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ANALOG ELECTRONICS CIRCUIT LAB.

ASSIGNMENT : 6
(Experiment No. : 06)

Date : 24.09.2021.

University of Engineering and Management, Kolkata.

Experiment No. : 06.
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Title : Study of Voltage Adder using Op-Amp.

Aim :- The aim of the experiment is to study and understanding the voltage adder circuit which was built using the inverting and non inverting Op Amp.

Apparatus Required :- (i) Op-Amp (3 channel)
(ii) Voltage Source (AC)
(iii) Resistors
(iv) Voltmeters (probes)
(v) Ground
(vi) Connecting wires.

Theory :- We saw previously in the inverting Op-Amp that the inverting Op-Amp 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 output resistor which is input (R_{in}) we end up with another operational amplifier is called a Summing Amplifier, "summing inverter" or even a "voltage adder."

In the simple summing amplifier the output voltage (V_{out}) now becomes proportional to the sum of the input voltages V_1, V_2, V_3 etc. Then we can modify the original equation for inverting amplifier to take account of those new inputs thus :-

$$I_F = I_1 + I_2 + I_3 = -\left[\frac{V_1}{R_{in}} + \frac{V_2}{R_{in}} + \frac{V_3}{R_{in}}\right]$$

Inverting equation : $V_{out} = -\frac{R_f}{R_{in}} \times V_{in}$

then, $-V_{out} = \left[\frac{R_f}{R_{in}} V_1 + \frac{R_f}{R_{in}} V_2 + \frac{R_f}{R_{in}} V_3\right]$

However all the impedences are equal in value then we can simplify the above equation we have,

$$-V_{out} = \frac{R_f}{R_{in}} (V_1 + V_2 + V_3 \dots)$$

This allows the output voltage to be easily calculated if more input resistors are connected to the amplifiers inverting input terminal. The input impedence of each row individual channel is the value of their respective input resistors R_1, R_2, R_3 etc. Now here comes the property of gain. gain $(A_V) = V_{out}/V_{in}$

But as we can implement inverting summing amplifiers, we can also use the non inverting input of the Op-Amp to create the non-inverting summing amplifier. The biggest advantage is that, because there is no virtual earth condition across the input terminals, its input impedance is much higher than that of the standard inverting amplifier. Here,

$$I_{R1} + I_{R2} = 0 \ (KCL).$$

$$\frac{V_1 - V+}{R_1} + \frac{V_2 - V+}{R_2} = 0.$$

$$\therefore \left(\frac{V_1}{R_1} + \frac{V+}{R_1}\right) + \left(\frac{V_2}{R_2} - \frac{V+}{R_2}\right) = 0.$$

If we make two input resistances equal in value then, $R_1 = R_2 = R$

$$V+ = \frac{V_1 + V_2}{2}$$

Then the standard equation for calculating the output voltage,

$$V_{OUT} = \left[1 + \frac{R_A}{R_B}\right] \frac{V_1 + V_2}{2}$$

The non inverting amplifiers closed loop gain voltage Av is given as. $1 + R_A/R_B$. If we make the closed loop voltage gain equals to 2 as. $R_A = R_B$ Then the output voltage becomes the sum of all input voltages as shown.

$$V_{out} = (1+1) \frac{V_1 + V_2}{2}$$

$$= (V_1 + V_2)$$

Procedure :- (i) Open Multisim live simulator in your browser and click on the create circuit section.

(ii) After that drag and drop the required apparatus from the box and put them in the right position according the circuit diagram.

(iii) Connect the apparatus using the connecting wires and then save the circuit.

(iv) Run the simulation and then split the windows to have the observation in the grapher section.

(v) Take the observation and provide the conclusion accordingly.

