The University of Texas Rio Grande Valley
College of Engineering and Computer Science
Department of Electrical & Computer Engineering

EECE 3101-01 Electronics Lab 1
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Lab Report 1

by

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I. INTRODUCTION

This report details the procedures and results of Laboratory 1 with our assigned project letter C: Operational Amplifier Circuits, conducted in the EECE 3101 - Electronics Lab I course at the University of Texas Rio Grande Valley. The experiment explores the principles and applications of operational amplifiers, focusing on the construction and analysis of various amplifier configurations. We investigate inverting, noninverting, differential, and summing amplifiers, while also examining the practical limitations of these devices. Normally this experiment and lab report is done in about three weeks, however, this is a summer class. Meaning our time frame to complete this experiment and report is a week and a half starting from July 15, 2024, to July 24, 2024.

The primary objectives of this laboratory experiment are:

1. To construct and verify the functionality of basic operational amplifier circuits
2. To observe inaccuracies and limitations on performance of operational amplifier.
3. To design and build a simple analog system using basic amplifier circuits as building blocks

Through hands-on experimentation, we aim to bridge theoretical knowledge with practical application in electronic circuit design. This report will cover the equipment and components used, experimental procedures, and the analysis of our observations and measurements with proper operational amplifier terminology. Keep in mind that our project letter C gives us specific design specifications in different steps throughout the laboratory experiment.

II. DESCRIPTION OF MAIN CONCEPTS

The following concepts provide an initial explanation and description of the topics addressed in this report.

2.1 Operational Amplifier (Op-Amp)

An operational amplifier, commonly known as an op-amp, is a high-gain electronic voltage amplifier with differential inputs and a single output. It forms the foundation for many analog circuit designs. Op-amps are versatile components used in a wide range of applications, including signal conditioning, filtering, and mathematical operations on electrical signals.

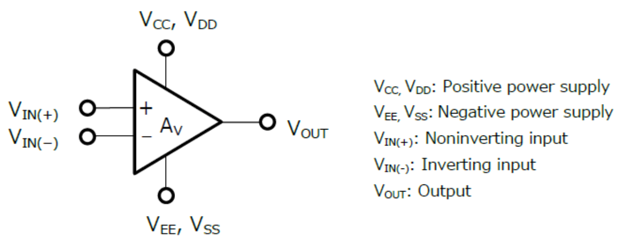

Figure 1.- Operational Amplifier (Op-Amp).

2.2 Basic Op-Amp Configurations

The following fundamental op-amp configurations were explored in this lab:

2.2.1 Inverting Amplifier: An inverting amplifier reverses the polarity of the input signal and provides a gain determined by the ratio of two resistors. The gain equation is $\frac{V_{out}}{V_{in}} = -\frac{R_f}{R_i}$, where R_f is the feedback resistor and R_i is the input resistor. This configuration is essential for applications requiring signal phase inversion.

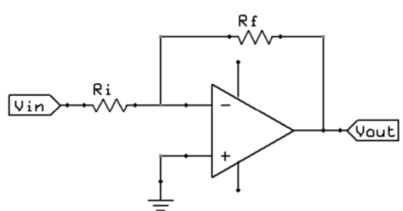

Figure 2.- Inverting Amplifier (Op-Amp).

2.2.2 Non-inverting Amplifier: The non-inverting amplifier maintains the input signal's polarity while providing gain. Its gain is given by $\frac{V_{out}}{V_{in}} = 1 + \frac{R_f}{R_i}$. This configuration is widely used when a high input impedance is needed, as it ideally draws no current.

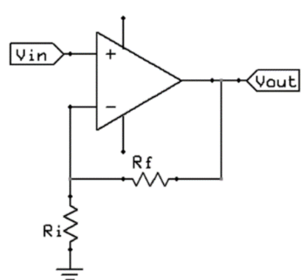

Figure 3.- Non-Inverting Amplifier (Op-Amp).

2.2.3 Voltage Follower: A voltage follower, also known as a buffer, provides no voltage gain (gain = 1) but offers a high input impedance and low output impedance. It is used to prevent loading effects in a circuit.

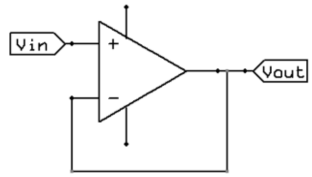

Figure 4.- Voltage Follower (Op-Amp).

2.2.4 Differential Amplifier: A differential amplifier amplifies the difference between two input signals. The gain for this configuration is $A_d = R_2/R_1$, and it is used in applications where signal subtraction is needed. If $\frac{R_4}{R_3} = \frac{R_2}{R_1}$, then the output voltage of this circuit is given by $V_{out} = \frac{R_2}{R_1}(V_1 - V_2)$.

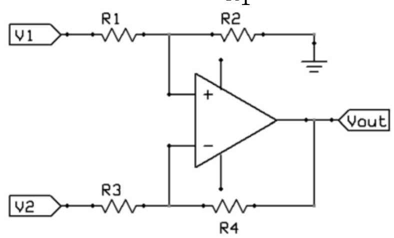

Figure 5.- Differential Amplifier (Op-Amp).

