Electronics Design Principles

Differential Amplifier and Instrumentational Amplifier

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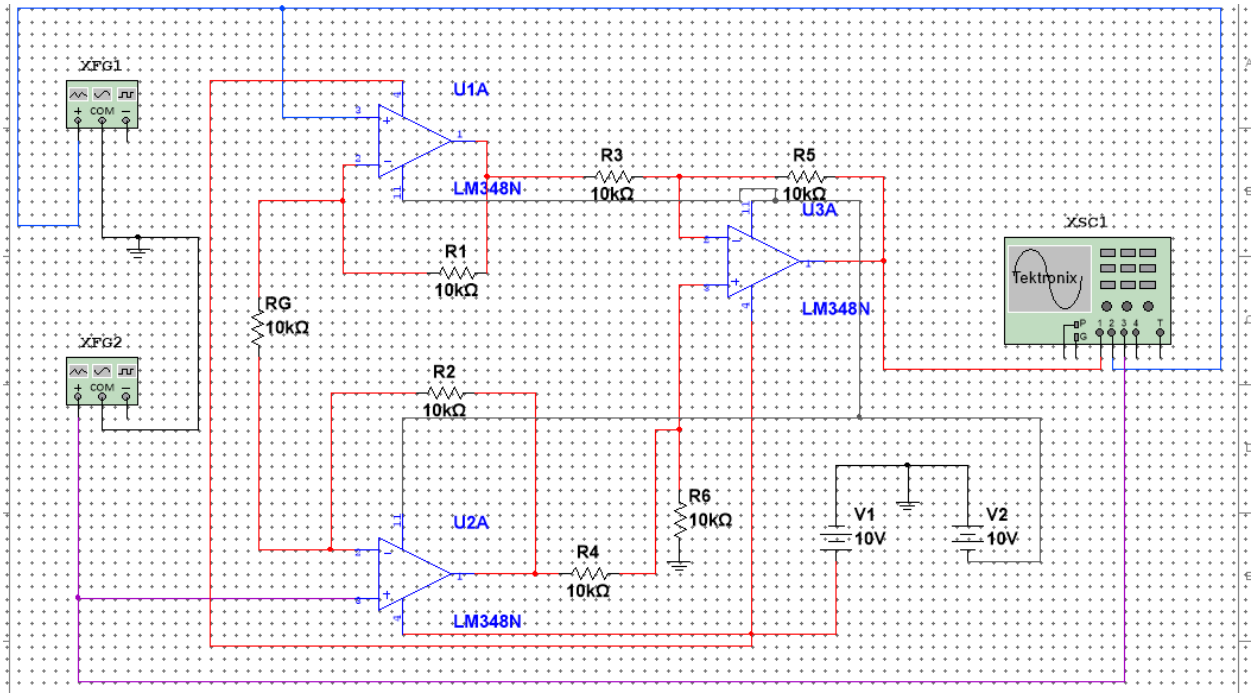
Object: Design and build an instrumentational amplifier using an identical R values for all 7 resisters.

Build a differential amplifier first to test out your circuits before connecting to the rest.

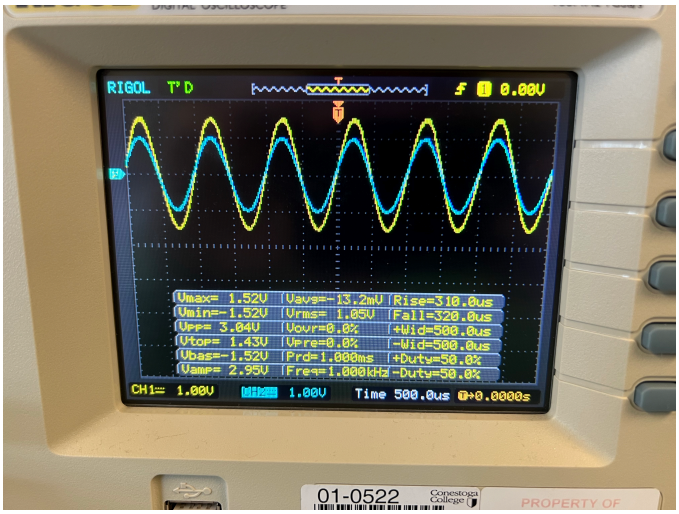
Equipment: Oscilloscope, power supply, function generator, resistors, LM348M op amp, wires, breadboard.

