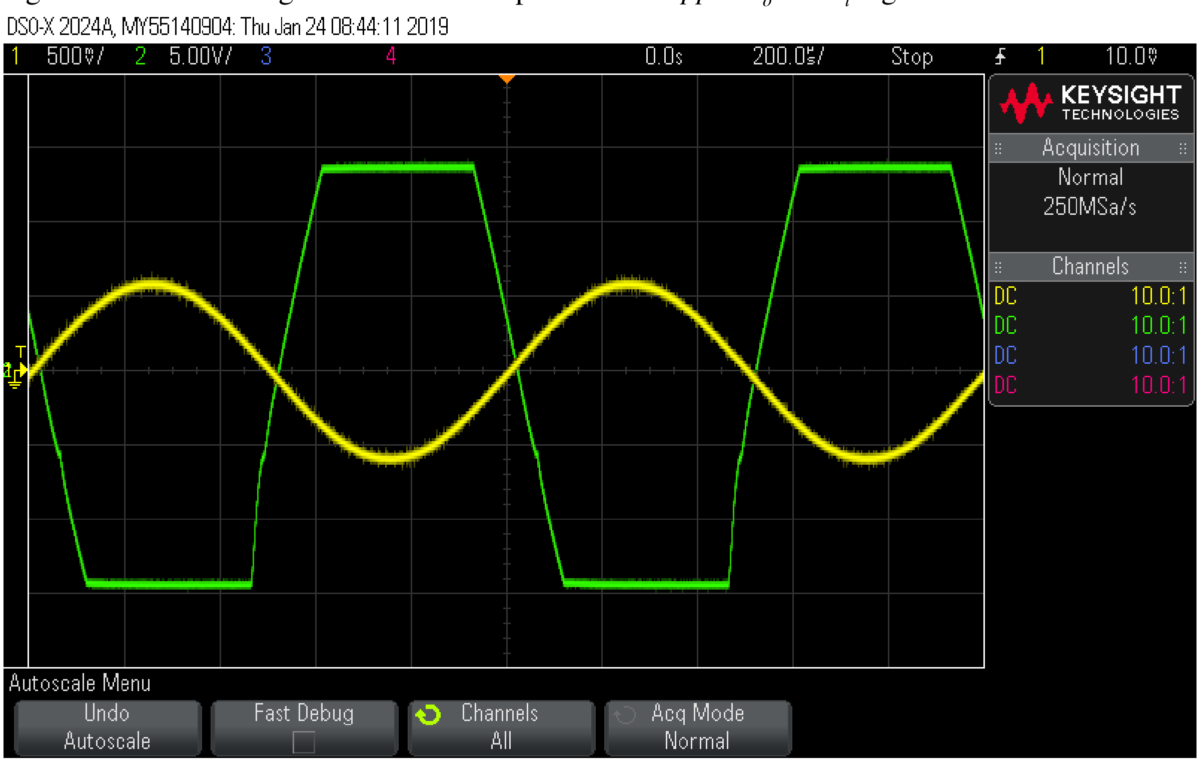


Figure 6: Insert an image of the oscilloscope trace of *clipped* v_o and v_i together.



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Maximum output without clipping: v_o (max) = ______________13.6v___________________

Figure 7: Insert an oscilloscope image of the inverting transfer characteristic when the output *is not* clipped.

