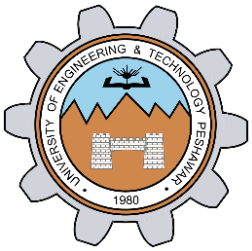
LAB # 7



CSE-203L Circuit & Systems-II Lab

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Submitted by: Ali Asghar

Registration No.: 21PWCSE2059

Class Section: C

"On my honor, as student of University of Engineering and Technology, I have neither given nor received unauthorized assistance on this academic work."

Student Signature: _____

Submitted to:

Engr. Faiz Ullah

6th December, 2022

Department of Computer Systems Engineering

University of Engineering and Technology, Peshawar

TITLE:

Operational Amplifiers

Basic Characteristics and Applications

OBJECTIVES:

- To learn how to use the operational amplifier (op-amp).
- To learn some of its applications like the Inverting amplifier, non-inverting amplifier.

APPARATUS:

- Oscilloscope
- AC Function Generator

COMPONENTS:

- 10k Ω Resistor
- 100k Ω Resistor
- 741 Op-Amp

THEORY OVERVIEW:

The Operational Amplifier (Op Amp) is an extremely useful device, as we will see in this lab. With the addition of a few external components, an extraordinary variety of functions can be implemented. The Op Amp is an active element that needs to be supplied with power to operate. A common way to supply this power is shown in Figure 1(a). Two power supply voltages are used, with equal values denoted by V_{cc} and V_{DD} (or $\pm V_{CC}$) (often in the range of 5 V to15 V). The common node between the supplies is the ground node. The op amp's output voltage is taken between the output terminal and the ground node. The remaining two terminals are the input of the op amp. An interesting property of the op-amp is that the output voltage is only a function of the difference of the two input Terminals. Figure 1(b) shows the top view of widely used Op Amp type known as the 741. It comes in a package, with metal pins.

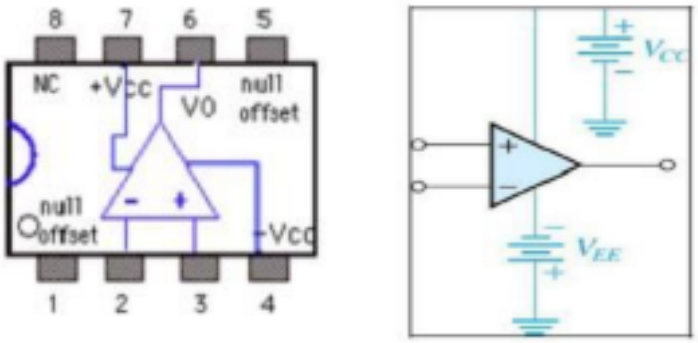


Figure 1 (a) and (b)

The most basic function of the op amp is the voltage amplification. However, the output voltage of a real op amp is limited to the range between certain limits that depend on the internal design of the op amp. As shown in Figure 2, when the output voltage tries to exceed these limits, clipping occurs.

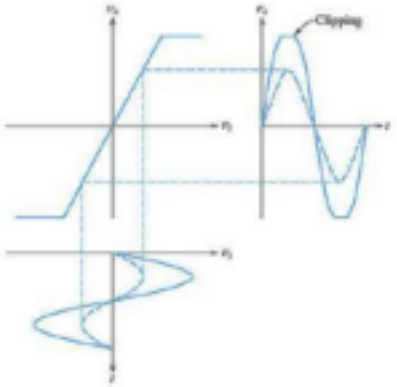


Figure 2.

PROCEDURE:

INVERTING AMPLIFIER

1. Make the circuit for Inverting Amplifier with R_f = 100 kΩ and R_{in}= 10kΩ (gain =10).
2. For five or more values of V_{in}, in the range ±0.7V calculate the value of V_{out} using the following formula for voltage gain of Inverting amplifier and write them in below Table.
3. *Av=Vout /Vin= -Rf / Rin.*
4. Measure the value of V_{out} for each value of V_{in} as mentioned above. Find the % age error.
5. Set the Function generator at a frequency of 1 kHz and apply as input V_{in} to the inverting amplifier. Use the two channels of the scope to monitor the inverting input V_{in} of the op-amp and the output V_{out}. Slowly increase the amplitude of the input signal, starting near zero. Observe the phase difference between the input and output. Keeping the amplitude of the input low and constant, vary its frequency. Observe the reduction in output amplitude as frequency increases.

