ELEC-237
ELECTRONICS LABORATORY-I

FINAL EXPERIMENT

Some Types of Opamps and Their Applications

Name:...

Surname: ....

Student ID:...

Section:...

Date:...

OBJECTIVE: *Familiarizing with basic properties and applications of the integrated circuit operational amplifier.*

DEPARTMENT OF ELECTRONICS ENGINEERING GEBZE TECHNICAL UNIVERSITY

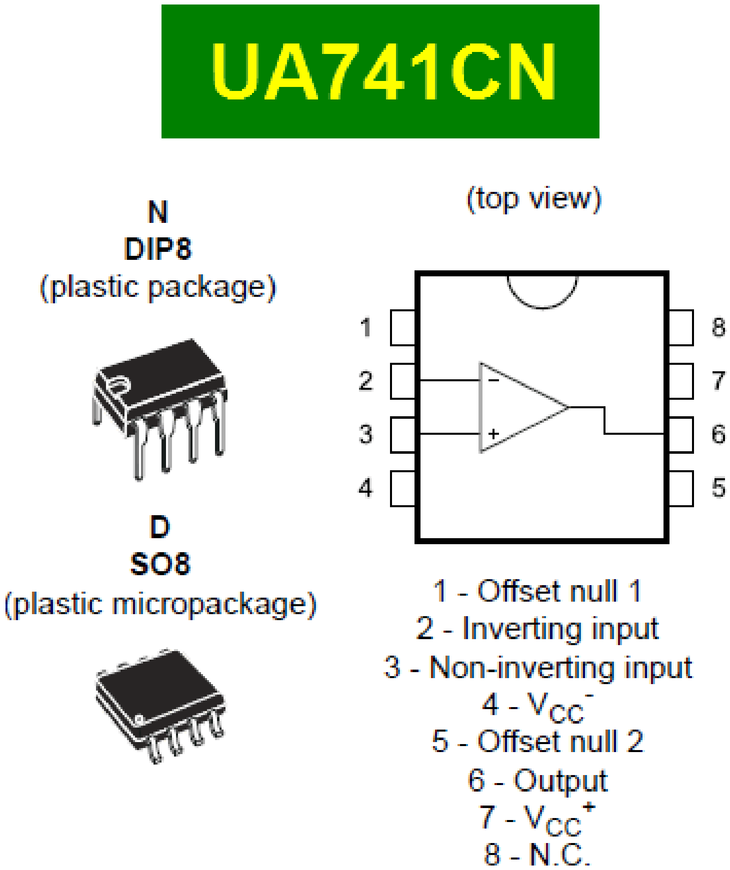

Figure 1. UA741CN Opamp with pin connections.

1. Op-Amp Based Adder/Subtractor

Purpose of Experiment and Theoretical Information:

The purpose of this experiment is to understand the use of the opamp and to establish the adder subtractor circuits and to verify the theoretically learned rules by trying them on the opamp. Gain calculation should be done by establishing adder and subtractor circuits. The use of the oscilloscope is also understood by changing the voltage sources from AC to DC.

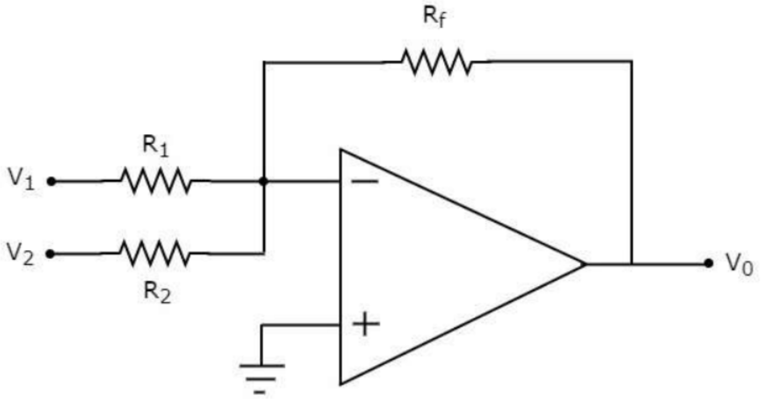

Figure 1: Adder Amplificator

An op-amp based collector produces an output equal to the sum of the input voltages applied at the inverting terminal. Because the output is amplified, it is also called a summation amplifier. The circuit diagram of an op-amp based collector is shown in figure2.