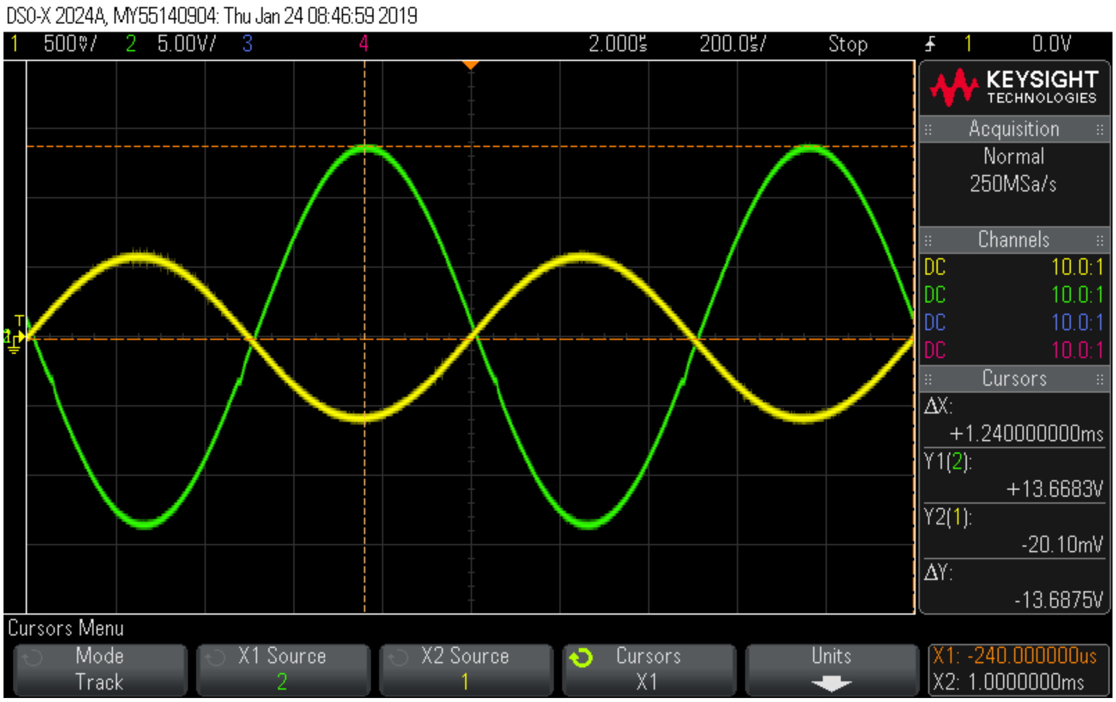
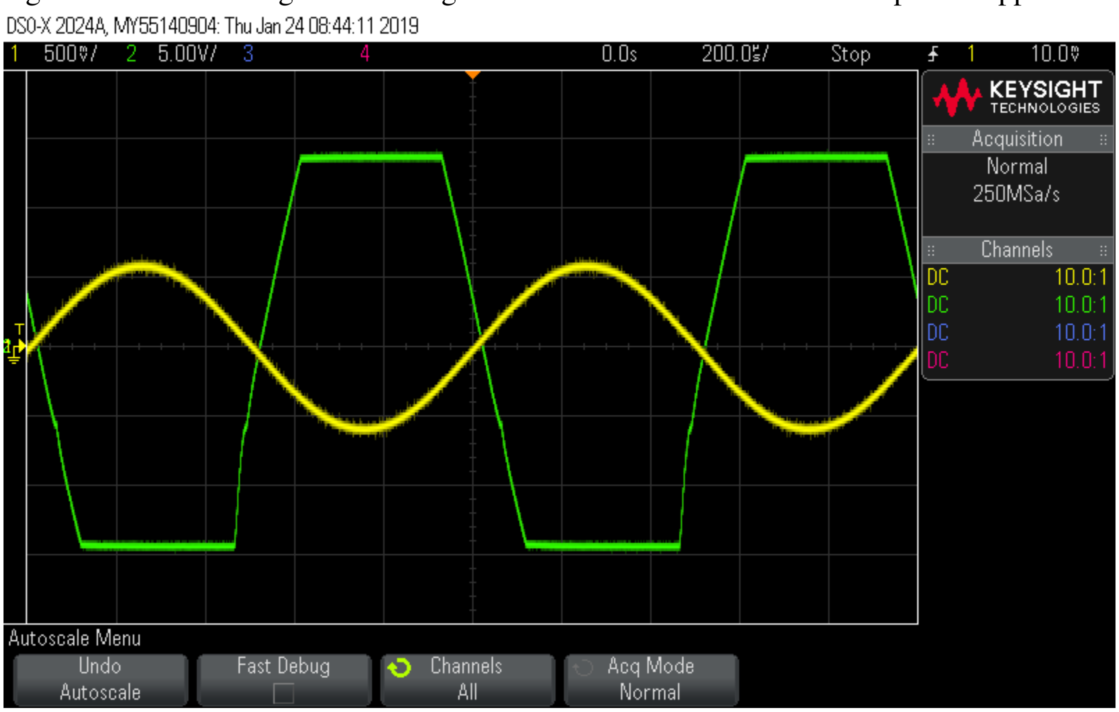


Figure 8: Insert an image of inverting transfer characteristic when the output *is* clipped.