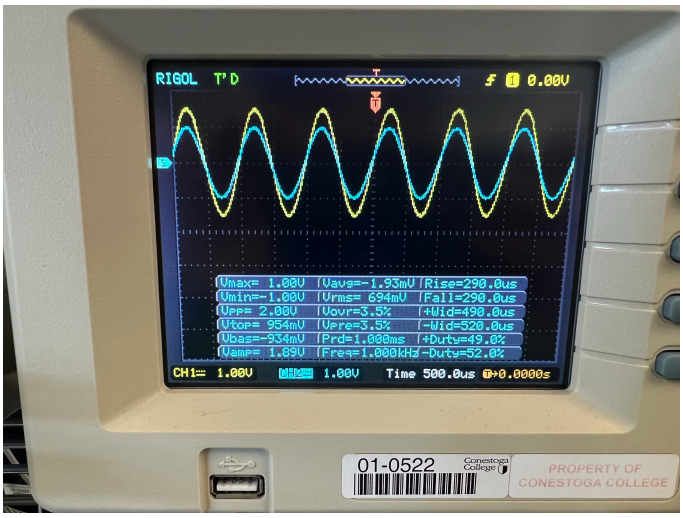
Schematic:



Output:

Case 1:
CH1: 2 Vpp
CH2: 1 Vpp





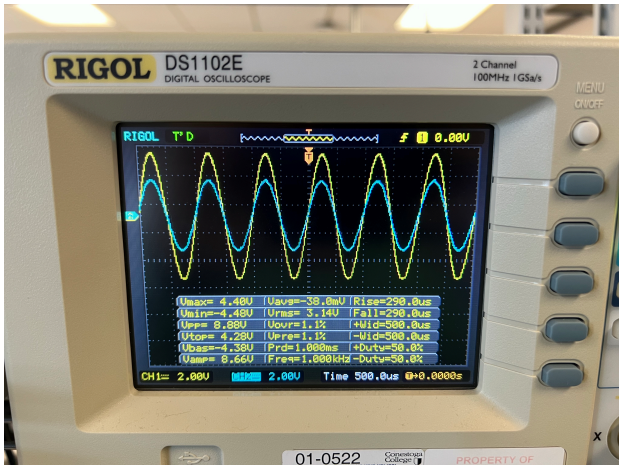
Real Values

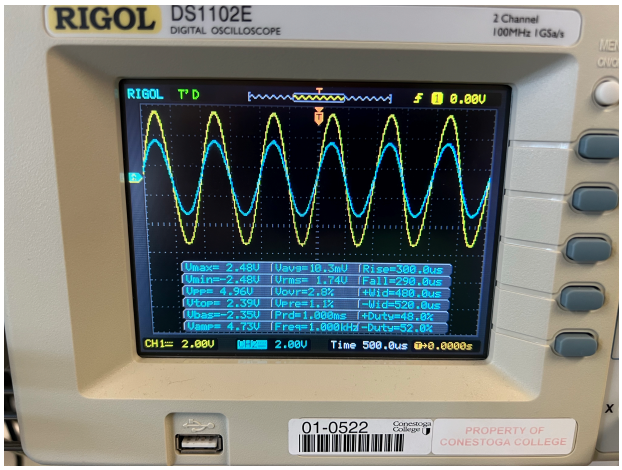
Type	CH1	CH2
V_{max}	1.52V	1V
V_{min}	−1.52V	-1V
V_{pp}	3.04V	2V