In the above circuit, the non-inverting input terminal of the op-amp is connected to ground. This means that zero volts is applied at the non-inverting input terminal. According to the virtual short concept, the voltage at the inverting input terminal of an op-amp is the same as the voltage at the non-inverting input terminal. Thus, the voltage at the inverting input terminal of the op-amp will be zero volts.

$$V_o = -\left\{V_1\frac{R_f}{R_1} + V_2\frac{R_f}{R_2}\right\}$$ Gain = Vout/Vin

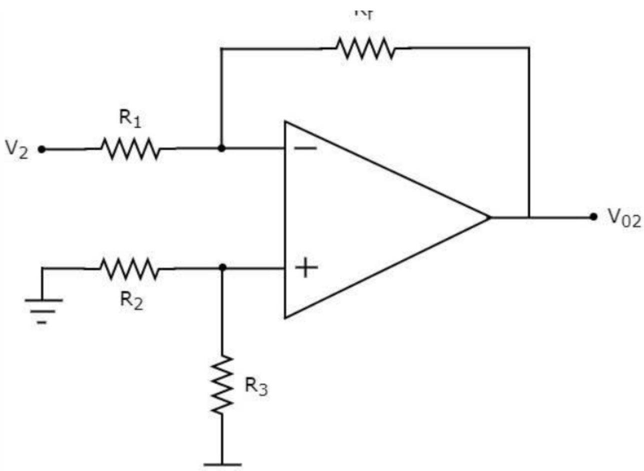

Figure 2: Substractor Amplifier

You can observe that the voltage at the non-inverting input terminal of the op-amp will be zero volts. This means that the circuit above is simply an inverting op-amp.

$$V_o = V_2\left\{\frac{R}{R_2+R}\right\}\left\{1+\frac{R_f}{R_1}\right\} - V_1\left\{\frac{R_f}{R_1}\right\}$$