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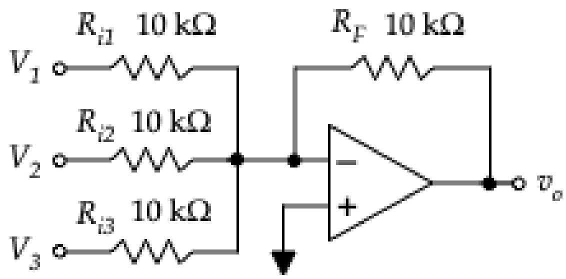
E. Summing amplifier



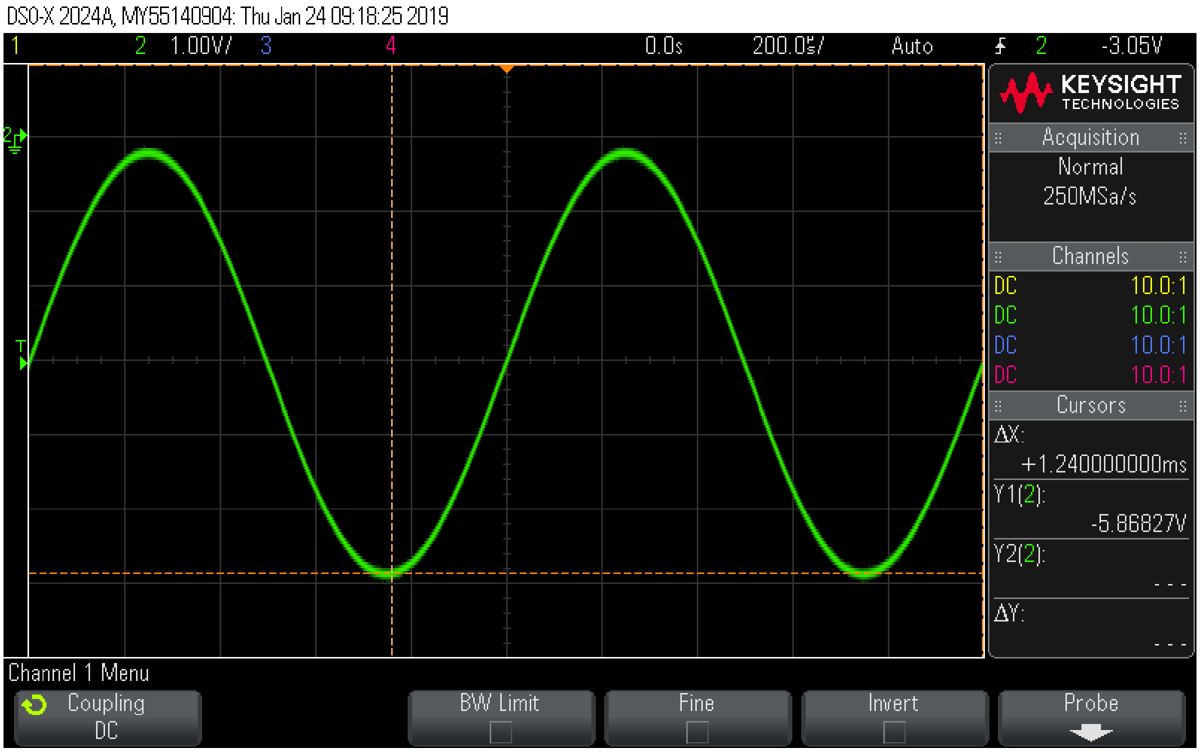
Expected out function : v_o = ____f(V1, V2, V3) = V1+V2+V3_____

$$V_o = -Rf/R1 * V1 - Rf/R2 * V2 - \ldots \quad => \quad -V1 - V2 - V3$$

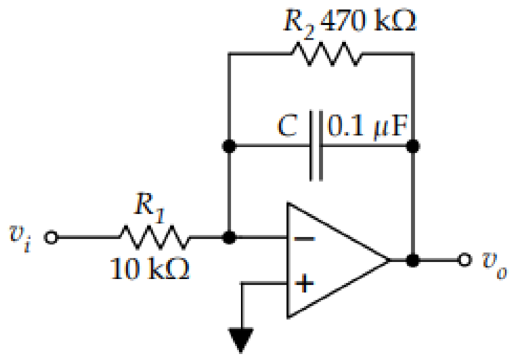
V_1	V_2	V_3	v_o*(calculated)*	v_o*(measured)*
1 V	1 V	1 V	-3v	-3v
2 V	1 V	1 V	-4V	-4
2 V	– 2 V	4 V	-4V	-4
4 V	– 3 V	5 V	-6V	-6

Figure 9: Insert an oscilloscope image of the v_o when the one of the inputs is a sinusoid and the other two inputs are some combination of DC values. (Be sure to list the voltages used.)