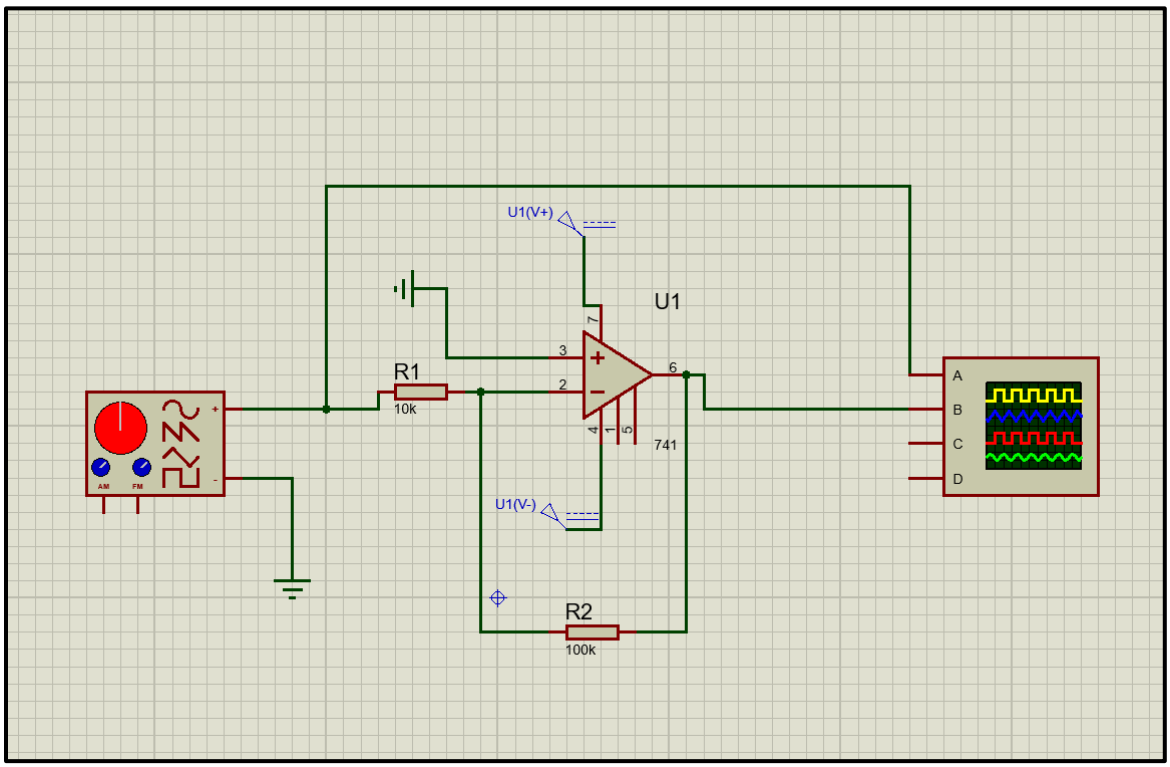
6. Repeat for DC Supply.