1.1.1. Gain Of Adder Circuit At DC Voltage :

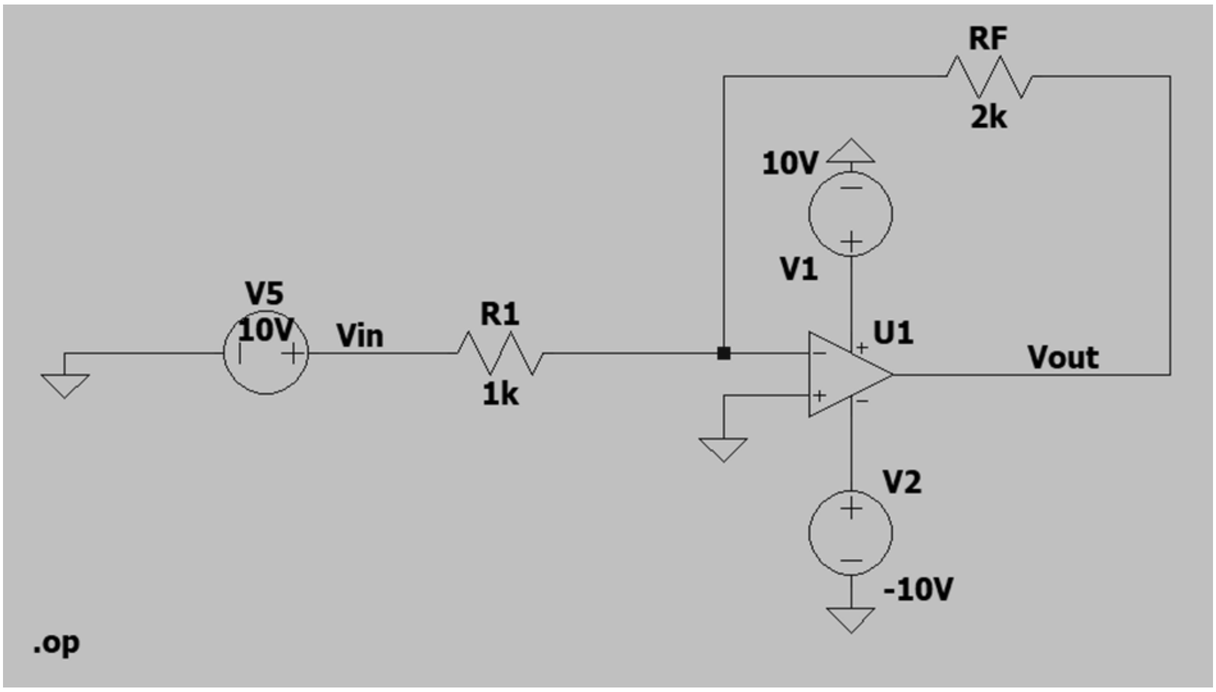

Figure 3 : Opamp Adder Circuit

Set up the circuit as in figure 2. a) Measure the Vout value. b) Then shunt the R1 resistor with a 5kΩ resistor. c) Shunt the R2=R3=10kΩ resistors to the R1 resistor. Write down the values you have measured in the appropriate places in Table1 and compare and interpret the values in b) and c).

	a)	b)	c)
V_{out}			
Gain			

Table 1 : DC Gain changes

Note your observations here:

....
....
....
....

1.1.2. AC Voltage and Gain

Rebuild the circuit in Figure 2. Change the voltage source to AC voltage source. Set the source to Vp=10V f = 1kHz. Measure the output voltage with the help of the oscilloscope. Then set the Source to square wave and repeat the same measurement. Note down the values and the graph in the appropriate places.

a)

V_{out} = ...

Waveform of
....
..................................V / cm
.... ms / cm

Waveform of
....
..................................V / cm
.... ms / cm

b) Shunt the R2=R3=10kΩ resistors into the circuit in Figure2 to the R1 resistor. Set the AC voltage source as Vp=10V f=1kHz and measure the output voltage (Vout) with the help of the oscilloscope.

V_{out} = ...

Waveform of
....
................................V / cm
.... ms / cm

1.2.1 Gain Of Subtractor Circuit At DC Voltage :

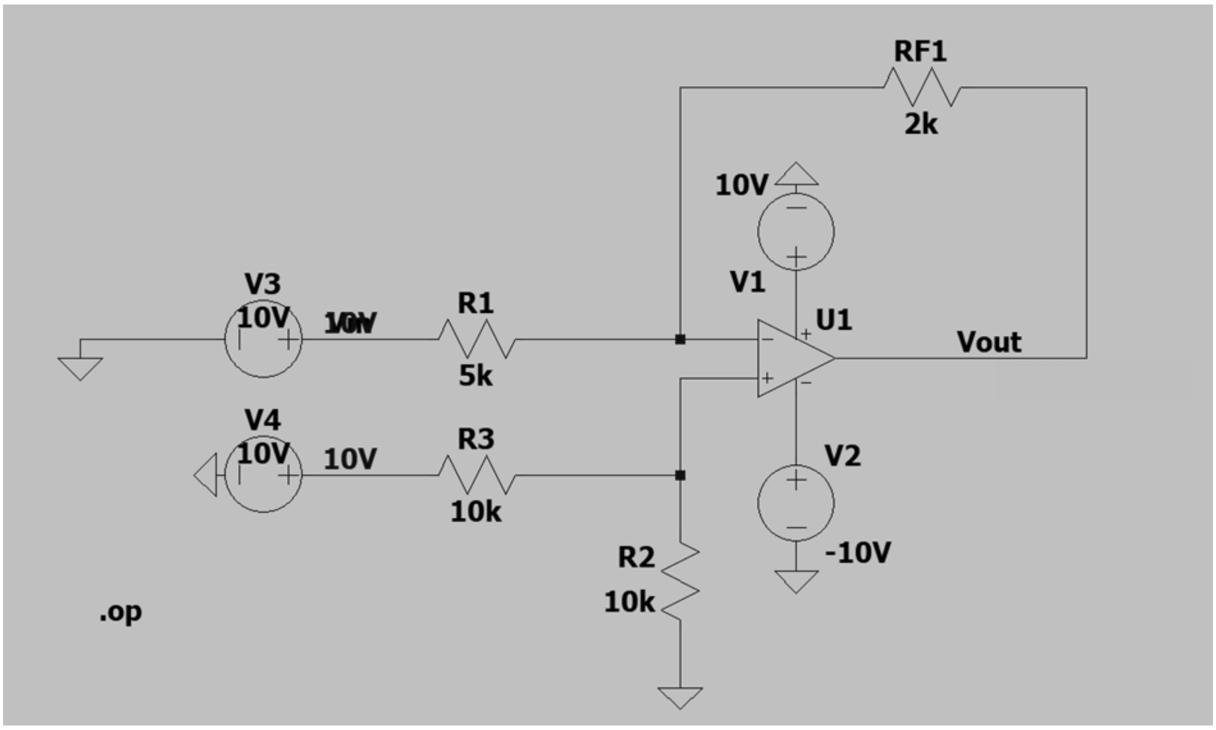

Figure 4 :Opamp based Subtractor circuit

Set up the circuit as in Figure 3. a) Measure the Vout value. b) Then replace the resistor R1 with a 10kΩ resistor and repeat the measurement. Write the values you find in the appropriate places in Table2.

