**OPERATIONAL AMPLIFIERS – BASICCHARACTERISTICS AND**

**APPLICATIONS**

**LAB # 07**



**Fall 2022**

**CSE-203L**

**Circuits & System-2 Lab**

Submitted by: **NAVEED AHMAD**

Registration No.: **22PWCSE2165**

Class Section: **B**

“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: A blue line drawing on a white background

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Submitted to:

**Engr. Usman Malik**

11/12/2023

Department of Computer Systems Engineering

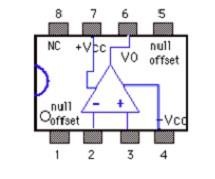
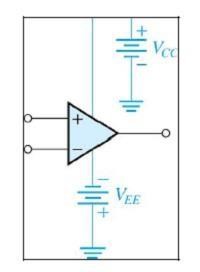
University of Engineering and Technology, Peshawar

OBJECTIVES:

* The objective of this lab experiment is to learn how to use the operational amplifier (op-amp). In this experiment some of the basic characteristics of the op-amp would be examined and then some of its applications like the Inverting amplifier, non-inverting amplifier will be experimented.

**Theory:**

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 Vcc and VDD (or ±VCC) (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 OpAmp type known as the 741. It comes in a package, with metal pins.



## Figure 1 (a) and (b) showing amplifier and IC

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.

**EQUIPMENT AND COMPONENTS:**

1. Digital multimeter
2. Variable DC power supply
3. Oscilloscope
4. Function generator
5. Protoboard
6. 100kΩ
7. 10kΩ
8. 741 op-amp