All voltages 1v



F. Integrating amplifier



Sketch the expected output voltage when the input is a 5-V square-wave on the graph below.

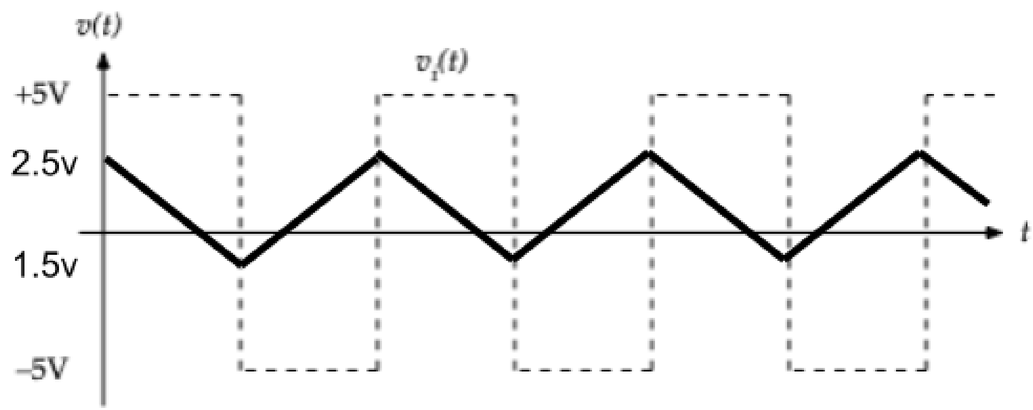


Figure 10. Oscilloscope trace of measured square-wave input and integrator output together.

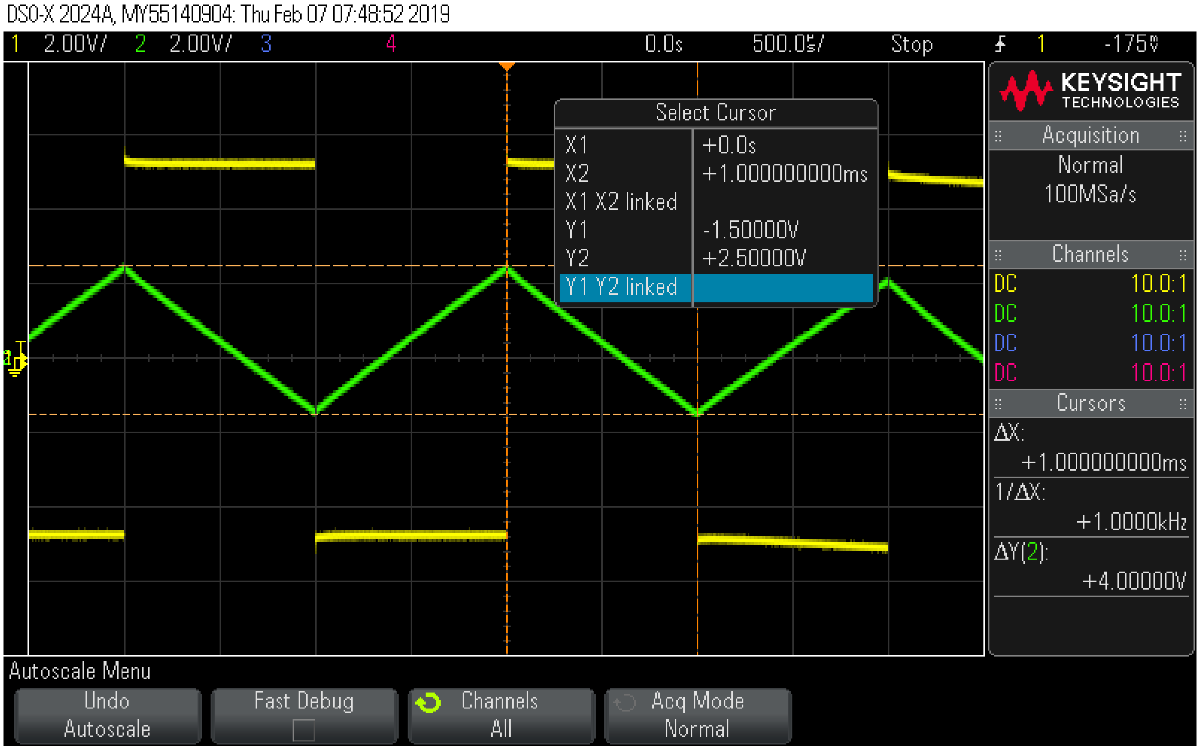


Figure 11. Oscilloscope trace of measured ramp-wave input and integrator output together.