	a)	**b)**
$\mathbf{V_{out}}$		
Gain		

Table 2 : DC Gain Changes

1.2.2 Gain Of Subtractor Circuit At AC Voltage :

Change the Voltage source of the circuit in Figure3 to an AC voltage source. Set the source to Vp=10V f = 1kHz. Measure the output voltage with the help of an oscilloscope. Then set Source to square wave and repeat the same measurement. Note down the values and the graph in the appropriate places.

V_{out} = ...

Waveform of
....
.................................V / cm
.... ms / cm

Waveform of
....
..................................V / cm
.... ms / cm

2.The Integrator Amplifier

Aim of Experiment and Theoretical Information:

The aim of this experiment is to better understand the working conditions of integrator circuits and to understand some types of opamps. Integrators are commonly used in wave-shaping applications, and these load amplifier circuits are often built using an operational amplifier, although they can use high-gain discrete transistor configurations.

It transfers the signal applied to the input integrally to the output. If a square wave is applied to the input of the integrator circuit, it gives a triangular wave to the output. If a sine wave is applied, a cosine wave is obtained. Integrator circuits are generally used in analog-to-digital converters, wave-forming circuits.

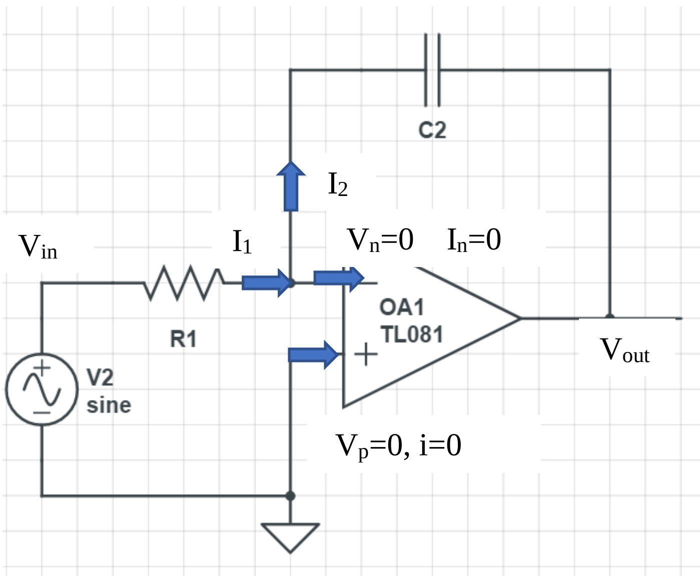

Figure 4:An integrator circuit

$$\boldsymbol{V_P = V_n = 0 \rightarrow Virtual\ ground}$$

We have two currents, $\boldsymbol{I_1}$ is the current through $\boldsymbol{R_1}$, $\boldsymbol{I_2}$ is the charging current of the capacitor . Apply KCL at the inverting terminal ;

$$\boldsymbol{I_1 = I_2 + I_n}$$

$$I_1 = \frac{V_i - V_i}{R_1} \rightarrow V_n = 0 \rightarrow \frac{V_i}{R_1} = I_1$$

I_2 is the current flowing to charge or discharge the capacitor.

$$I_2 = C_F \times d\,\frac{V_C}{dt}$$

V_C is the voltage across the capacitor. As the current is flowing from inverting from non-inverting terminal to output terminal, we can assume $V_C > V_{out}$

$$I_2 = C_F \times d\,\frac{(V_n - V_{out})}{dt}$$

As inverting terminal voltage $V_n = 0V$

$$I_2 = -C_F \times d\,\frac{V_{out}}{dt}$$

$$I_1 = I_2 + \cancel{I_n}$$

$$\frac{V_i}{R_1} = I_1 \text{ and } I_2 = -C_F \times d\,\frac{V_{out}}{dt}$$

$$\left.\frac{V_i}{R_1} = -C_F \times d\,\frac{V_{out}}{dt} \rightarrow \frac{-V_i}{R_1 \times C_F} dt = dV_{out}\right\}$$

We'll keep dV_{out} at one side, and rest of the terms at another side.