2.2.5 Summing Amplifier: This configuration adds multiple input signals together, with the ability to weigh each input differently. Its output is given by: $V_{out} = -(\frac{R_f}{R_1}V_1 + \frac{R_f}{R_2}V_2 + \frac{R_f}{R_3}V_3 + \cdots)$.

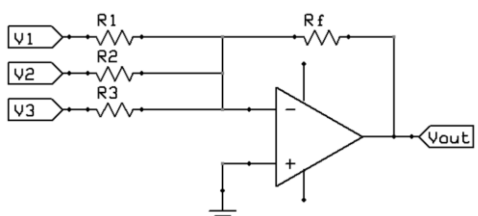

Figure 6.- Summing Amplifier (Op-Amp).

2.3 Op-Amp Characteristics

The following key characteristics of op-amps were explored in this lab:

2.3.1 Offset Voltage: The small voltage that appears at the output when both inputs are at the same potential.

2.3.2 Slew Rate: The maximum rate of change of the output voltage, usually specified in volts per microsecond.

2.3.3 Frequency Response: The variation of amplifier gains with frequency, typically represented as a Bode plot.

This lab provides hands-on experience with these concepts, allowing us to design, build, and analyze various op-amp circuits, gain practical insight into their behavior and limitations.

III. DEVELOPMENT

Operational Amplifier Circuits—This lab assignment focused on constructing and verifying the functionality of basic operational amplifier circuits, including inverting, noninverting, differential, and summing amplifiers. The objectives included observing inaccuracies and limitations on the performance of operational amplifiers and designing and building a simple analog system using these basic amplifier circuits as building blocks.

3.1 Part I: Voltage Follower

The voltage follower, shown on *Figure 4,* produces no voltage gain. The output voltage is equal to the input voltage, so the gain is $\frac{V_{out}}{V_{in}} = 1$. Like the noninverting configuration in *Figure 3*, its theoretical input impedance with an ideal op-amp is infinite. Its main purpose is to yield a very high impedance and a very low output impedance.

3.1.1 Step 1

We built a voltage follower using a LM741 op-amp. For the power supply used, we set it to +15V and -15V.

Note:

- Keep in mind that the chip does not have a ground pin.
- We left the “Null Offset” pins unconnected.
- The input implemented used a potentiometer configured as a voltage divider.
- The potentiometer is not considered part of the voltage follower. We simply used it as a variable voltage source to test the follower without using an extra power supply.

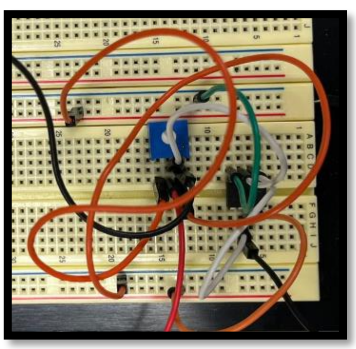

Figure 7.- Voltage Follower using an LM741 IC Chip.

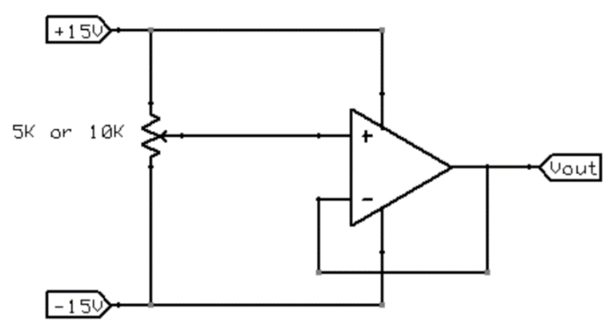

Figure 8.- Voltage Follower Circuit.

3.1.2 Step 2

We varied the input voltages using a potentiometer incrementing by three volts starting from -15 Volts to +15 Volts. Then we recorded input and output voltages to verify follower behavior. Below you can find the measurements recorded for both the input and corresponding output voltages.

Table 1 – Voltage Follower 1

Potentiometer Voltage (V)	Measured Input Voltage (V)	Measured Output Voltage (V)
-15	-14.929	-14.989
-12	-12.062	-12.062
-9	-9.047	-9.047
-6	-6.085	-6.094
-3	-3.0352	-3.0370
0	0.0180	0.0175
3	3.0362	3.0360
6	6.087	6.087
9	9.046	9.046
12	12.053	12.052
15	15.010	14.990

3.1.3 Step 3

Using the data we recorded in the previous step; we were able to conclude that the voltage follower cannot "follow" all the way to +15 and -15 Volts. We determined the points where the $V_{out} = V_{in}$ relationship starts to fail, on both the positive and negative sides.

1. The first and last row of measurements recorded on Table 1 are the points where the relationships start to fail. The potentiometer can only hold up to 30 Volts.