Circuit Diagram :-

① Voltage Adder circuit using Inverting Op-Amp :-

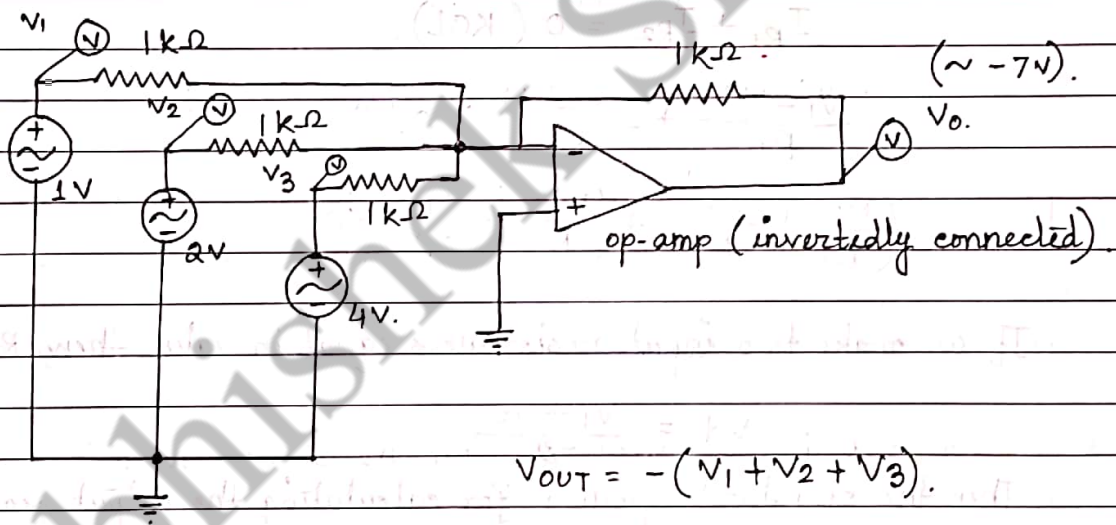

Fig : Voltage adder circuit using inverting Op-Amp.

② Voltage Adder circuit using Non-inverting Op-Amp :-

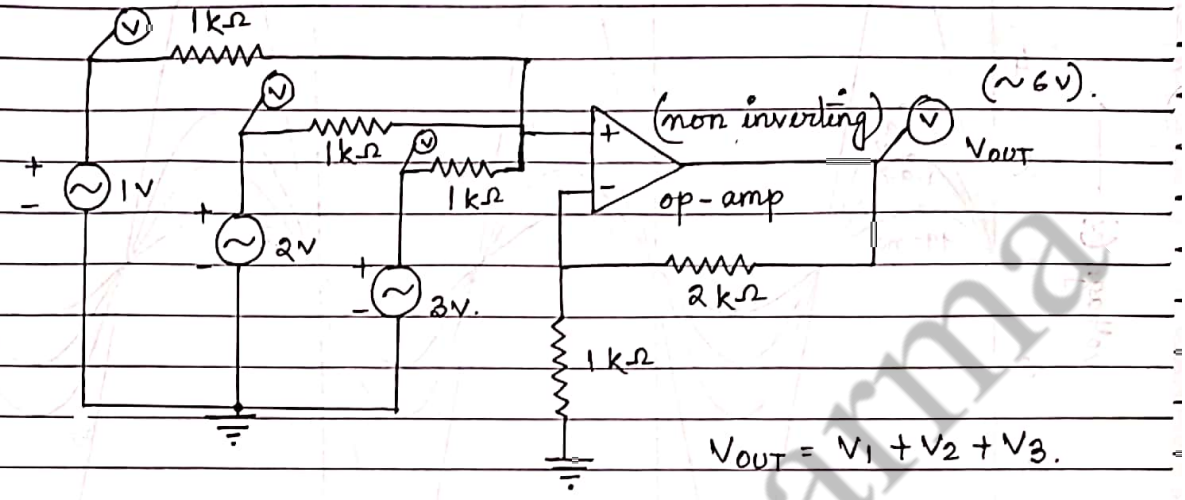

Fig :- Voltage Adder circuit using non-inverting Op-Amp.

