IEC103 Basic Electronic Circuits Lab

Experiment 2

Objective: To build an inverting and non-inverting amplifier using Op-amp and draw their transfer characteristics.

Equipment Required: Breadboard, Regulated Power Supply (∓12 V), Function (Signal) Generator, and CRO.

Components Required: OP-AMP 741 IC, Resistances (1KΩ, 4.7KΩ), and connecting wires.

Theory:

- **Operational Amplifier (Op-amp)**

  Operational Amplifier is a linear device that has all the properties required for amplifying signals from DC (zero frequency) to a wide range of frequencies. Operational amplifier is used extensively in signal conditioning, filtering and also to perform mathematical operations such as add, subtract, integration, differentiation, etc. An ideal operational amplifier is basically a 3-terminal device that consists of two high impedance inputs, one an inverting input marked with a negative sign, ("-") and the other a non-inverting input marked with a positive plus sign ("+").

  Operational Amplifiers have a very high open loop gain, commonly known as the Open Loop Differential Gain, and is given the symbol (Ao). By using some form of negative feedback we can build an amplifier with a very precise gain that is dependent only on the feedback elements used. An operational amplifier only responds to the difference between the voltages at its two input terminals, known commonly as the "Differential Input Voltage" and not to their common potential. Then if the same voltage potential is applied to both terminals the resultant output will be zero.

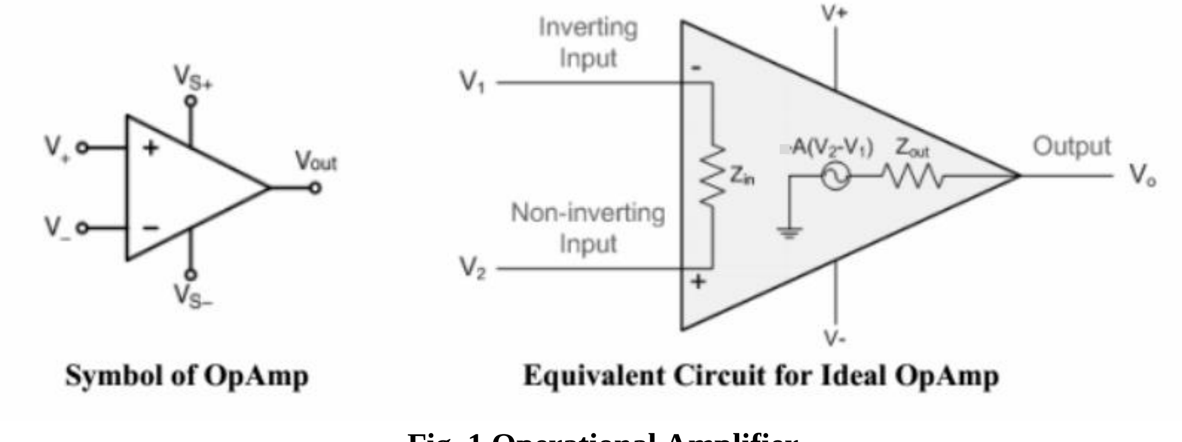

Fig. 1 Operational Amplifier

Ideally, for an op-amp,
Open Loop Gain (Ao) = ∞
Input Resistance (Zin) = ∞
Output Resistance (Zo) = 0
Bandwidth = ∞
Offset Voltage = 0

For Ideal OP-AMP we consider that,

1. No current flows into either of the input terminals.
2. The differential input offset voltage is zero.

However, real Operational Amplifiers (e.g. 741) do not have infinite gain or bandwidth but have a typical "Open Loop Gain" which is defined as the op-amp's amplification without any external feedback connected to it and for a typical operational amplifier it is around 100dB at DC (zero Hz). This output gain decreases linearly with frequency down to "Unity Gain" or 1.

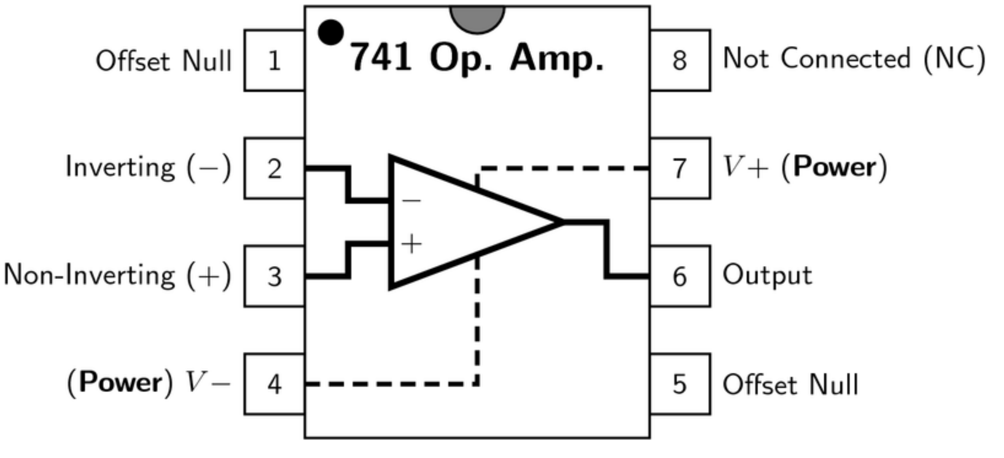

Fig. 2 Pin diagram of 741 op-amp

Inverting and non-inverting amplifiers using op-amp are shown in Fig. 3 and Fig. 4

Procedure:

Transfer Characteristics of an Inverting Amplifier

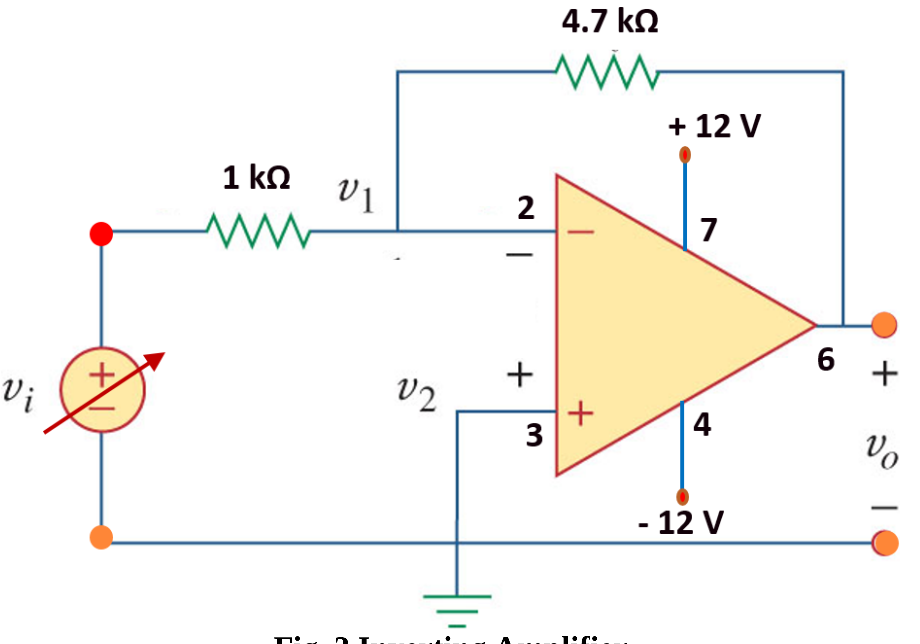

Fig. 3 Inverting Amplifier

$$\mathbf{v_o = -(4.7k/1k)\, v_i}$$

1. Connect the circuit as per the diagram shown in Fig. 3.
2. Generate a sinusoidal signal of frequency 1 kHz and magnitude specified in Table 1.
3. Measure input and output voltages using CRO.
4. Try the same experiment for different set of input voltages.
5. Plot the transfer characteristics (input-output characteristics, i.e., v_o-v_i characteristics)

S. No	V_i (Volt) (peak)	V_o (Volt) (peak)	Gain (v_o/v_i)
1	0.5		
2	0.75		
3	1		
4	1.25		
5	1.5		

Table-1

Transfer Characteristics of a Non-inverting Amplifier

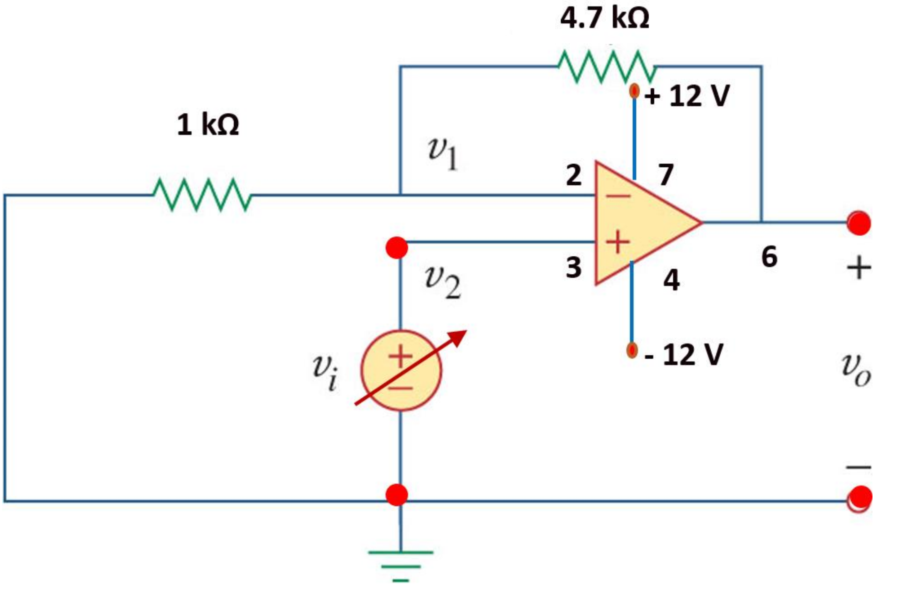

Fig. 4 Non-inverting Amplifier

$$\mathbf{v_o = (1 + 4.7k/1k)\, v_i}$$

1. Connect the circuit as per the diagram shown in Fig. 4.
2. Generate a sinusoidal signal of frequency 1 kHz and magnitude specified in Table. 2
3. Measure input and output voltages using CRO.
4. Try the same experiment for different set of input voltages.
5. Plot the transfer characteristics (input-output characteristics, i.e., v_o-v_i characteristics)

S. No	V_i (Volt) (peak)	V_o (Volt) (peak)	Gain (V_o/V_i)
1	0.5		
2	0.75		
3	1		
4	1.25		
5	1.5		

Table-2

Precautions to be taken:

1. Ensure that all the discrete components are working properly.
2. Make sure that all the connections in the circuit are correct before giving supply to circuit.
3. Remove the supply before changing any connections in circuit.
4. Check the amplitude of the supply signal before applying it to the circuit.
5. Ensure that the op-amp does not saturate.