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EEE-Departmant

Integrator Operational Amplifier

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1. Objectives

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

2. Equipment

a. Oscilloscope
b. Capacitors
c. AC Source
d. Vcc (+15v)
e. Vdd (-15v)
f. IC-741
g. Resistors(1kΩ, 2kΩ, 3kΩ, 4kΩ)

3. Circuit Diagram

Figure 1 shows the circuit diagram for two input integrator configuration.

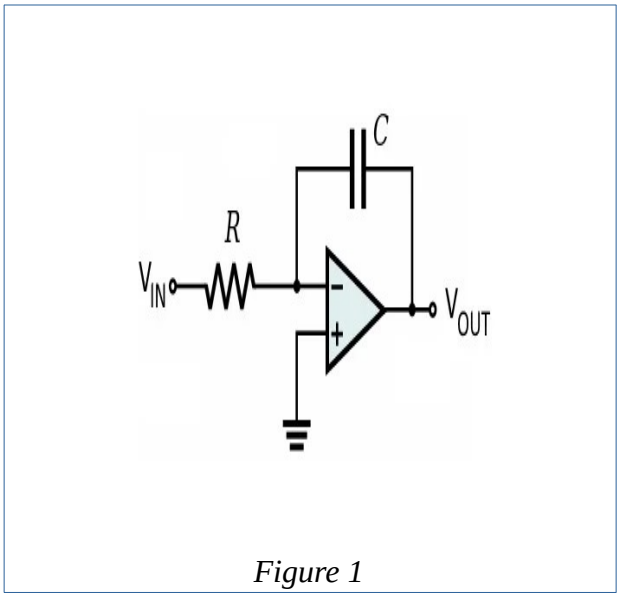

Figure 1

Figure 2 shows the circuit connection for integrator configuration.

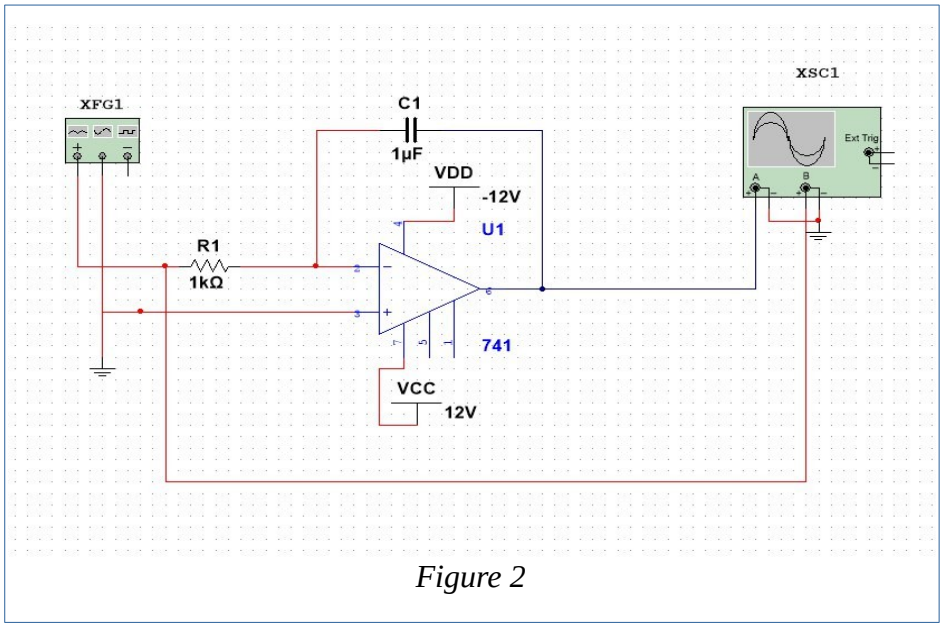

Figure 2

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 integrator operation amplifier configuration and this configuration has a negative gain and negative feedback loop and this configuration can integrate input voltage and for this configuration the input/output relationship is
given by:

$$Vo = -\int_0^t Vin \frac{dt}{Rin * C} = \frac{-1}{Rin * C} \int_0^t Vin\, dt$$

Formula 1

and the previous output can also be re-written as Formula 2:

$$Vo = \frac{-1}{j\omega RC} Vin$$

Formula 2

- **Oscilloscope output**

The Figure 3 shows the output where the input is Sine wave, where the input is the red and output is blue.

