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EEE-Departmant

Non-Inverting Operational Amplifier

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1. Objectives

The objective of this experiment is to study and simulating non-inverting configuration of 741 operational-amplifier using multisim simulating kit.

2. Equipment

a. Oscilloscope
b. Function-generator
c. Vcc (+12v)
d. Vdd (-12v)
e. IC-741
f. Resistors(1kΩ, 2kΩ, 3kΩ, 4kΩ)

3. Circuit Diagram

Figure 1 shows the circuit diagram for non-inverting configuration.

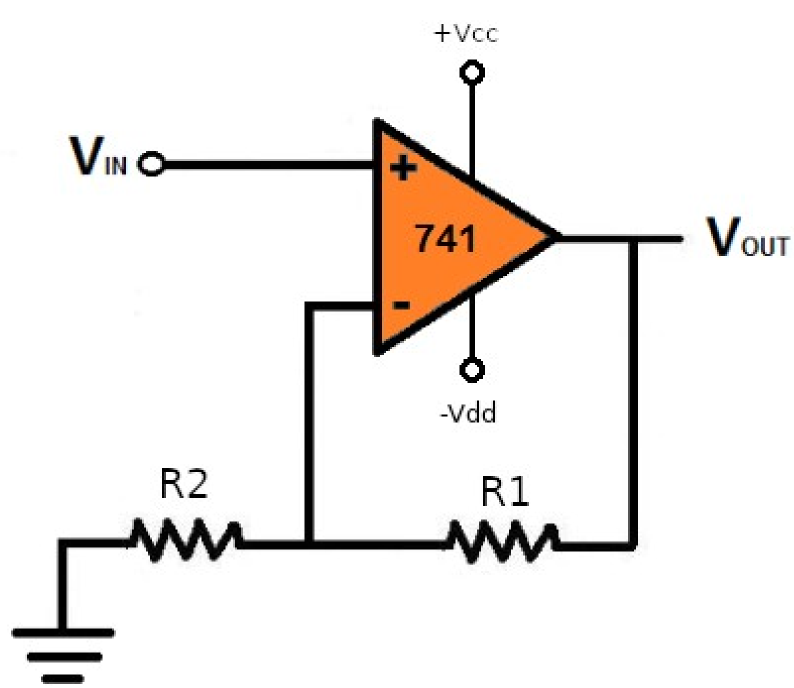

Figure 1

Figure 2 shows the circuit connection for non-inverting configuration on multisim simulating application.

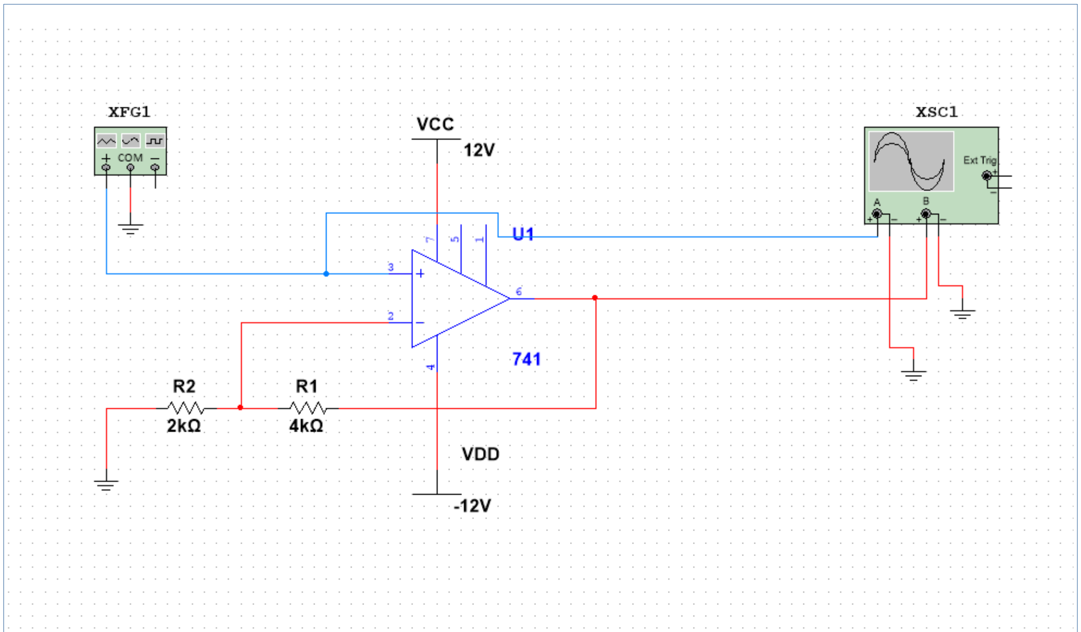

Figure 2

4. Theory

A modern op-amp has hundreds of transistors integrated on a single chip, It is not necessary to understand how the internal circuitry works in order to use the op-amp; it can be treated as a “black-box” device.