NON-INVERTING AMPLIFIER

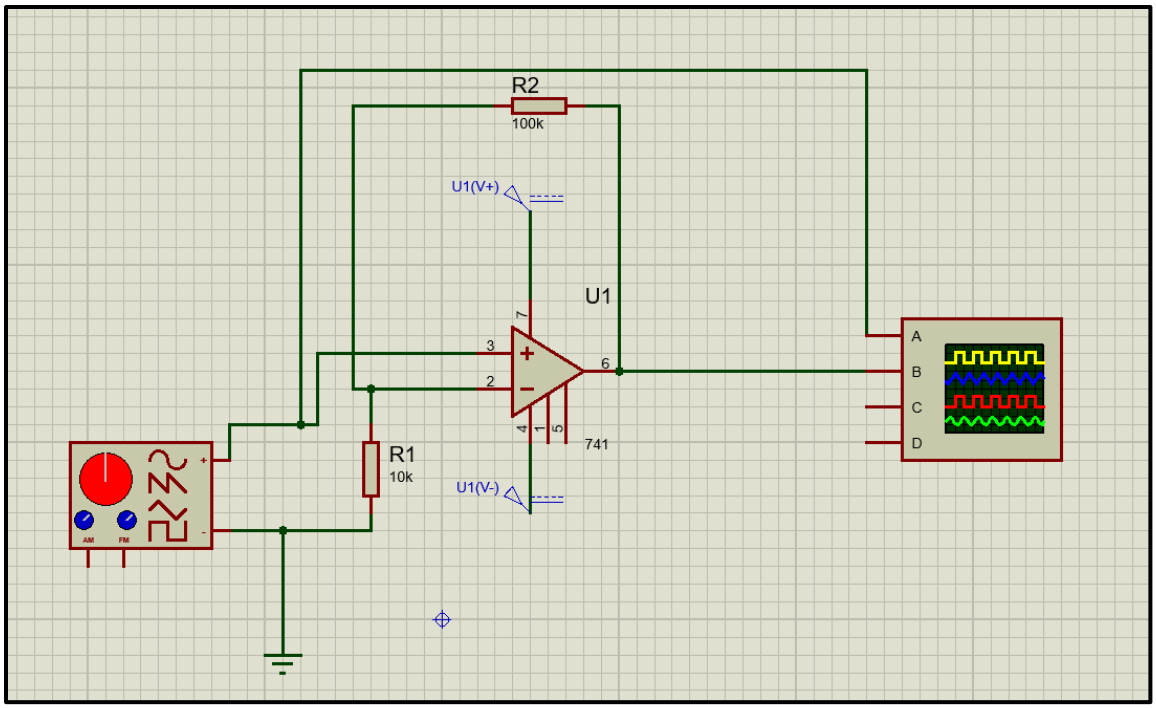
1. Set up the non-inverting amplifier circuit of Figure 4 with R_1 = 10 k. With a 1 kHz sinusoidal input having different amplitudes, calculate the output with R_2 = 100k and with R_2= 10k using the
2. formula and write the results in front of each input in Table below :
3. *Av =Vout/Vin=1+R2/R1*
4. Measure the output with an oscilloscope and write them in front of each input in the table. Find the % age error.
5. Repeat for DC supply.

OBSERVATIONS:

A)FOR AC SOURCE



Inverting Amplifier



Non-Inverting Amplifier

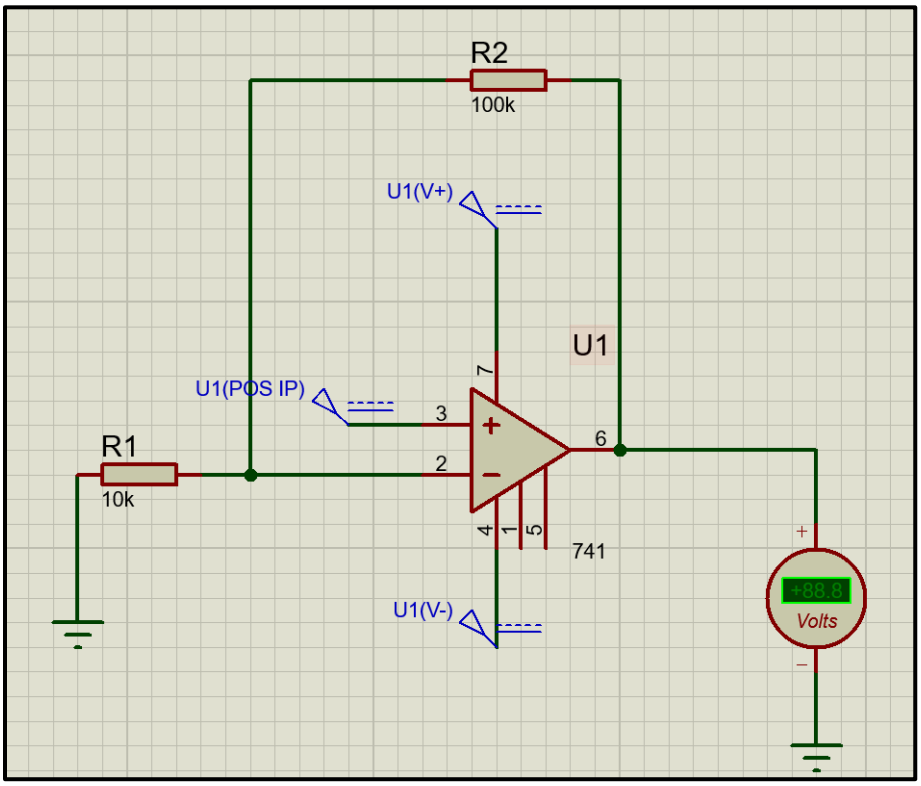
Table 1(Inverting Amp)