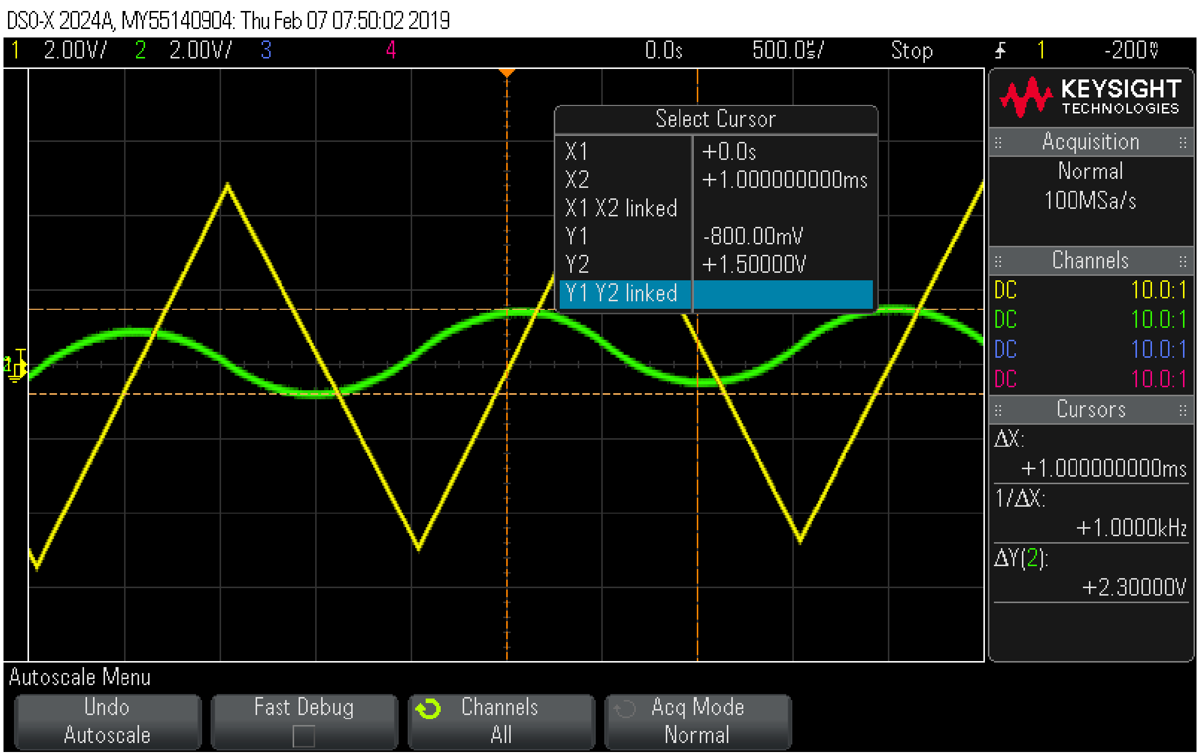
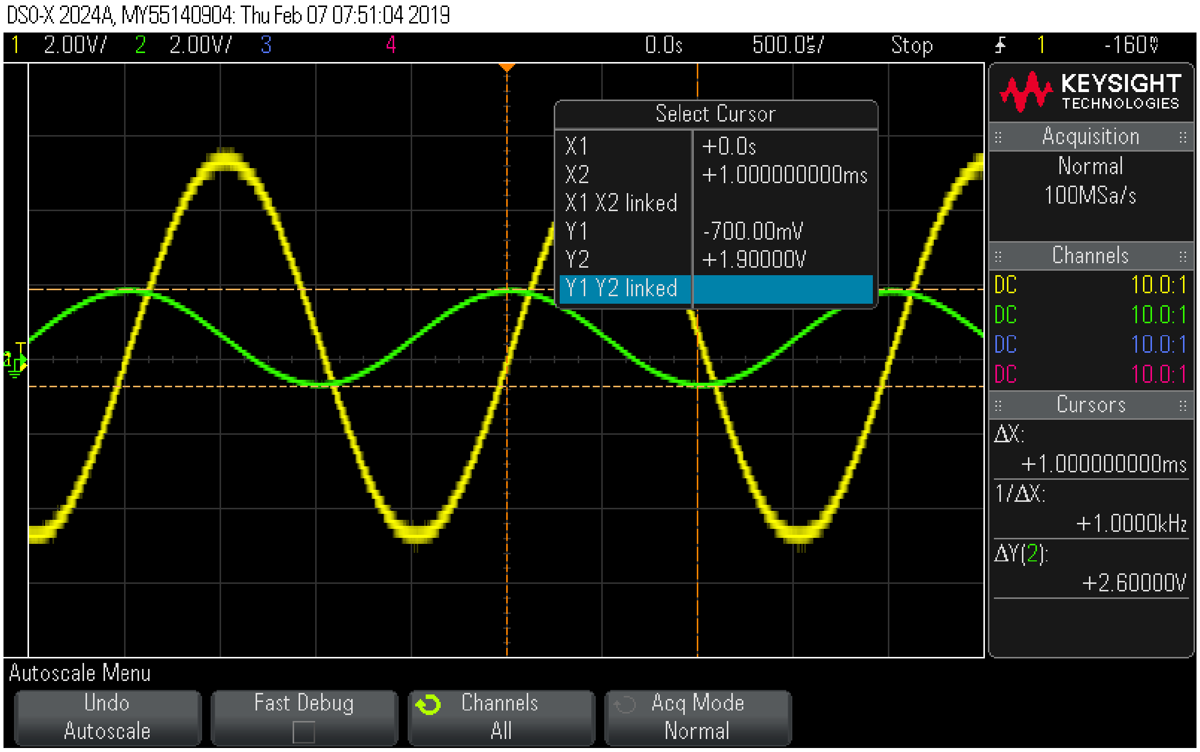


