Experiment – 6

Title: Voltage Adder Circuit and Difference Amplifier Circuit of Op-Amp

Objective: Study of Voltage Adder Circuit, Difference Amplifier using Op-

Amp

Theory: The Summing Amplifier is a very flexible circuit based upon the standard Inverting Operational Amplifier configuration. We know that the inverting amplifier has a single input signal applied to the inverting input terminal. If we add another input resistor equal in value to the original input resistor, Rin we end up with another operational amplifier circuit called a Summing Amplifier, "Summing Inverter" or even a "Voltage Adder" circuit as shown in the circuit diagram.

The output voltage, (Vout) now becomes proportional to the sum of the input voltages, V1, V2, V3 etc. Then we can modify the original equation for the inverting amplifier to take account of these new inputs thus:

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

$$\text{then,}\quad V_{out} = -\frac{R_F}{R_{in}}\left(V_1 + V_2 + V_3\right)$$

Now, we can also connect signals to both of the inputs at the same time to produce another common type of operational amplifier circuit called a differential amplifier. The resultant output voltage will be proportional to the "Difference" between the two input signals, V1 and V2. This type of circuit can also be used as a subtractor.

The transfer function for a differential amplifier circuit is given as:

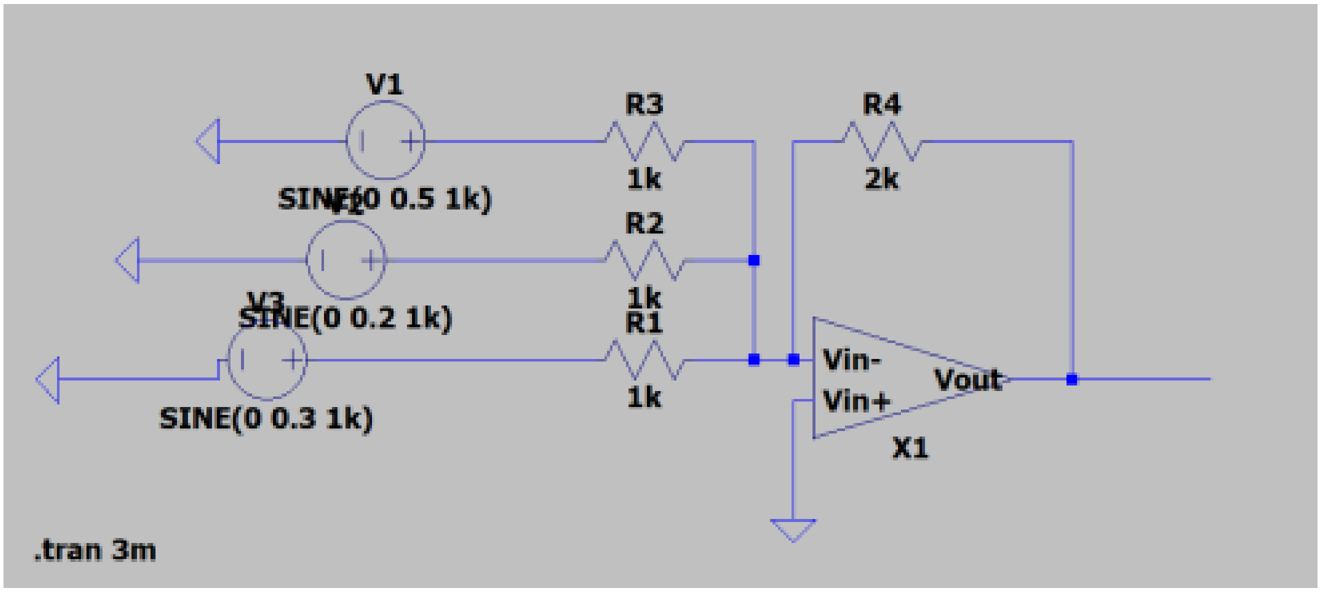
$$V_o = -\frac{R_2}{R_1}V_1 + \left(1 + \frac{R_2}{R_1}\right)\left(\frac{R_4}{R_3 + R_4}\right)V_2$$

When R1 = R3 and R2 = R4 the transfer function formula can be modified to the following:

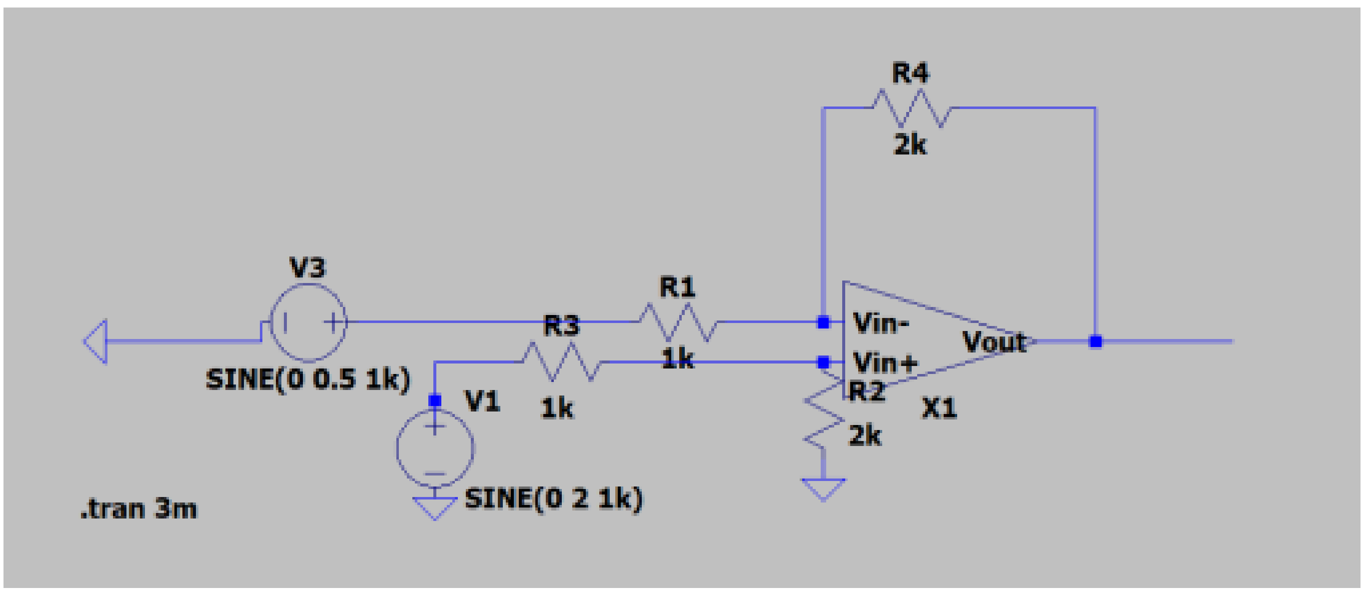
$$V_o = \frac{R_2}{R_1}(V_2 - V_1)$$

Circuit Diagram:

Adder Circuit

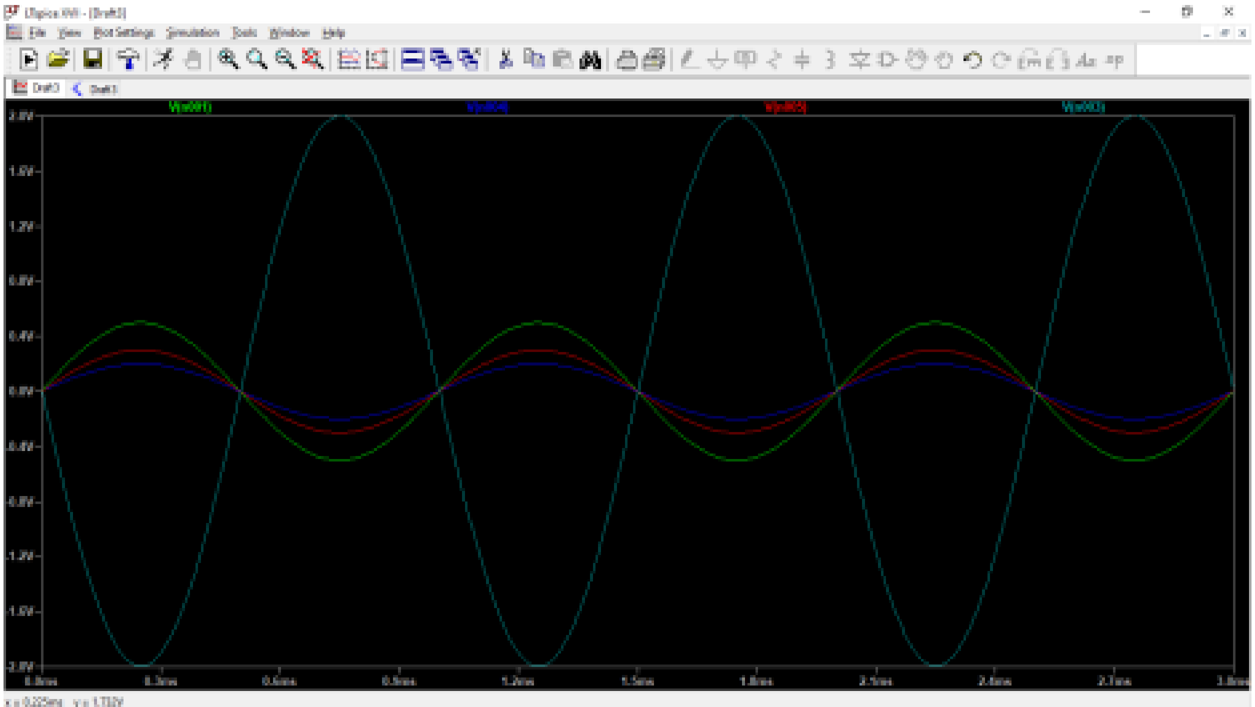


Subtractor Circuit-



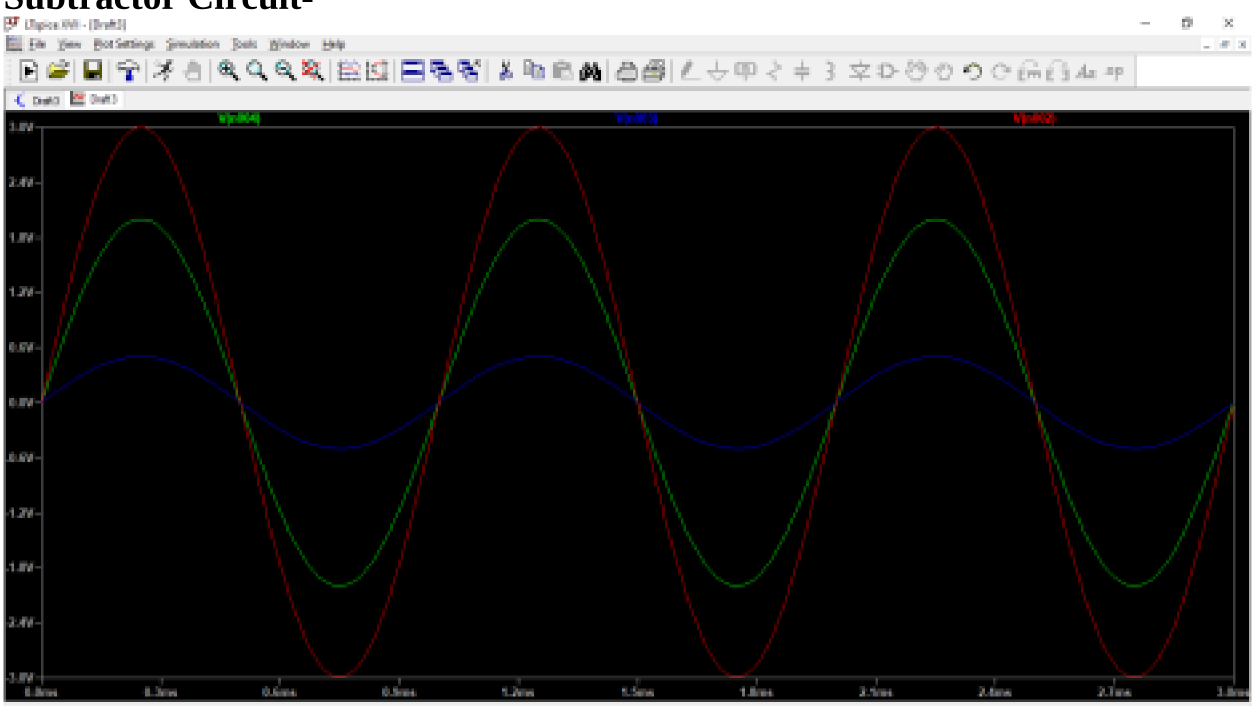
Result:

Adder Circuit



V1 (V)	V2 (V)	V3 (V)	Rin (for each) (kOhm)	Rf (kOhm)	Rf/Rin	Vin (total) (V)	Vout (V)
0.5	0.2	0.3	1	2	2	1	-2

Subtractor Circuit-



V1 (V)	V2 (V)	R1 = R3 (kOhm)	R2 = R4 (kOhm)	R2/R1	Vin1 (V)	Vin2 (V)	Vout (V)

0.5	**2**	**1**	**2**	**1**	**1.25**	**1.25**	**3**

Discussion:

The resultant output for both the circuit matches with the calculated value which verifies the action of these circuits completely. For example, in the adder circuit the resultant output voltage is inverted and the summation of all the individual input voltages passing through the inverting port of the Op-amp. Similarly, in the subtractor circuit the resultant output voltage is the difference of the two input voltages passing through the inverting port and non-inverting port of the Op-amp respectively (also as the input voltage passing through the non-inverting port is higher, the output is non-inverted).