**CIRCUIT AND FIGURES:**

***Inverting amplifier:***

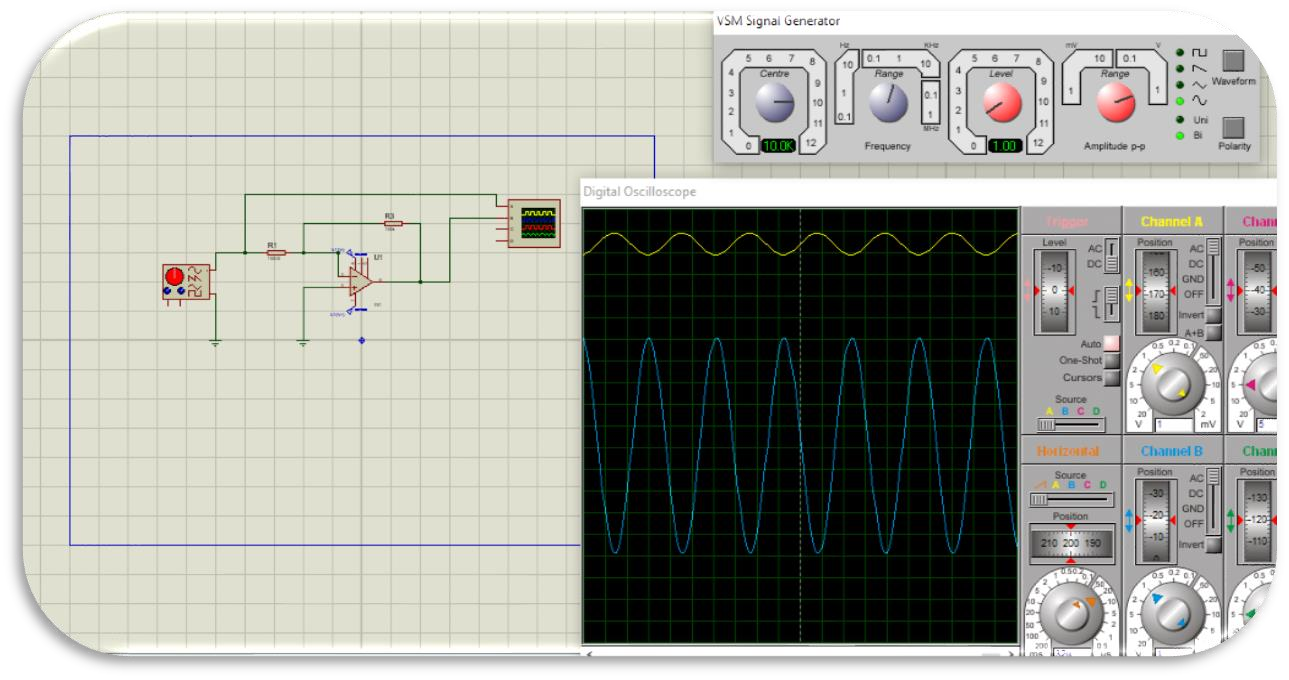


Fig #1 showing inverting amplifier

***Non – Inverting Amplifier:***

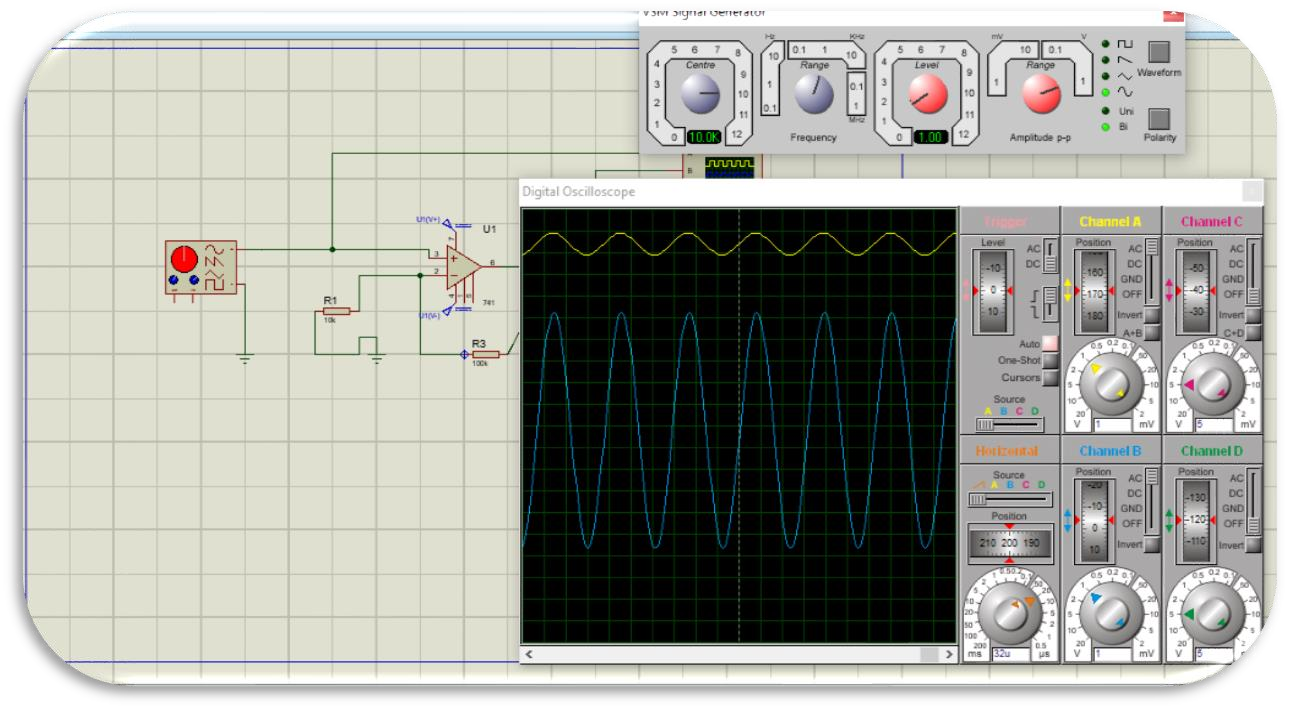
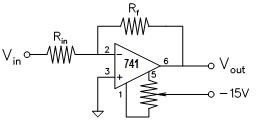