Graphs :-

① Voltage adder using inverting Op-Amp :-

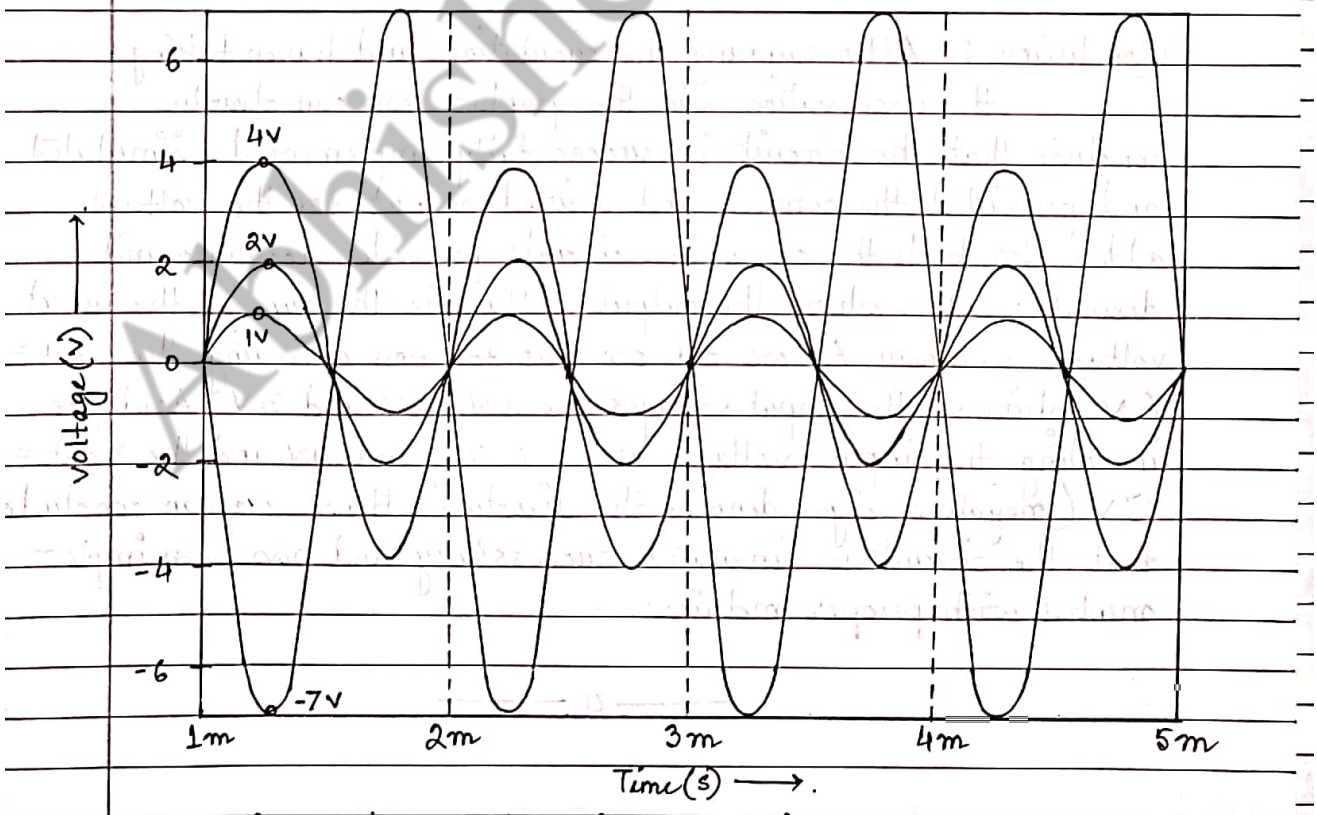

Fig : Voltage Adder using Inverting Op-Amp.