The symbol for an 741 op-amp is shown in figure 1, This is the most basic op-amp symbol with five terminals comprised of positive (non-inverting) and negative (inverting) inputs; V+ and V- supply terminals; and one output.

All equations that describe the behavior of op-amp circuits rely on certain assumptions about the op-amp. These assumptions about an ideal op-amp are summarized in table 1 and compared to the real op-amp used in this lab, the 741.

A modern op-amp approaches an ideal op-amp when used within its bandwidth and output limitations. For non-critical applications the ideal op-amp assumptions are valid.

In the case of the 741 as long as the device is operated at low frequencies and does not exceed its rated output voltage and current limits the ideal assumptions are valid.

Parameter	Ideal Op-Amp	741
R_{in}	Infinite	2MΩ
Open loop Gain	Infinite	200,000
Bandwidth	Infinite	1MHz
Voltage Output	Infinite	+/- 15.0V
Current Output	Infinite	25mA
R_O	Zero	75Ω
Input Offset Voltage	Zero	1mV
Input Bias Current	Zero	0.2nA

Table 1

The behavior of an op-amp can be described by two rules:

1. An op-amp will attempt to make the voltage at both its inputs equal through the use of a feedback path.
2. No current can flow through inputs terminals.

Now by connected the 741 as shown in figure 1, we will get the non-inverting operation amplifier configuration and this configuration has a positive gain and negative feedback loop and for this configuration the input/output relationship is given by:

$$Vo=\left(1+\frac{R1}{R2}\right)Vi$$

Formula 1

and Transfer function is given by:

$$G=1+\frac{R1}{R2}$$

Formula 2

5. Observation Data

- **Simulation Readings**

table 2 shows all the readings that we got from the simulation using different values of R_1 and R_2 and different input voltages.

R_1(kΩ)	R_2(kΩ)	F(Hz)	V_{i1}(v)	V_{o1}(v)	V_{i2}(v)	V_{o2}(v)	V_{i3}(v)	V_{o3}(v)
1	1	1	1	1.994	2	3.986	3	5.983
2	1	1	1	2.992	2	5.974	3	8.972
3	1	1	1	3.992	2	7.966	3	11.115
4	1	1	1	4.990	2	9.920	3	11.115
1	2	1	1	1.496	2	2.993	3	4.500
2	2	1	1	1.997	2	3.987	3	5.973
3	2	1	1	2.497	2	4.991	3	7.475
4	2	1	1	2.994	2	6.001	3	8.972

Table 2

Table 3 shows both the theoretical Gain calculated using the Formula 1 and the Actual gain for the Table 2 and Averaged Gain error.

Theoretical Gain	Actual Gain	Error (%)
2	1.993	0.35
3	2.989	0.36
4	3.898	2.55
5	4.551	8.98
1.5	1.497	0.20
2	1.993	0.35
2.5	2.494	0.24
3	2.995	0.16

Table 3

- **Oscilloscope output**

The Figure 3 shows the input signal and the amplified output signal on the Oscilloscope.