Figure 12. Oscilloscope trace of measured sinusoidal input and integrator output together.



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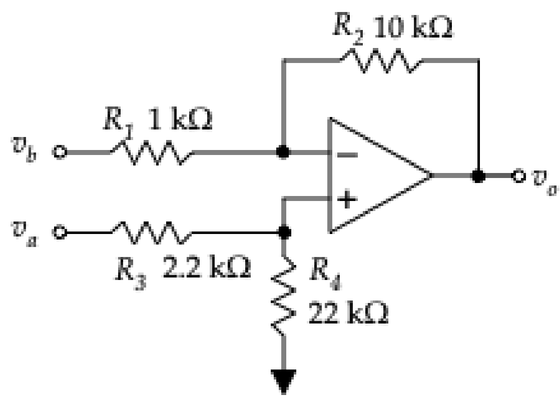
G. Difference amplifier



Expected out function : v_o = ______________________

With v_b grounded:

v_a = _________.35v_________, v_o = __________3.58v________, G_a = ________10.2________

With v_a grounded:

v_b = _________.35v_________, v_o = __________3.45v________, G_b = ________9.86________

With $v_a = v_b = v_c$ (common-mode operation)

v_c = _________7.07v________, v_o = __________6.5v_________, G_c = ________.919_________

CMRR = _______________-20.9______________

Figure 13: Insert an image of the input and output traces with $v_a = v_i$ and $v_b = 0$. *(Green is input here)*