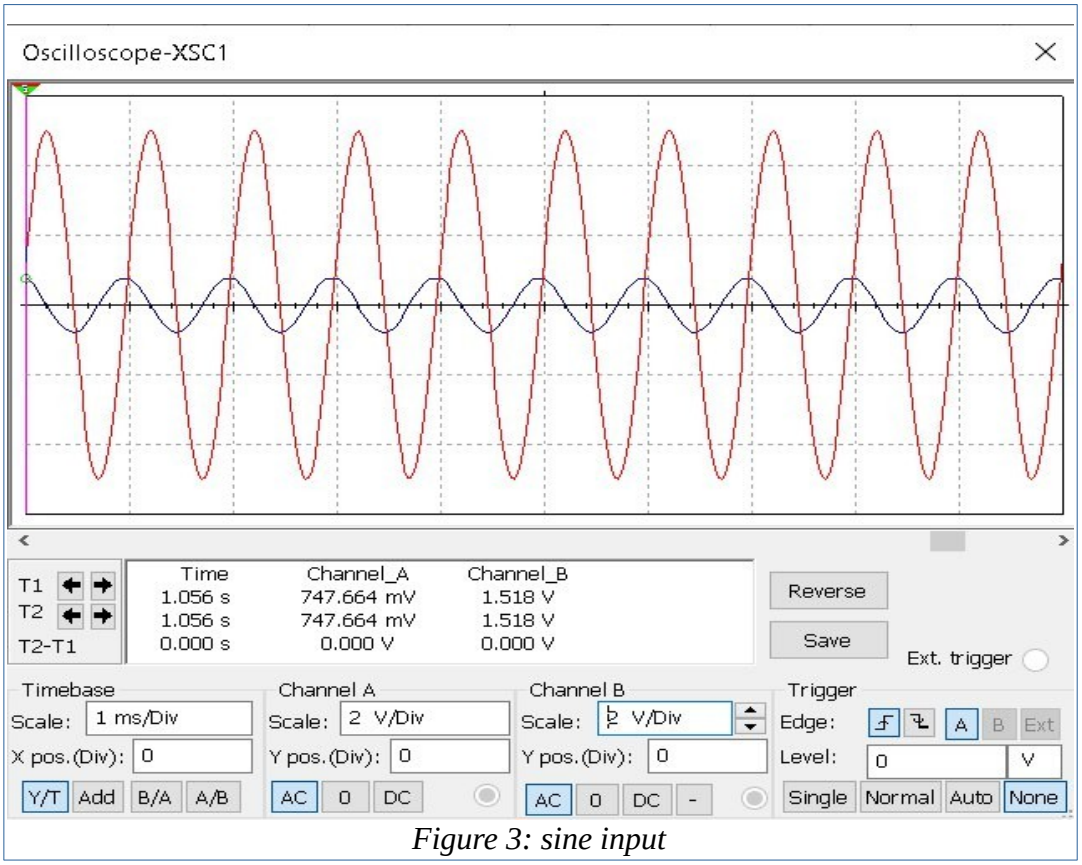

Figure 3: sine input

The Figure 4 shows the output where the input is Square wave, where the input the red and output is blue.