Fig #1 showing non-inverting amplifier

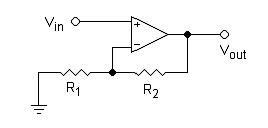
**PROCEDURE**:

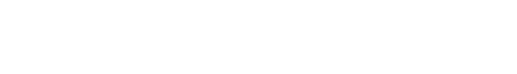
1. *Inverting amplifier:*



* the circuit shown with Rf = 100 kΩ and Rin= 10kΩ (gain 10); Set DMM to an appropriate scale.
* For five or more values of Vin, in the range ±0.7V calculate the value of Vout using the following formula for voltage gain of Inverting amplifier and write them in Table 1:
* *Av=Vout /Vin= -Rf / Rin.*
* Measure the value of Vout for each value of Vin as mentioned above, using a DC voltmeter and write the results in Table 1. Find the % age error.
* Set the Function generator at a frequency of 1 kHz and apply as input Vin to the inverting amplifier. Use the two channels of the scope to monitor the inverting input Vin of the op-amp and the output Vout. 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.

1. *Non – Inverting Amplifier:*



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

***CALCULATION AND OBSERVATIONS:***

*Table 1 Inverting DC:*

|  |  |  |  |
| --- | --- | --- | --- |
| *Vin*  *(v)* | *Vout Theoretical (v)* | *Vout Experimental (v)* | *% Deviation* |
| *0.1* | *-1* | *-0.98* | *2* |
| *0.2* | *-2* | *-1.98* | *2* |
| *0.3* | *-3* | *-2.98* | *2* |
| *0.4* | *-4* | *-3.98* | *2* |
| *0.5* | *-5* | *-4.98* | *2* |

*Table 2 Non-Inverting DC:*

|  |  |  |  |
| --- | --- | --- | --- |
| *Vin*  *(v)* | *Vout Theoretical (v)* | *Vout Experimental (v)* | *% Deviation* |
| *0.1* | *1.1* | *1.12* | *2* |
| *0.2* | *2.2* | *2.22* | *2* |
| *0.3* | *3.3* | *3.32* | *2* |
| *0.4* | *4.4* | *4.42* | *2* |
| *0.5* | *5.5* | *5.52* | *2* |

*Table 3 Inverting AC:*

|  |  |  |  |
| --- | --- | --- | --- |
| *Vin*  *(v)* | *Vout Theoretical (v)* | *Vout Experimental (v)* | *% Deviation* |
| *0.1* | *-1* | *1* | *0* |
| *0.2* | *-2* | *2* | *0* |
| *0.3* | *-3* | *3* | *0* |
| *0.4* | *-4* | *4* | *0* |
| *0.5* | *-5* | *5* | *0* |

*Table 4 Non-Inverting AC:*

|  |  |  |  |
| --- | --- | --- | --- |
| *Vin*  *(v)* | *Vout Theoretical (v)* | *Vout Experimental (v)* | *% Deviation* |
| *0.1* | *2.2* | *2.22* | *0* |
| *0.2* | *3.3* | *3.33* | *0* |
| *0.3* | *4.4* | *4.44* | *0* |
| *0.4* | *5.5* | *5.55* | *0* |
| *0.5* | *6.5* | *6.66* | *0* |

***CONCLUSION:***

*“An operational amplifier is an integrated circuit that can amplify weak electric signals. An operational amplifier has two input pins and one output pin. Its basic role is to amplify the voltage of both inputs. One input is called inverting pin, It is called Inverting Amplifier because the op-amp changes the phase angle of the output signal exactly 180 degrees out of phase with respect to input signal. Same as like before, we use two external resistors to create feedback circuit and make a closed loop circuit across the amplifier. The second one is inverting amplifier produces an inverted output which is expressed with negative polarity. The output produced by a noninverting amplifier is non-inverted in nature and expressed with positive polarity. Thus, the gain of the inverting amplifier is just a ratio of resistances.”*