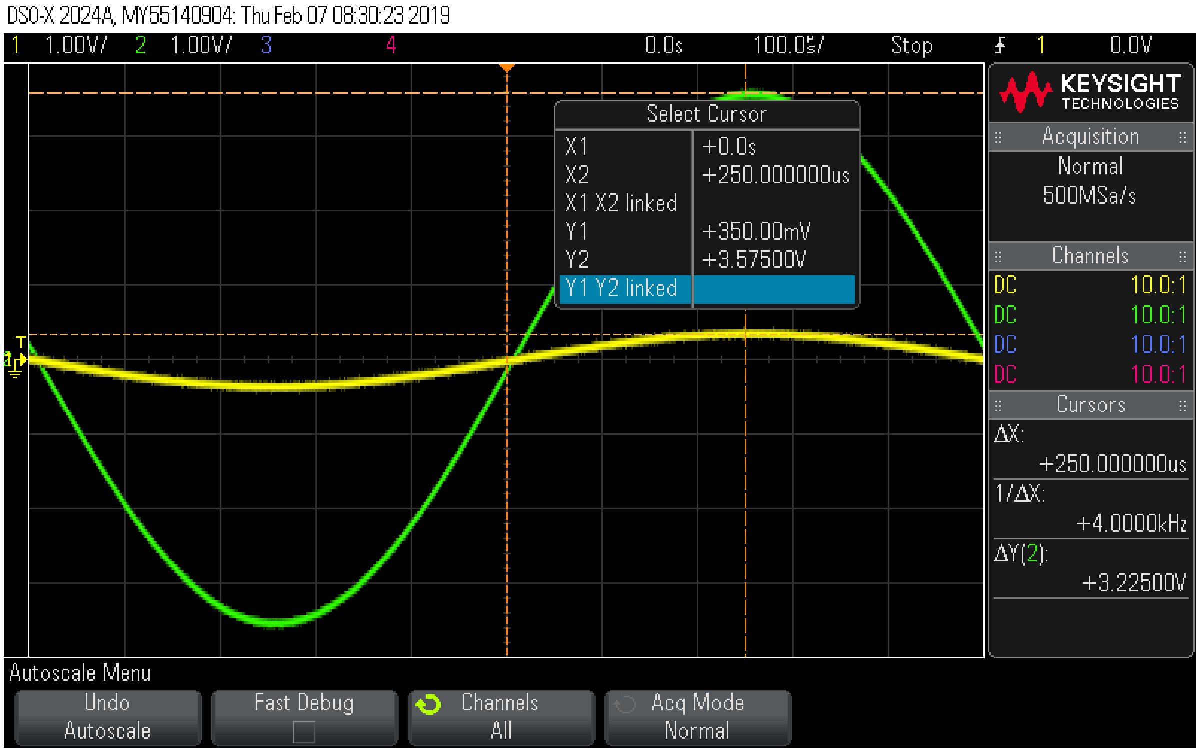
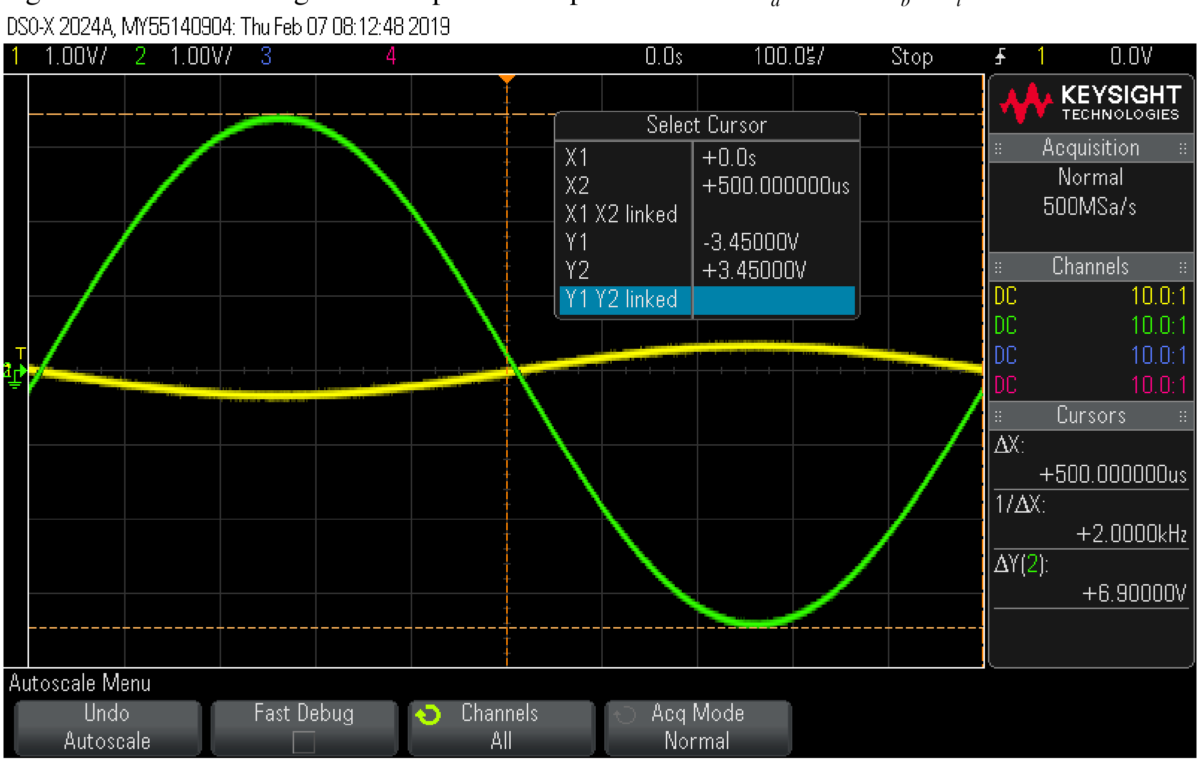


Figure 14: Insert an image of the input and output traces with $v_a = 0$ and $v_b = v_i$.



