M.Sc. Sem III Physics

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MPHYCC-12 Electronics II

OP-AMP applications :-

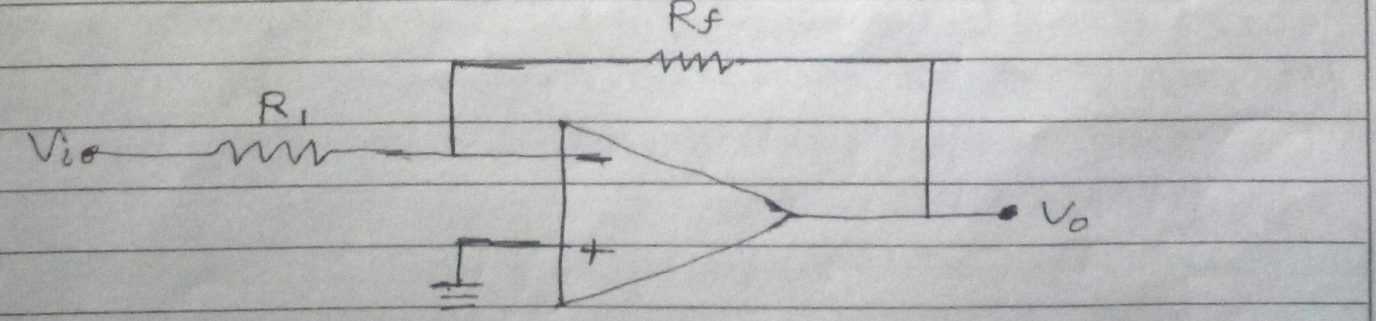
A circuit is said to be linear, if there exists a linear relationship between its input and the output. Similarly, a circuit is said to be non-linear, if there exists a non-linear, relationship between its input and output.

OP-amps can be used in both linear and non-linear applications. The following are the basic applications of OP-amp —

Inverting Amplifier :-

An inverting amplifier takes the input through its inverting terminal through a resistor R_1 and produces its amplified version as the output. This amplifier not only amplifies the input but also inverts it.

The Circuit diagram of an inverting amplifier is shown in the following figure :-



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Note that for an OP-amp, the voltage at the inverting input terminal is equal to the voltage at its non-inverting input terminal. Physically there is no short between those two terminals but virtually, they are in short with each other.

In the circuit shown above, the non-inverting input terminal is connected to ground. That means zero volts is applied at the non-inverting input terminal of the OP-amp.

According to the virtual short concept the voltage at the inverting input terminal of an OP-amp will be zero volts.

The nodal eqn at this terminals node is as shown below

$$\frac{0-V_i}{R_1} + \frac{0-V_o}{R_f} = 0$$

$$\Rightarrow \quad \frac{-V_i}{R_1} = \frac{V_o}{R_f}$$

$$\Rightarrow \quad V_o = \left(\frac{-R_f}{R_1}\right) V_i \quad \Rightarrow \quad \frac{V_o}{V_i} = \frac{-R_f}{R_1}$$

The ratio of the output voltage V_o and the input voltage V_i is the voltage-gain of the amplifier. Therefore, the gain of inverting amplifier is equal to $-R_f/R_1$.

Note that the gain of the inverting amp. is having a -ve sign. It indicates that there exists a 180° phase difference between the input and the output

Non-Inverting Amplifier :-

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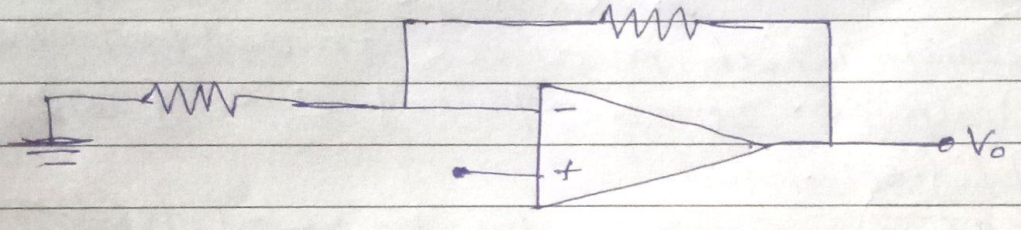
A non-inverting amplifier takes the input through its non-inverting terminal, and produces its amplified version as the output. As the name suggests, this amplifier just amplifies the input, without inverting or changing the sign of the output.

The circuit diagram of a non-inverting amplifier is shown in the following figure-



In the above circuit, the input voltage V_i is directly applied to the non-inverting input terminal of OP-amp. So, the voltage at the non-inverting input terminal of the OP-amp will be V_i.

By using voltage division principle we can calculate the voltage at the inverting input terminal of the OP-amp as shown below.

$$V_1 = V_o\left(\frac{R_1}{R_1 + R_f}\right)$$

According to the virtual short concept, the voltage at the inverting input terminal of an OP-amp is same as that of the voltage at its non-inverting input terminal

$$\Rightarrow V_1 = V_i$$

$$\Rightarrow V_o\left(\frac{R_1}{R_1 + R_f}\right) = V_i$$

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$$V_o / V_i = R_1 + R_f / R_1$$

$$\Rightarrow \frac{V_o}{V_i} = 1 + \frac{R_f}{R_1}$$

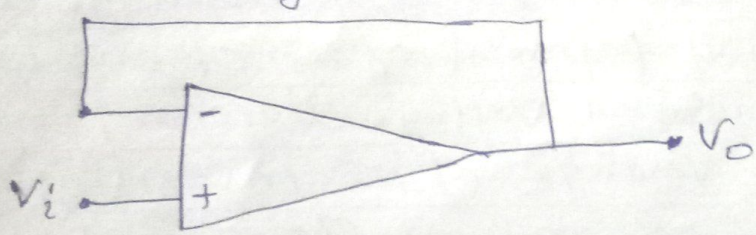
Now, The ratio of output voltage V_o and input voltage V_i or the voltage-gain or gain of the non-inverting amplifier is equal to $1 + \frac{R_f}{R_1}$

Note That the gain of the non-inverting amplifier is having a +ve sign. It indicates That there is no phase difference between the input and the output.

Voltage follower :-

A voltage follower is an electronic circuit, which produces an output That follows The input voltage. It is a special case of non-inverting amplifier.

If we consider The value of feedback resistor, R_f as Zero ohms and The value of resistor, R_1 as infinity ohms, then a non-inverting amplifier bekomes a voltage follower is shown in figure.



In The above circuit, The input voltage V_i is directly applied to The non-inverting input terminal of the OP-amp. So, The voltage at the non-inverting input terminal of OP-amp is equal to V_i. Here, The output is directly connected to The inverting input terminal of OP-amp. Hence the voltage at the inverting input terminal of OP-amp is equal to V_o.

According to the virtual short concept, the voltage at the inverting input terminal of the op-amp is same as that of the voltage at its non-inverting input terminal.

$$\Rightarrow V_o = V_i$$

So, the output voltage V_o of a voltage follower is equal to its input voltage V_i.

Thus, the gain of a voltage follower is equal to one since, both output voltage V_o and input voltage V_i of voltage followes are same.