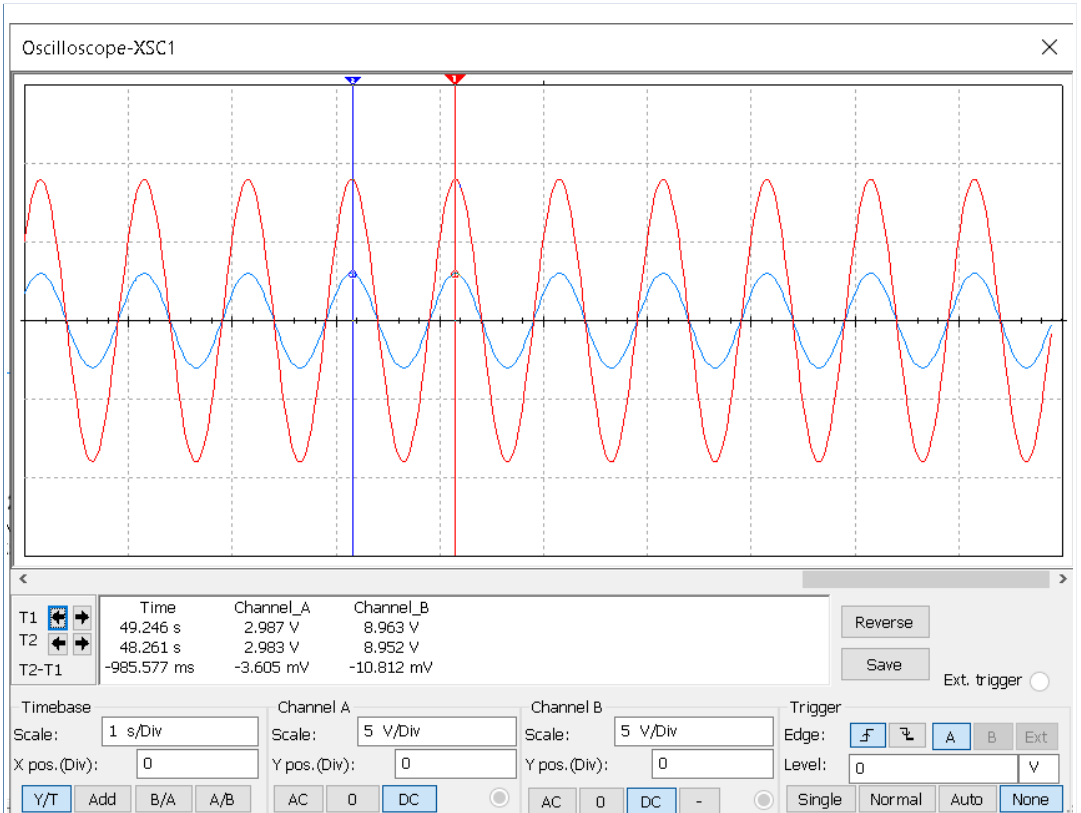

Figure 3: input and output signals

The Figure 4 shows the input signal and Saturated Output signal.

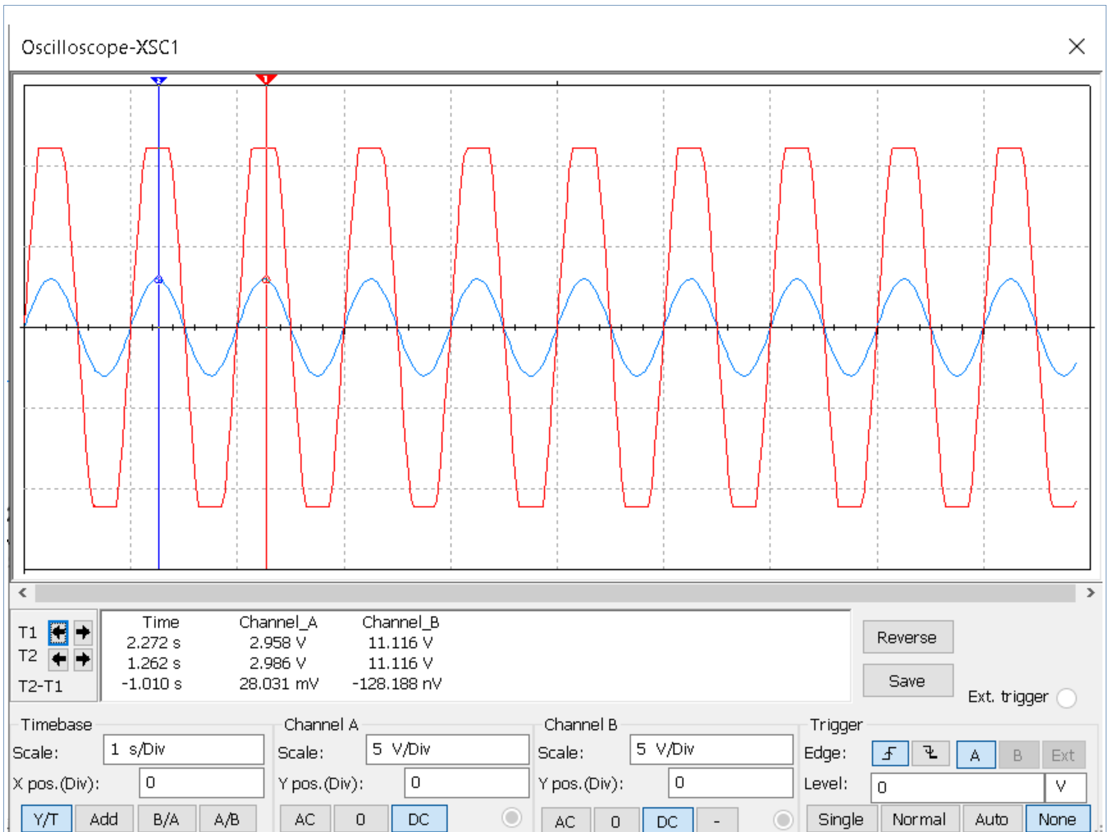

Figure 4: Saturated output Signal

6. Graphs

The Figure 5 shows the graph between Theoretical Gain and Actual Gain.