Multisim Value

Type	CH1	CH2
Max	1.5V	1V
Min	-1.5V	-1mV
Pk-Pk	3V	2mV

Case 2:
CH1: 5 Vpp
CH2: 2 Vpp





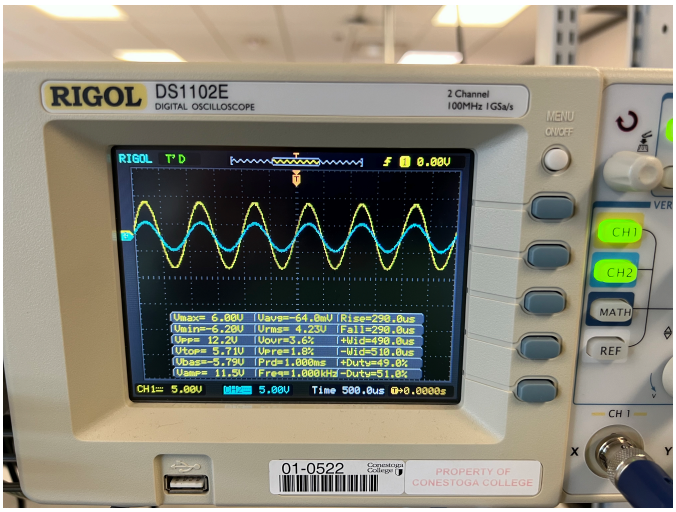
Real Value

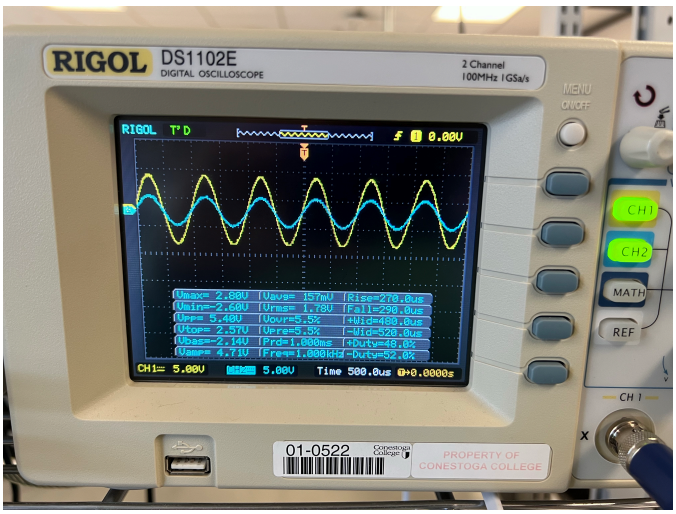
Type	CH1	CH2
V_{max}	4.4V	2.48V
V_{min}	-4.48V	-2.48mV
V_{pp}	8.88V	4.96V

Multisim Value

Type	CH1	CH2
Max	-4.5V	2.5V
Min	-4.5V	-2.5V
Pk-Pk	9V	5V

Case 3:
CH1: 5 Vpp
CH2: 1 Vpp





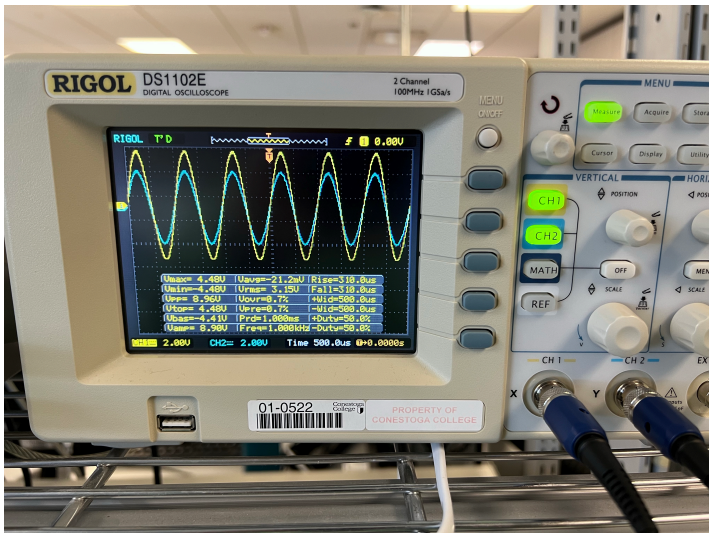
Real Value

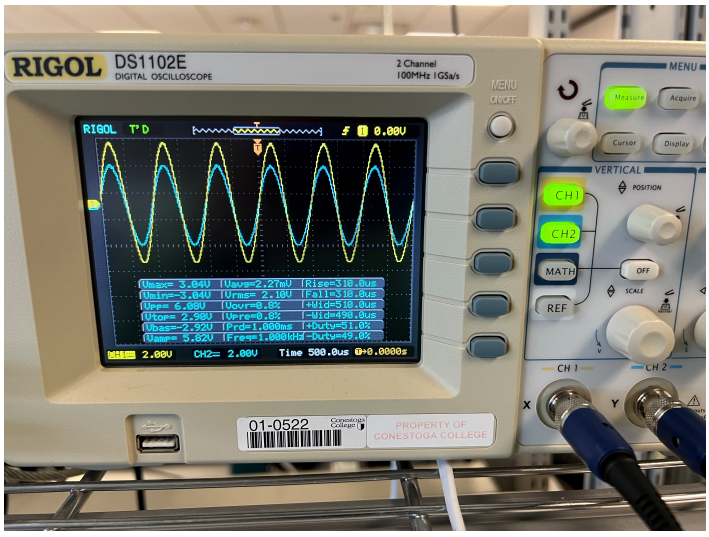
Type	CH1	CH2
V_{max}	6V	2.8V
V_{min}	-6.2V	-2.6V
V_{pp}	12.2V	5.4V