V_{in}	Calculated V_{out}	Measured V_{out}	%Deviation
0.50V	-5.0 V	-5.00 V	0 %
0.65 V	-6.5 V	-6.40 V	1.5 %
0.20 V	-2.0 V	-2.00 V	0 %
0.30 V	-3.0 V	-3.00 V	0 %
0.10 V	-1.0 V	-1.00 V	0 %

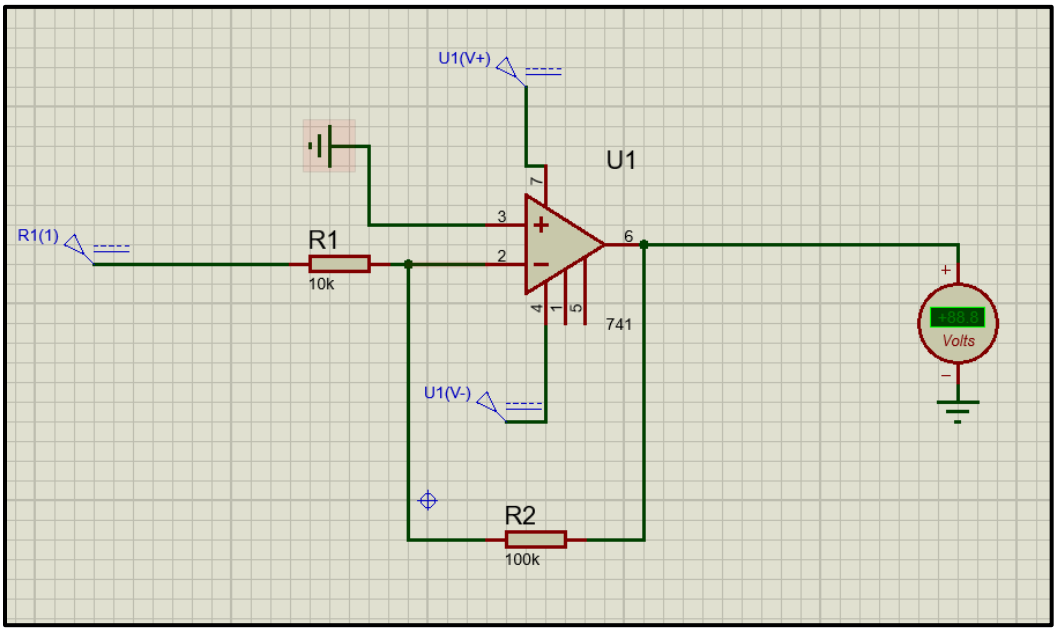
Table 2(Non-Inverting Amp)

V_{in}	Calculated V_{out}	Measured V_{out}	%Deviation
0.50V	5.5 V	5 divisions x 1.1 = 5.5 V	0 %
0.65 V	7.15 V	6.5 divisions x 1.1 = 7.15 V	0 %
0.20 V	2.2 V	2 divisions x 1.1 = 2.2 V	0 %
0.30 V	3.3 V	3 divisions x 1.1 = 3.3 V	0 %
0.10 V	1.1 V	1 divisions x 1.1 = 1.1 V	0 %

B) FOR DC SOURCE



Non-Inverting Amplifier



Inverting Amplifier

Table 3(Non-Inverting Amp)

V_{in}	Calculated V_{out}	Measured V_{out}	%Deviation
0.50V	-5.5 V	-5.52 V	0.36 %
0.65 V	-7.15 V	-7.17 V	0.28 %
0.20 V	-2.2 V	-2.22 V	0.90 %
0.30 V	-3.3 V	-3.32 V	0.60 %
0.10 V	-1.1 V	-1.12 V	1.81 %

Table 4(Inverting Amp)

V_{in}	Calculated V_{out}	Measured V_{out}	%Deviation
0.50V	-5.0 V	-4.98 V	0.40 %
0.65 V	-6.5 V	6.48 V	0.31 %
0.20 V	-2.0 V	-1.98 V	1.00 %
0.30 V	-3.0 V	-2.98 V	0.60 %
0.10 V	-1.0 V	-1.00 V	2.00 %

CONCLUSION:

We conclude the following results from this experiment:

- Operational Amplifier amplifies a signal by some gain value
- Operational Amplifier can perform different functions in different circuit configurations
- Operational Amplifier can invert a signal when used as an Inverting Amplifier or it can amplify a signal without inverting it; when used as a Non-Inverting Amplifier
- The value of gain k of an Inverting/Non-Inverting Op-Amp depends upon the value of R_1(connected btw input and inverting terminal) and R_f (known as feedback resistor; connected btw output and inverting terminal)