Potentiometer Voltage (V)	Measured Input Voltage (V)	Measured Output Voltage (V)
-15	-14.929	-14.989
15	15.010	14.990

Figure 9.- Measurements where the $V_{out} = V_{in}$ relationship starts to fail.

3.1.4 Step 4

We built a second identical voltage follower on the same board for use in subsequent experiments. Below you can find the a few points we measured and recorded in order to verify that it's working.

Note:

- The advantage of using the voltage follower is that its output has a low (almost zero) output impedance: thus, it looks like an ideal voltage source. The potentiometer by itself would have a nonzero output impedance.

Table 2 – Voltage Follower 2

Potentiometer Voltage (V)	Measured Input Voltage (V)	Measured Output Voltage (V)
-15	-14.929	-14.929
-5	-5.040	-5.040
5	5.032	5.032
15	15.010	14.989

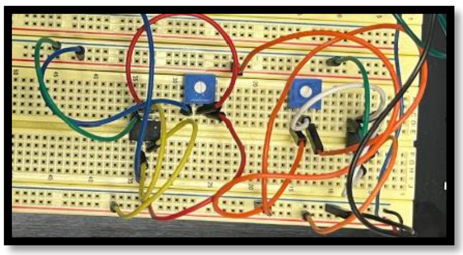

Figure 10.- Voltage Followers 1 & 2 using an LM741 IC Chip.

3.2 Part II: Inverting and Noninverting Amplifiers

The inverting amplifier, as shown in *Figure 2*, changes the sign of a signal (180-degree phase shift). When $R_f = R_i$ it can be used to change the sign of signal without changing the magnitude. By varying the values of R_f and R_i any low-frequency gain from zero up to the open loop gain A_0 is theoretically possible. In practice a gain of up to 1000 may be easily obtained.

The noninverting amplifier, as shown in *Figure 3*, does not change the sign of the signal passing through it. Unlike the inverting amplifier, the gain must be greater than or equal to 1. Because the input is only connected to the op-amp, which ideally draws no current, the theoretical input impedance is infinite. In practice the input impedance can be very high: 100 Megaohms or more, depending on the op-amp type.

3.2.1 Step 5

We constructed an inverting amplifier with a specified gain and input impedance based on our project letter, C. We tested the op-amp by connecting the output of one of our voltage follower circuits to the input and recorded the output voltages and input voltages.

Note:

- Project C Specifications: Gain$= -4$ & Input Impedance$= 5k\Omega$
- Our acquired resistor values were obtained by the use of multiple resistors since the values we needed were unavailable.
    - We used two $10k\Omega$ resistors in series giving us a value of $19.873k\Omega$ for R_f.
    - We used two $2k\Omega$ resistors and one $1k\Omega$ resistor in series which gave us a value of $4.961k\Omega$ for R_i.

Finding our resistor values:

$$Gain \rightarrow -\frac{R_f}{R_i} = \frac{20k\Omega}{5k\Omega} = -4 \qquad \therefore R_f = 20k\Omega,\ R_i = 5k\Omega$$

Table 3 – Output Voltage vs. Input Voltage

Potentiometer Voltage (V)	Measured Input Voltage (V)	Measured Output Voltage (V)
−14.991	-13.583	14.193
−12.012	-13.589	12.076
−9.014	-13.598	9.021
−6.062	-13.607	6.027
−3.018	-12.031	2.986
−0.062	-0.12970	0.03054
3.012	12.192	-3.077
6.027	14.206	-6.044
9.003	14.199	-9.011
12.052	14.193	-12.047
15.010	14.190	-13.080

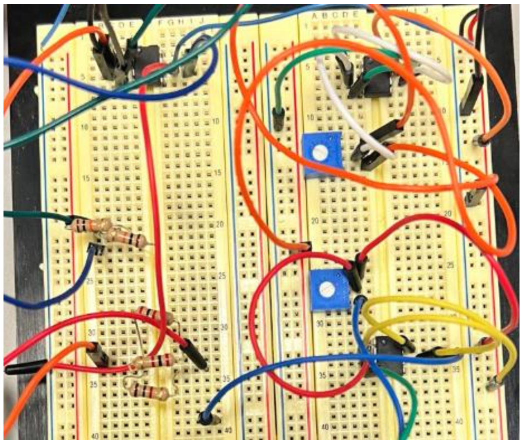

Figure 11.- Inverting Amplifier using an LM741 IC Chip.

3.2.2 Step 6

Using the same circuit as in the previous step, we changed the input to a 1V peak-to-peak sine wave at a frequency of 100Hz. Then we observed the behaviors of the input and output waveforms on the oscilloscope. Below you will find a screenshot showing the input and output waveforms on the same screen.

Figure 12.- Input and Output waveforms on an oscilloscope.

3.2.3 Step 7

We built a noninverting amplifier with specified gain based on our project letter, C. Then we tested the op-amp and recorded its output versus input characteristics, as we did in the previous step.