② Voltage adder using Non inverting Op-Amp :-

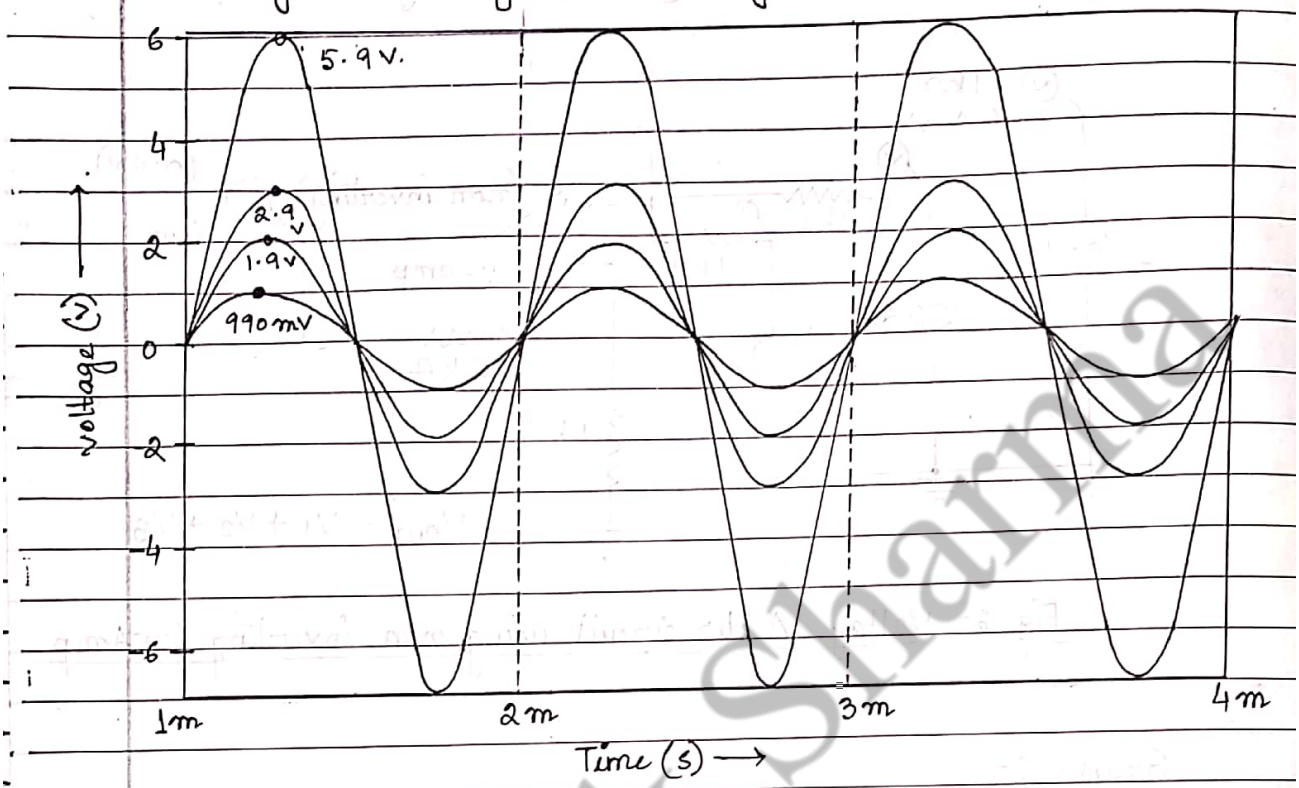

Fig : Voltage Adder using Non inverting Op-Amp.

Conclusion :- After running the simulation and haven taking the observation via the grapher, we can clearly conclude that the circuit is successfully implemented, simulated and provided the correct and disired output for the voltage adder. In both the cases the circuits provides accurate and desired results, where the output voltage is the sum of the input voltages genuinely. As we can see that for non inverting the Vout = 6 V whereas the input voltages are 1 V, 2 V and 3 V. And for inverting the input voltages are 1 V, 2 V and 4 V and the Vout = -7 V (negative sign denotes the direction). Hence, we can conclude that the circuit is simulated successfully and has been implemented with proper metrices.

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