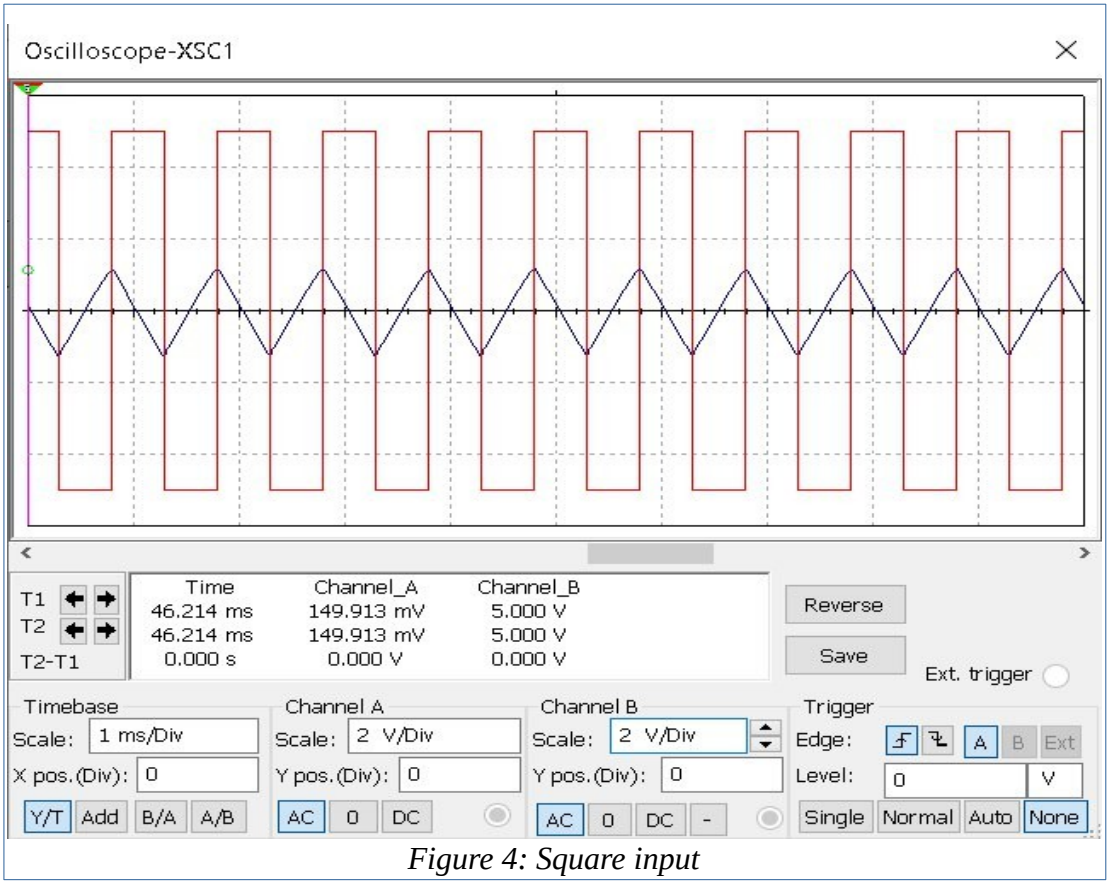

Figure 4: Square input

The Figure 5 shows the output where the input is Triangular wave, where the input the red and output is blue.

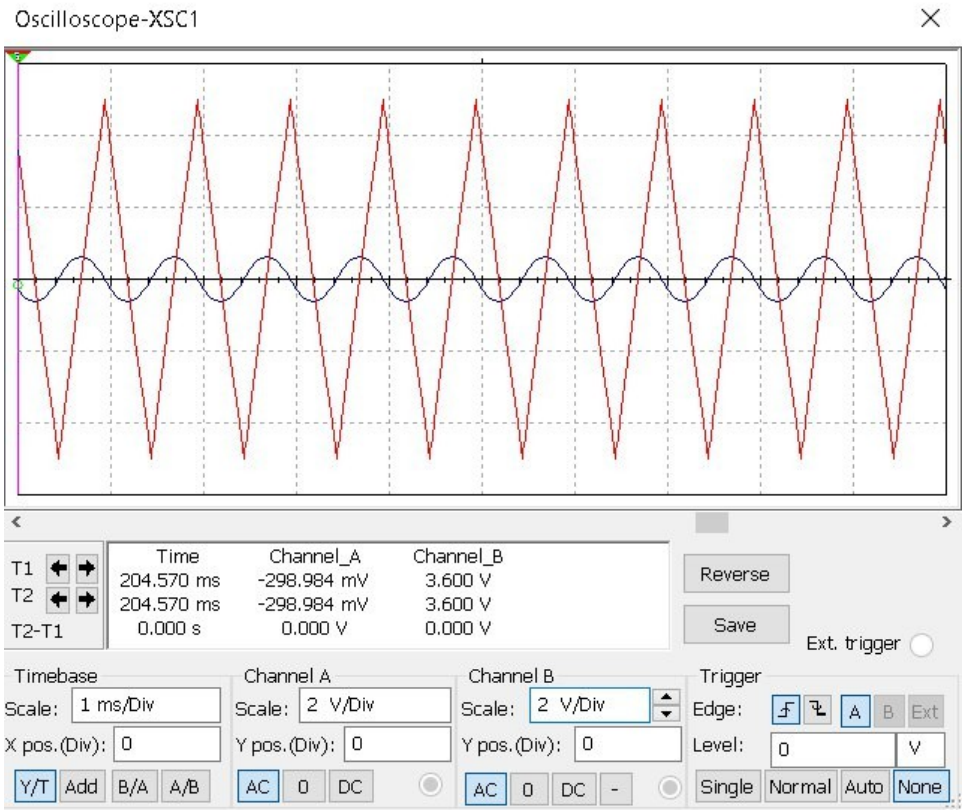

Figure 5: Triangular input

5. Analysis

From the output that we got from simulating and showed in Figures we can see that the output depend on input and we can change the Gain by changing the Value R and C 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.

From the Figures we can see that output signal is the Integration of the input Signal and the output is out-phase (negative-gain).

6. Conclusion

From this experiment we can see that the Integrator configuration provides a simple way to Integrate input voltage signals with negative fixed gain that can choose its value by changing R and C.

And also we see one of the limitation of the summing and its Limited input voltage range, and the Frequency limit and slewing-rate limit.