Note:

- Project C Specifications: Gain$= 4$
- Our acquired resistor values were obtained by the use of multiple resistors since the values we needed were unavailable.
  - We used one $10k\Omega$ resistor, two $2k\Omega$ resistors, and one $1k\Omega$ resistor in series which gave us a value of $14.867k\Omega$ for R_f.
  - We used two $2k\Omega$ resistors and one $1k\Omega$ resistor in series which gave us a value of $4.961k\Omega$ for R_i.

Finding our resistor values:

$$Gain \rightarrow 1 + \frac{R_f}{R_i} = 1 + \frac{15k\Omega}{5k\Omega} = 4 \qquad\qquad \therefore R_f = 15k\Omega,\ R_i = 5k\Omega$$

Table 3 – Output Voltage vs. Input Voltage

Potentiometer Voltage (V)	Measured Input Voltage (V)	Measured Output Voltage (V)
−14.991	-5.018	-13.395
−12.012	-4.0289	-12.136
−9.014	-3.014	-9.085
−6.062	-2.0503	-6.181
−3.018	-1.0053	-3.0237
−0.062	-0.01172	-0.03025
3.012	0.998	3.552
6.027	2.036	7.105
9.003	3.014	10.097
12.052	4.0301	12.737
15.010	5.053	14.060

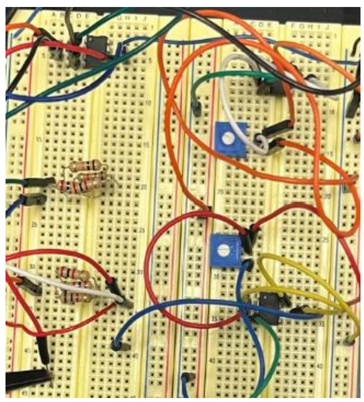

Figure 13.- Non-Inverting Amplifier using an LM741 IC Chip.

3.2.4 Step 8

Using the same circuit as in the previous step, we changed the input to a 1V peak-to-peak sine wave at a frequency of 100Hz. Then we observed the behaviors of the input and output waveforms on the oscilloscope. Below you will find a screenshot showing the input and output waveforms on the same screen.

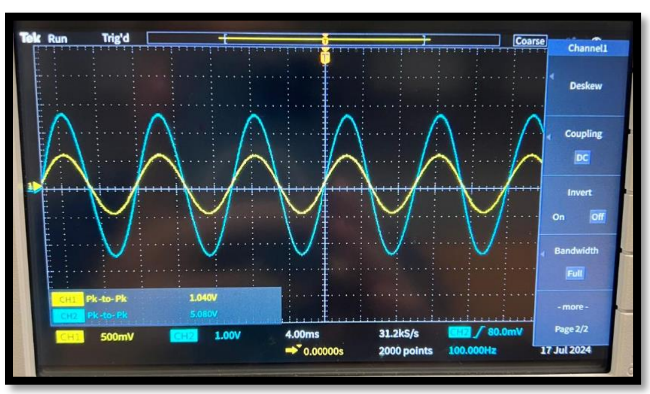

Figure 14.- Input and Output waveforms on an oscilloscope.

3.3 Part III: Differential and Summing Amplifiers

An operational amplifier can be configured as a differential amplifier using the circuit shown in Figure 5. This circuit amplifies the difference between the two inputs by a differential gain $A_d = R_2/R_1$. Since there is more than one input the input impedance can be defined in different ways. The small-signal impedance measured between input #1 and ground is $R_1 + R_2$. The small signal input impedance seen measured between input #2 and ground is R_1, assuming that input #1 is grounded. However, the quantity that is usually of interest us the differential input impedance, that is, the small signal impedance seen by a source connected between the two input terminals, it is given by $R_{in} = R_1 + R_3$.

The configuration shown in Figure 6 is an inverting summing amplifier with three inputs, but the circuit can be constructed with any number of inputs. The input impedance seen at input #1 is R_1, at input #2 is R_2, etc. The circuit is useful anywhere voltages need to be added together. Typical applications would include control circuits and audio mixers.

3.3.1 Step 9

We built a differential amplifier with a differential gain of 1 using resistors of at least 1kilohm but not more than 100 kilohms.

Note:

- We had to be careful in order to get the ratio of the resistances on the negative and positive sides to closely match. If they don't match within better than 1%, then we added small resistors in series or large resistors in parallel to some of the resistors as required to get a good match.