Add a short paragraph regarding CMRR.

CMRR is the ratio of differential voltage gain to common mode voltage gain. CMRR is calculated in decibels, using the equation db = 20log(CMRR). Common means both inputs are equal.

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H. Instrumentation amplifier

Expected difference-mode gain : G = ______________________

Measured difference-mode gain :

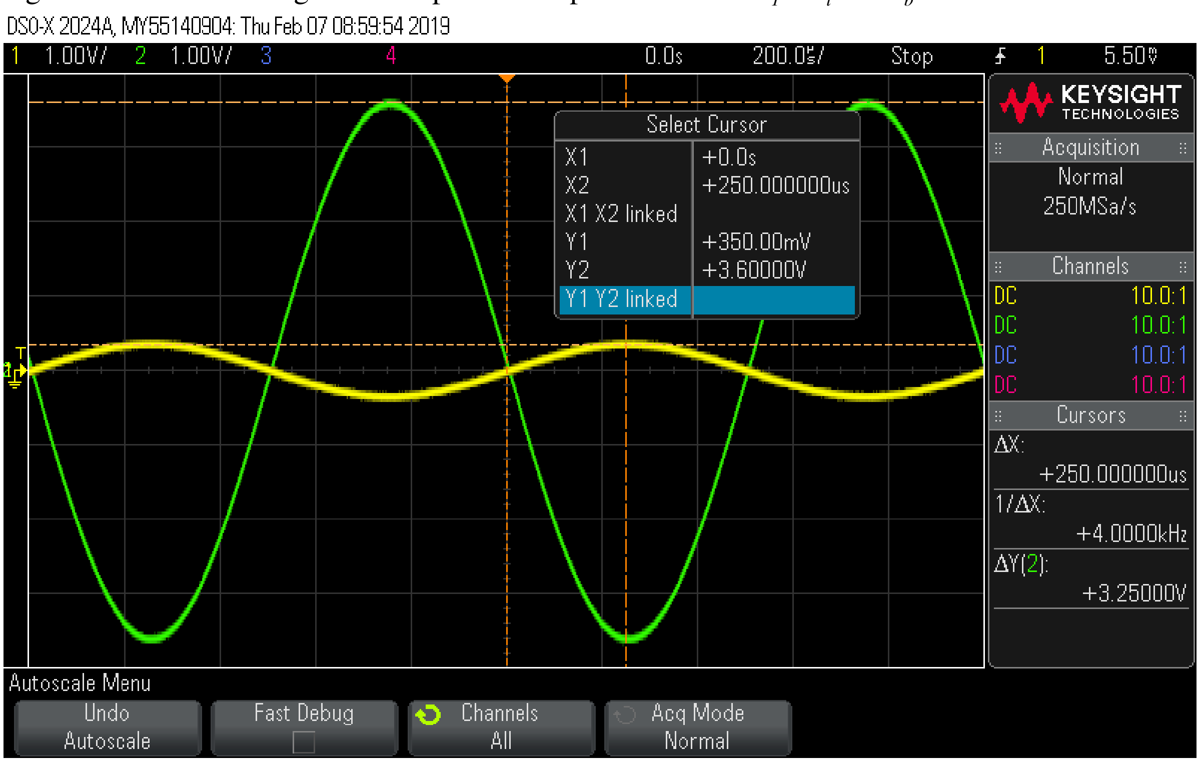
v_i = ______.35v_______, v_o = ________3.6v________, G = _______10.29______

With $v_1 = v_2 = v_c$ (common-mode operation)

v_c = ______.35v________, v_o = _______7.125v________, G_c = _______20.36____

CMRR = ___________26.17_________________

Figure 15: Insert an image of the input and output traces with $v_1 = v_i$ and $v_b = 0$.



Conclusion

The lab went smoothly, with each section taking around the same time to complete. There were some measurement issues in part C that I was unsure of, but the rest of the lab seems relatively consistent to calculations.