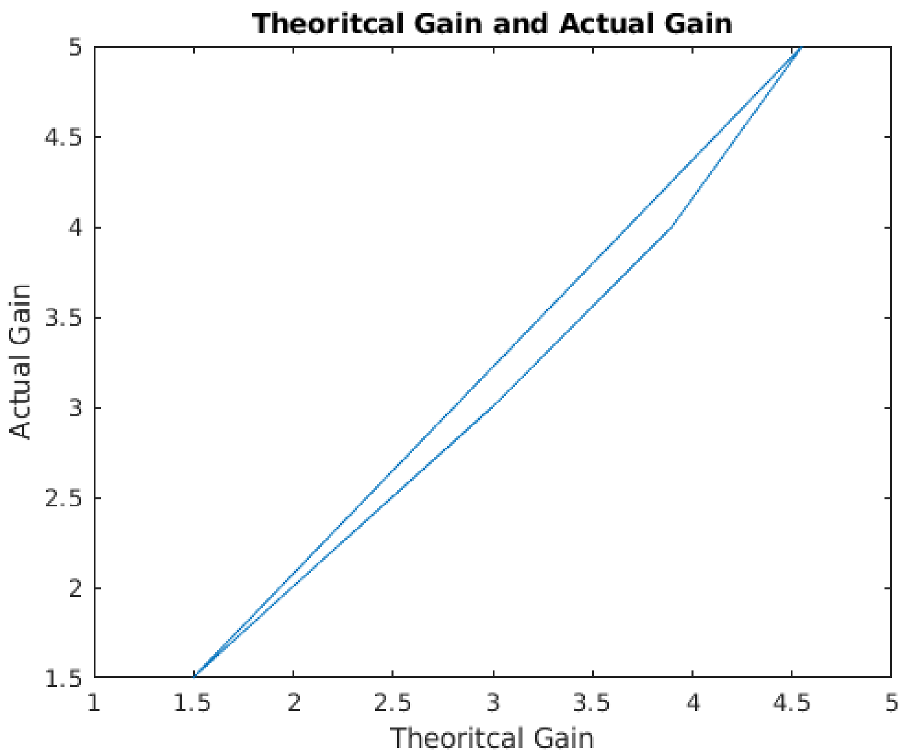

Figure 5: Theoretical Gain and Actual Gain Graph

The Figure 6 shows the input and output for different values of Gain.

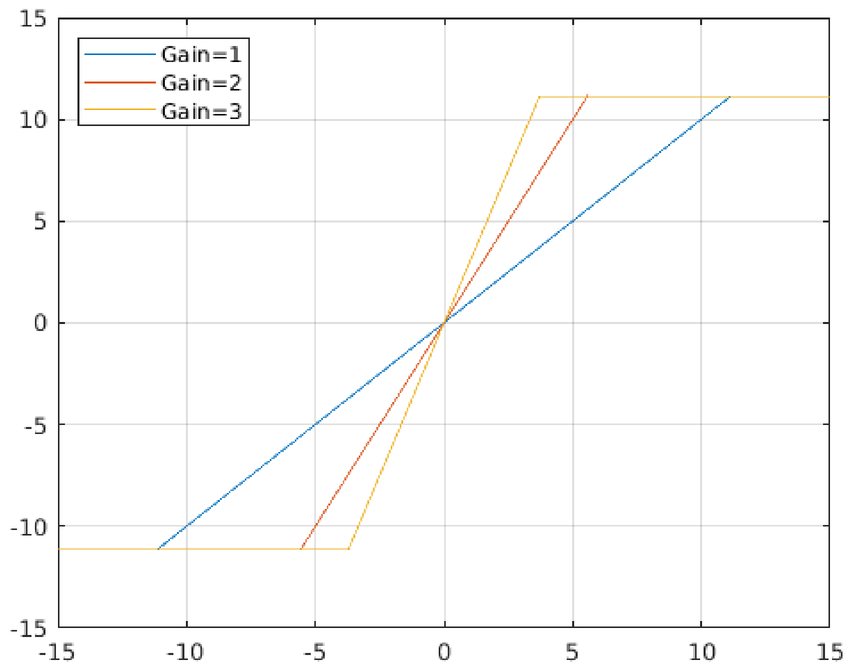

Figure 6: Input and Output Voltages

7. Analysis

From the readings that we got from simulating and showed in table we can see that the output depend on input and we can change the Gain by changing the Values of the R_1 and R_2 and we can see that we can't get the Theoretical output voltage because there is an Output Resistance For operational amplifier and its value shown in Table 1.

If we see the Figure 4 we can notice that we got a cutting on output signal and that happened because the Amplified signal is Limited to the supply inputs voltages (+Vcc / -Vdd) and we can avoid that by increasing the input voltages but notice that we got a maximum value of input voltages for IC-741 as shown in Table 1, and from the Figure 3 we can see that output signal is amplified and its in-phase (positive-gain).

8. Conclusion

From this experiment we can see that the non-inverting configuration provides a simple way to amplify a voltage signal with positive fixed gain that can choose its value by changing the R_1 and R_2 Resistors.
And also we see one of the limitation of the non-inverting and its Limited input voltage range.