Finding our resistor values:

$V_{out} = \frac{R_2}{R_1}(V_1 - V_2) \quad \therefore R_1 = R_2 = R_3 = R_4 = 15k\Omega$

$\frac{R_2}{R_1} = \frac{15k\Omega}{15k\Omega} \rightarrow Gain\ of\ 1$

Test Trial:

$V_{out} = \frac{15k\Omega}{15k\Omega}(4 - 3) = 1$

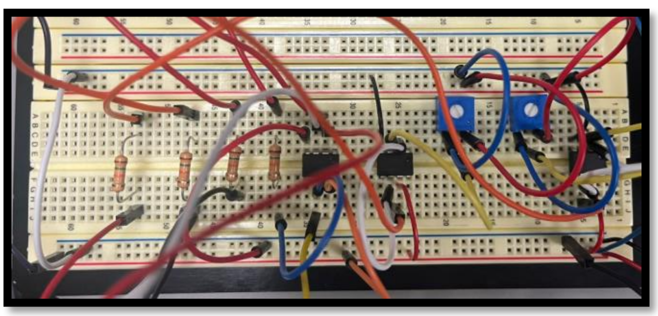

Figure 15.- Differential Amplifier using an LM741 IC Chip.

3.3.2 Step 10

We built a two-input inverting summing amplifier with an input impedance of 10 kilohms on each input, and a gain of negative one for each input.

Finding our resistor values:

$V_{out} = -(\frac{R_f}{R_1}V_1 + \frac{R_f}{R_2}V_2)$ $\quad\therefore R_1 = R_2 = R_f = 10k\Omega$ Test Trial:

$\frac{R_f}{R_1} + \frac{R_f}{R_2} = \frac{10k\Omega}{10k\Omega} \rightarrow -1(V_1 + V_2) \rightarrow Gain\ of -1$ $\quad V_{out} = -\frac{10k\Omega}{10k\Omega}(2-1) = -1$

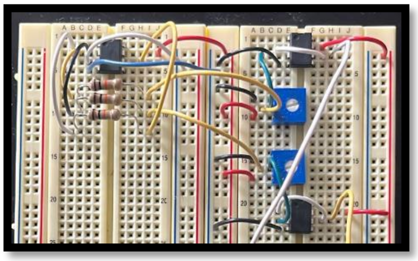

Figure 16.- Two-input Summing Amplifier using an LM741 IC Chip.

3.3.3 Step 11

We used the following combinations for V_1 and V_2 in order to record the values when measuring both inputs and their corresponding outputs for the differential and summing amplifiers. The table below shows our findings.

Table 4 – Two Voltage Inputs and Their Summing and Differential Outputs

Potentiometer V_1 (V)	Potentiometer V_2 (V)	Measured Differential Op-Amp Output (V)	Measured Summing Op-Amp Output (V)
−10.013	-10.056	0.031	14.169
−10.013	0.055	-10.067	10.529
−10.013	10.044	-13.555	-0.042
10.064	-10.005	14.209	0.012
10.064	0.054	10.030	-10.061
10.064	10.017	0.078	-13.449
3.049	-3.012	6.086	0.009
3.049	0.014	3.079	3.024
3.049	2.961	0.107	-5.977
−3.057	2.961	-5.999	0.112
−3.057	0.038	-3.080	3.181
−3.057	-3.025	-0.019	6.185

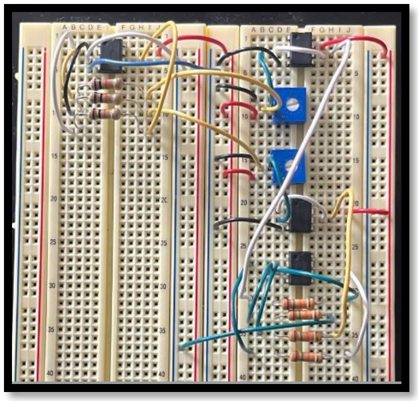

Figure 17.- Two-input Summing & Differential Amplifier using an LM741 IC Chip.

3.4 Part IV: Offset in Inverting Amplifiers

All operational amplifiers have a small amount of error as seen in the previous steps. However, the error is normally small but when the gain is very high it becomes more noticeable. In this part of the lab experiment, you'll notice that the small differential voltage that must be applied to the inputs to force the output to zero volts.

3.4.1 Step 12

For this step, we built a noninverting amplifier using an LM741 with a gain of approximately 1000. However, we made sure to arrange the components so that the chip can be pulled out and replaced easily without disturbing the resistors.

Note:

- We used one $10k\Omega$ resistor for R_f and one 10Ω resistor for R_i.
- In this step, we made the mistake of using a resistor below $1k\Omega$.
- The voltmeter maxed out at 14.899V because it had a gain of 1001.

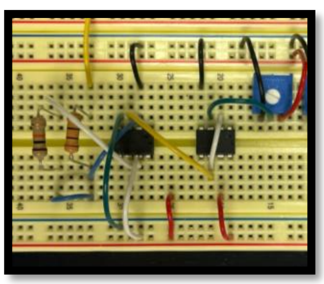

Figure 18.- Non-Inverting Amplifier using an LM741 IC Chip.

Table 5 – Resistor Values for Step 12

Resistor R_f ($k\Omega$)	Resistor R_i (Ω)
9.768	10.10

3.4.2 Step 13

Using the circuit from the previous step, we grounded the input of the noninverting amplifier and recorded the average output value. The nonzero reading is due to the input offset voltage. Afterwards we tested out two LM741 IC chips, we replaced them with another two TL081 and documented all the outputs.