And then we have tot do integration on both sides with respect to their integral operator.

$$\int dV_{out} = \frac{-1}{R_1 \times C_F} \int V_i\, dt$$

$$dV_{out} = \frac{-1}{R_1 \times C_F} \int V_i\, dt$$

2.1 Principle of an Integrator Amplifier

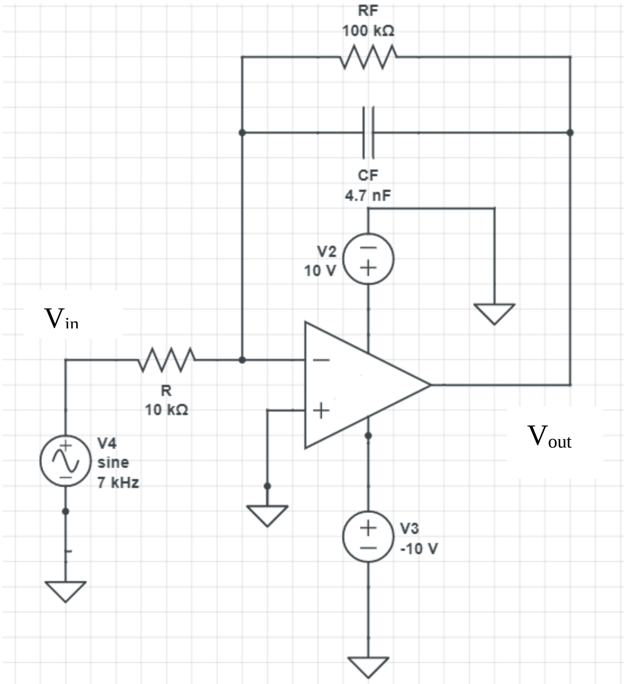

Figure 5: Practical integrator circuit

Assemble the circuit as shown in Figure 5. Adjust the power supply to ±10V. Set the peak value of the function generator to 1 V when the frequency value is 7kHz. Measure the V_{in} and V_{out} voltages. Starting from here, check whether the integrator amplifier circuit agrees with your theoretical calculations. Put your measurement results to Table 3. Consider whether the integrator circuit works in accordance with the principles of the 7 kHz frequency.

Table 3: Experiment results

Frequency	**V_{in}**	**V_{out}**
7 kHz		

COMMENT:…………………………………………………………………………………………… …………………………..

b)Calculate the gain in the circuit assemble up above.

GAIN: ……..

2.2 Different Frequencies of an Integrator Amplifier

Use the same circuit above.(Figure 5). . (Set the peak value of the function generator to 1 V when the frequency value which is indicated below) . Observe how the circuit behaves at various frequency values requested to be given to the integrator circuit, and indicate at which frequency values the integrator works in accordance with its principles.And then draw their graphs below.

Table 4: Experiment results for the given frequency values

SIN = sin(2п ?? t)	V_{in}	V_{out}
4 kHz	…….	…….
2 kHz	…….	…….
10 kHz	…….	…….

4 kHz

Waveform of

………………………………

………………………………V /cm

…………………………… ms /cm

2 kHz

Waveform of

....

.................................V /cm

.... ms /cm

10 kHz

Waveform of

....

.................................V /cm

.... ms /cm

CALCULATIONS and COMMENTS:

………………………………………………………………………………………………………
………………………………………………………………………………………………………
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2.3 <u>Different Wave forms of an Integrator Amplifier</u>

a)Use the same circuit above.(Figure 5). Adjust the signal generator to provide a **sine wave** at 7 kHz with 2 Vpp amplitude. Shunt resistor R1 by one of equal value. Observe and note the waveforms at nodes V_{in} and V_{out}. Indicate the voltage drop on peaks in the graph.

Waveform of
....
.................................V / cm
.... ms / cm

b)Use the same circuit above.(Figure 5). Adjust the signal generator to provide a **square wave** at 7 kHz with 2 Vpp amplitude. Observe and note the waveforms at nodes V_{in} and V_{out}. Indicate the voltage drop on peaks in the graph.

Waveform of
....
..............................V / cm
.... ms / cm

NOTES

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