Multisim Value

Type	CH1	CH2
Max	6V	2.5V
Min	-6V	-2.5V
Pk-Pk	12V	5V

Case 4:
CH1: 6 Vpp
CH2: 3 Vpp





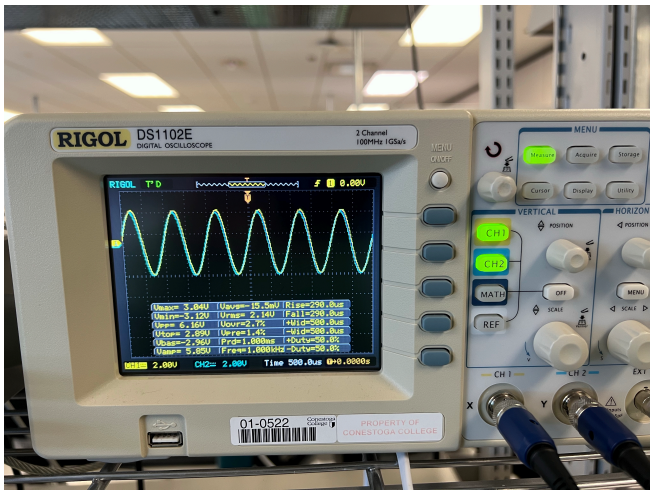
Real Value

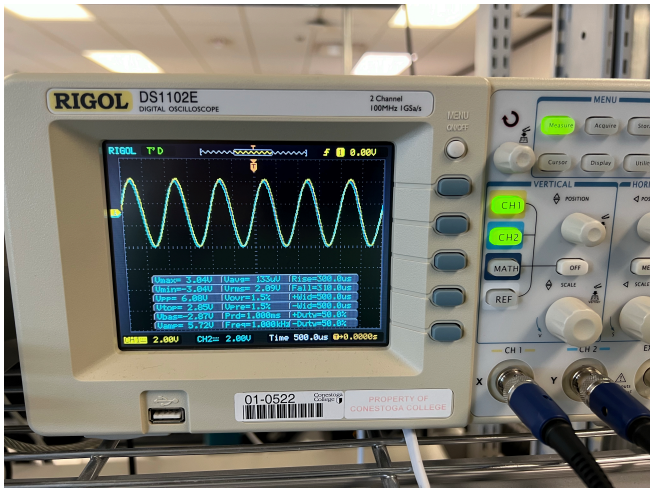
Type	CH1	CH2
V_{max}	4.48V	3.04V
V_{min}	-4.48V	-3.04V
V_{pp}	8.96V	6.08V

Multisim Value

Type	CH1	CH2
Max	4.5V	3V
Min	-4.5V	-3V
Pk-Pk	9V	6V

Case 5:
CH1: 6 Vpp
CH2: 4 Vpp





Real Value

Type	CH1	CH2
V_{max}	3.04mV	3.04V
V_{min}	-3.12mV	-3.04V
V_{pp}	6.16V	6.08V

Multisim Value

Type	CH1	CH2
Max	3V	3V
Min	-3V	-3V
Pk-Pk	6V	6V

Input:

Case 1:
CH1: 2 Vpp
CH2: 1 Vpp
Case 2:
CH1: 5 Vpp
CH2: 2 Vpp
Case 3:
CH1: 5 Vpp
CH2: 1 Vpp
Case 4:
CH1: 6 Vpp
CH2: 3 Vpp
Case 5:
CH1: 6 Vpp
CH2: 4 Vpp

Observations:

From the observation we can see that the V_{out} will be the 3 times the difference of the voltages supplied. We can also see that there is noise in the output where the values are not totally exact as the values that we get using the formula.

Calculations:

$A_{cl} = (1 + 2R_1/R_G)R_3/R_2 = (1 + 2(10K)/10K) * 10K/10K = (1 + 2) * 1 = 3$
Since all resistors have the same value.
Case 1:
$V_{out} = A_{cl} * (V_2 - V_1) = 3 (2 - 1) = 3V$
Case 2:
$V_{out} = A_{cl} * (V_2 - V_1) = 3 (5 - 2) = 9V$
Case 3:
$V_{out} = A_{cl} * (V_2 - V_1) = 3 (5 - 1) = 12V$
Case 4:
$V_{out} = A_{cl} * (V_2 - V_1) = 3 (6 - 3) = 9V$

Case 5:

$V_{out} = A_{cl} * (V_2 - V_1) = 3 (6 - 4) = 6V$

Theory Vs Practical:

If we look at the values from multisim and the actual values from the oscilloscope we can see that the values we get are not totally exact has the values since there is noice in the output has the values undershoot when the voltage is lower the 9 but overshoot when the voltage is around 12 V.

Conclusions:

We can finally conclude that if the resistors have the same voltage as the rest of the circuit the the instrumentational amplifier will have the difference of the supplied voltages amplified by 3. Also we can conclude that with the resistance of the Rg will increase or decrease the amplification if it is changed with increasing the resistance will lower the amplification. Also decreasing the Rg value will increase the amplification of the circuit.=