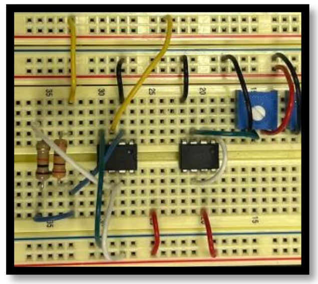

Figure 19.- Non-Inverting Amplifier with a grounded input using an LM741 IC Chip.

Table 6 – Op-Amp Sample Voltages

#1 LM741 (V)	#2 LM741 (V)	#1 TL081 (V)	#2 TL081 (V)
0.709	0.706	0.2112	0.2125

3.4.3 Step 14

For each amplifier that was used in the previous step, we calculated the input offset voltage. This is found by dividing the output voltage by the gain, which normally would give you the input voltage. However, since the input is at zero volts, the reading is due to the input offset.

Note:

- Typically values for the input offset voltage for the devices we're using are from 0 to 10mV.

#1 LM741

$$\frac{0.709V}{1001} \times 1000 = 0.708mV$$

#2 LM741

$$\frac{0.706V}{1001} \times 1000 = 0.705mV$$

#1 TL081

$$\frac{0.2112}{1001} \times 1000 = 0.210mV$$

#2 TL081

$$\frac{0.2125V}{1001} \times 1000 = 0.212mV$$

3.5 Part V: Slew Rate

Due to practical limitations in the internal circuitry, the output of an operational amplifier cannot change instantaneously, even if the input does. The slew rate SR is the maximum rate at which the output can change, and it's typically specified in volts per microsecond. Ordinary op-amps have slew rates in the range of 0.5V/us, while high speed op-amps can slew at the rate of 1000V/us or better. The slew rate is often specified with the amplifier configured as a voltage follower.

This parameter is most important when designing circuits which must put out a large amplitude signal at relatively high frequencies. Examples would be light-source drivers for fiber-optics, function generators, and circuits involved in high-speed digital communications.

3.5.1 Step 15

Using an LM741 type op-amp, we built a non-inverting amplifier with a gain of 30 as specified by our project letter, C. We then set up the function generator to produce a 2V peak-to-peak, 10kHz square wave, and connect this as the input to the non-inverting amp. The op-amp output will show a finite rise/fall time.

Table 7 – Resistor Values for Step 15

Resistor R_f (kΩ)	Resistor R_i (kΩ)
29.888	0.9798

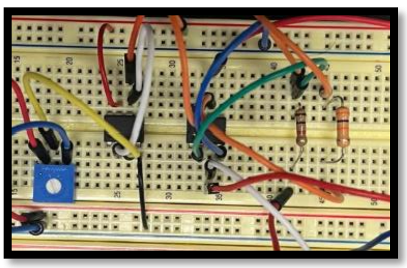

Figure 20.- Non-Inverting Amplifier with a gain of 30 using an LM741 IC Chip.

Figure 21.- Non-Inverting Amplifier showing a finite rise/fall time with a square wave.

Calculations:

Rising Edges

$t_1 = -50\mu s \quad t_2 = -13.6\mu s$

$v_1 = -15.2V \quad v_2 = 12.0V$

$\Delta t = 36.8\mu s \quad \Delta v = 27.2V$

Falling Edges

$t_1 = 5.6\mu s \quad t_2 = 12.4\mu s$

$v_1 = 12.4V \quad v_2 = -15.2V$

$\Delta t = 40.8\mu s \quad \Delta v = 27.6V$

3.6 Part VI: Frequency Response

A frequency response measurement determines how a given quantity in a linear circuit behaves as the frequency of its input changes. In this part, you will notice that frequency response must always be measured using a sinusoidal input and a sinusoidal response. If the output is not sinusoidal, the measurement is wrong.

3.6.1 Step 16

In this step, we change the function generator to produce a sine wave at 100Hz. Using the same amplifier as in the previous step. By adjusting the generator, we received a clearer and undistorted sine wave signal at both the input and output of the op-amp.

Note:

- We made sure to check the ratio of the input and output signals and make sure it is close to our specified gain of 30 based off our project letter, C.

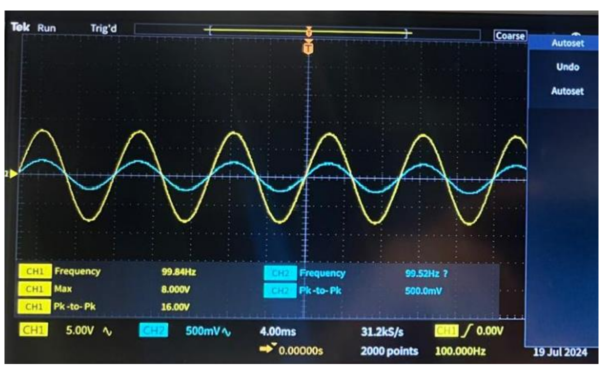

Figure 22.- Non-Inverting Amplifier showing a sine wave at 100Hz.

