Indian Institute of Information Technology, Allahabad

ELECTRONICS AND COMMUNICATION ENGINEERING DEPARTMENT

Course Name: Analog Electronics Laboratory

EXPERIMENT NO: 4

Objective:

To design and verify the operation of op-amp as an adder and substractor.

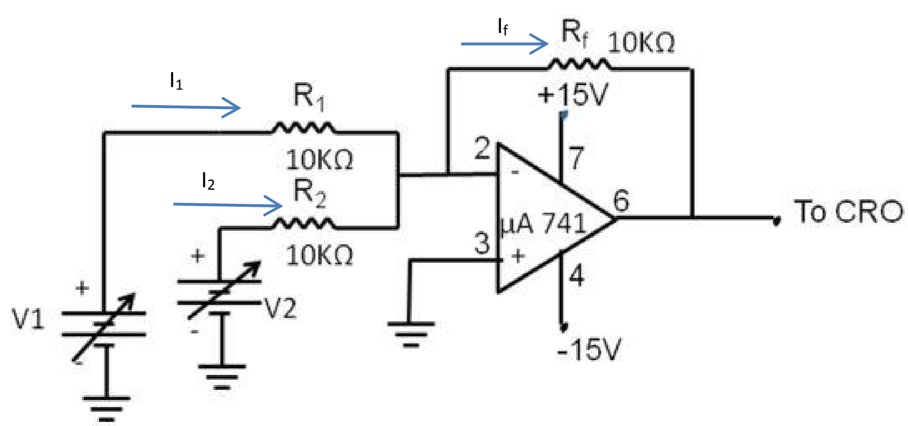
Materials/ Component Required:

S.No	Particulars	Specifications	Quantity
1	Op-amp	µA 741	01
2	Resistors	10Kohm	03
3	Multimeter		01
4	DC Power Supply		01
5	CRO + BNC Probes		01+ 03
6	Connecting Wires		As per use
7	Bread Board		01
8	Power Cords		03

(a) Summing Amplifier (Inverting)

Theory:
Previously in the inverting operational amplifier, the inverting amplifier has a single input voltage, (V_{in}) applied to the inverting input terminal. If we add more input resistors to the input, each equal in value to the original input resistor, (R_{in}) , this end up with another operational amplifier circuit called a Summing Amplifier, "summing inverter" or even a "voltage adder" circuit as shown below.

Circuit Diagram:



Design and Calculations:
From circuit, applying KCL at node 2 along with virtual ground concept at terminal 2 and 3,

$$I_1 + I_2 = I_f \quad \equiv \quad \frac{V_1}{R_1} + \frac{V_2}{R_2} = -\frac{V_{out}}{R_f}$$

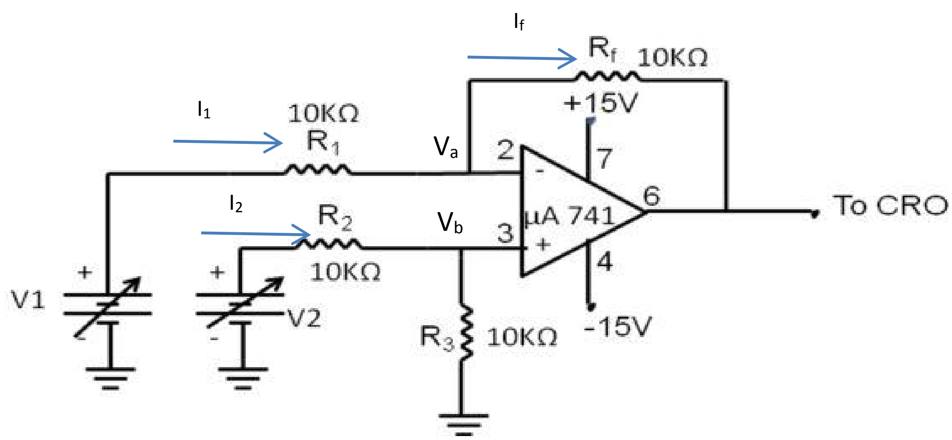
$V_{out} = -R_f\left(\frac{V_1}{R_1} + \frac{V_2}{R_2}\right)$ This is weighted summing amplifer

If R_1=R_2 then, $V_{out} = -\frac{R_f}{R_1}(V_1 + V_2)$ Summing Amplifier

If R_f=R_1 then, $V_{out} = -(V_1 + V_2)$ Inverting voltage adder/summing circuit

(b) Difference Amplifier

Theory:
In the previous circuits, only one terminal, inverting or non-inverting, were used as input. If both terminals connected to 2 different signals then the output will provide the difference of the two signals hence known as difference amplifier.



Design and Calculations:
From Circuit

$I_1 = \frac{V_1 - V_a}{R_1}$, $I_2 = \frac{V_2 - V_b}{R_2}$, $I_f = \frac{V_a - V_{out}}{R_f}$

Using virtual ground concept: V_a=V_b

Through voltage divider rule at non-inverting terminal: $V_b = V_2\left(\frac{R_3}{R_2+R_3}\right)$

Now, applying Superposition theorem:

If V_2=0, then: $V_{out(a)} = -V_1\frac{R_f}{R_1}$

If V_1=0, then: $V_{out(b)} = V_2\left(\frac{R_3}{R_2+R_3}\right)\left(\frac{R_1+R_f}{R_1}\right)$

$V_{out} = V_2\left(\frac{R_3}{R_2+R_3}\right)\left(\frac{R_1+R_f}{R_1}\right) - V_1\frac{R_f}{R_1}$, Weighted Difference Amplifier

If R_1=R_2 and R_3=R_f, then:

$V_{out} = \frac{R_3}{R_1}(V_2 - V_1)$, Difference Amplifier

If all resistances are equal then: $V_{out} = (V_2 - V_1)$ Substractor

Observation Table:

S.No	V_{ref}(Volts)	V_i (Volts)	V_o (Volts)
1			
2			
3			
4			

Report:

Result:

The summing and difference amplifier circuits has been implemented and operation verified accordingly.

Precautions:

a) Connections should be verified before switching on the supply.
b) The resistance to be chosen should be in proper range and of calculated values.

References:

1. https://www.electronics-tutorials.ws/opamp/opamp_4.html
2. https://www.electronics-tutorials.ws/opamp/opamp_5.html
3. R.A. Gayakward, “Op-Amps and Linear Integrated Circuits” 4th Ed. Pearson-Prentice Hall