3.6.2 Step 17

We measured the amplitude of the frequency response from 100Hz to 1MHz. We recorded 9 points to accurately shape the curve and to determine the 3dB down point by adjusting the input voltage. This helped us maintain a clean sine wave at the output.

Note:

- For frequency response measurement it’s important to ensure the output amplitude is controlled by a small signal frequency response rather than the slew rate.

Table 8 – Amplitude Measurement of Frequency Response

Frequency (kHz)	Pk-Pk Channel 1 V_{output} (V)	Pk-Pk Channel 2 V_{in} Output (mV)	Gain	Gain (dB)
0.1	15.92	500	31.84	30.05946118
0.5	15.80	504	31.34920635	29.92453101
1	15.80	512	30.859375	29.78774252
5	15.40	512	30.078125	29.5650152
10	14.80	512	28.90625	29.21983509
15	13.60	520	26.15384615	28.35071129
20	11.80	512	23.046875	27.25224093
25	10.00	520	19.23076923	25.67993313
30	8.80	520	16.92307692	24.56958657

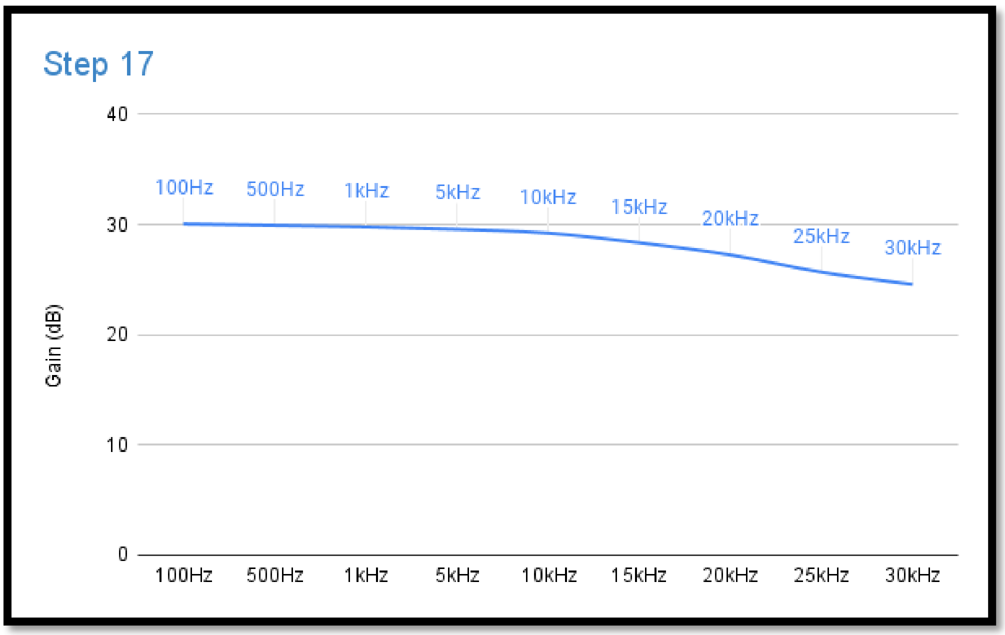

Figure 23.- Table 8's Measurements on a graph.

3.6.3 Step 18

We changed the amplifier to have a gain one-tenth as large as in Step (16) using the same operational amplifier. Then we repeated the frequency response measurement as in the previous step.

Note:

- The gain in Step 18 is based on our project letter, C, which is 3.

Table 9 – Amplitude Measurement of Frequency Response

Frequency (kHz)	Pk-Pk Channel 1 V_{output} (V)	Pk-Pk Channel 2 V_{in} Output (mV)	Gain	Gain (dB)
0.1	1.54	504	3.055555556	9.701803688
0.5	1.54	512	3.0078125	9.565015197
1	1.54	504	3.055555556	9.701803688
50	1.52	520	2.923076923	9.316804886
100	1.48	520	2.846153846	9.085167435
150	1.40	520	2.692307692	8.602493841
175	1.32	520	2.538461538	8.091411751
200	1.24	520	2.384615385	7.548366831
225	1.14	520	2.192307692	6.818030154
250	1.08	520	2.076923077	6.348408237
275	0.98	520	1.884615385	5.504454641

Table 10 – Resistor Values for Step 18

Resistor R_f (kΩ)	Resistor R_i (kΩ)
9.771	12.71

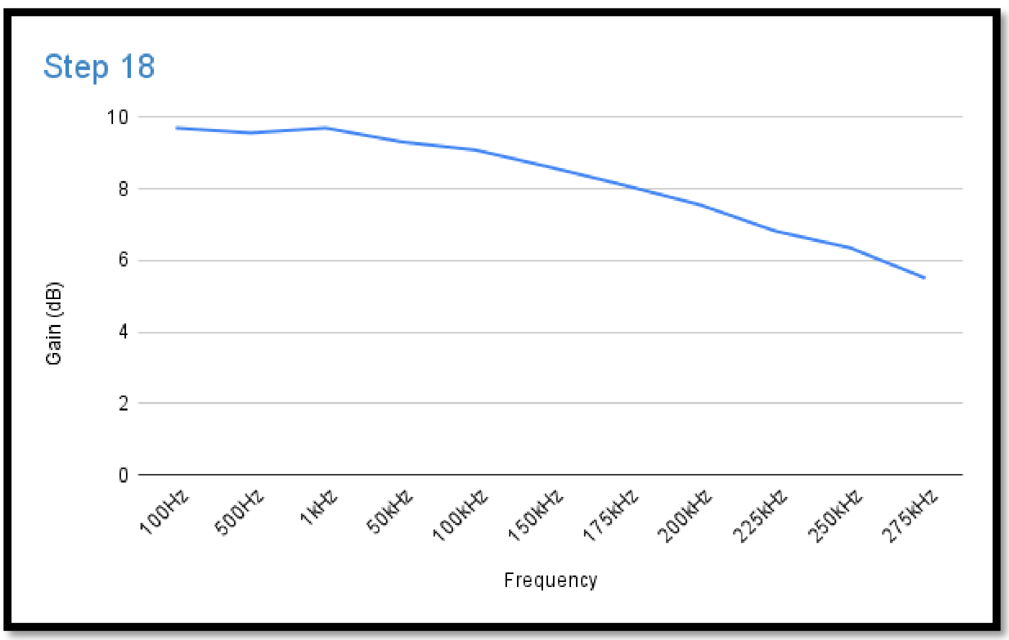

Figure 24.- Table 9's Measurements on a graph.

3.7 Part VII: Designing Using Basic Amplifier Blocks

For the last part of this lab report, we need to design, build, and test a two-input circuit with specific characteristics. Using what we've learned up to this point, building basic amplifier blocks required us to think about all the op-amp configurations we've come to learn so much about.

3.7.1 Step 19

We built a two-input circuit with the following characteristics: $V_{out} = K_1 \times V_1 + K_2 \times V_2$. In order to make this circuit, we had to use

Note:

- Where K_1 and K_2 are specific constants based of project letters. For project letter C, we received that $K_1 = 1.5$ and $K_2 = -1.0$.
- Where Input #1 and #2 are input impedances based of project letters. For project letter C, we received that $R_{in}(Input\ \#1) = \infty$ and $R_{in}(Input\ \#2) = 5k\Omega$.
- An input impedance marked as infinite in the table means that no significant current should flow into the input.

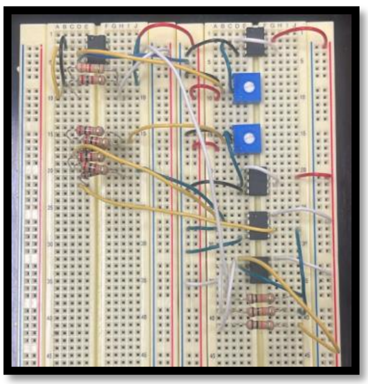

Figure 25.- Two-input circuit with specified characteristics.

We used four LM741 chips and one TL082 chip to make this circuit. Our resistors vary due to unavailable resistor values. We needed to be connected multiple of them in series to get the desired value.

Table 11 – Two-Input Circuit Calculations

V_1	V_2	V_{out}
-1.018	-1.021	-0.402
-1.018	-0.012	-1. 686
-1.018	1.007	-3.012
1.049	-1.064	3.099
1.049	0.060	1.698
1.049	1.027	0.493

I. CONCLUSIONS

The objectives of Lab 1 Project C, focusing on operational amplifier circuits, were to construct and verify the functionality of various amplifier configurations, observe inaccuracies and limitations, and design a simple analog system using these circuits. The results obtained showed that while the theoretical gains and input/output impedances closely matched the practical and simulated outcomes for inverting, noninverting, differential, and summing amplifiers, minor discrepancies were observed due to real-world factors such as input offset voltages and finite slew rates. These deviations, though within acceptable ranges, highlighted the limitations of the LM741 and TL081 op-amps used, particularly in high-gain scenarios where input offset and slew rate significantly affected performance. Overall, the lab successfully met its objectives, demonstrating both the practical application and inherent limitations of operational amplifiers in various configurations.

Lab 1 – Demonstration Form

Summer II 2024
Instructor: Carlos A. Rodriguez Betancourth

Instructions
Request a signature from the instructor every time a demonstration is performed and approved by the instructor.

	Signature	**Date**
Part I: Voltage Follower		7/15/2024
Part II: Inverting & Non-inverting Amplifiers.		7/16/2024
Part III: Differential & Summing Amplifier		7/17/2024
Part IV: Offset in Inverting Amplifiers		7/17/2024
Part V: Slew Rate		7/17/2024
Part VI: Frequency Response		7/22/2024
Part VII: Design using basic amplifier blocks		7/22/2024