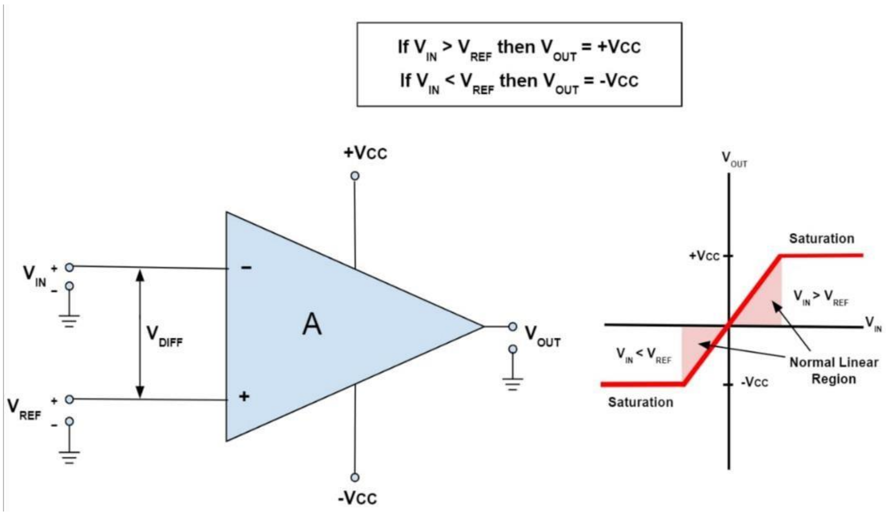
Operational Amplifier

An Operational Amplifier (op-amp) is a high gain amplifier used to perform a variety of function(add. , sub. , diff. , Integ.)Op-Amp for short, is an electronic component that amplifies the difference between two input voltages. It has a non-inverting input and an inverting input, and the output voltage is the difference between the voltages applied to the two inputs, amplified by the voltage gain of the Op-Amp.

Op-Amps are commonly used in electronic circuits because they have a very high input impedance and a low output impedance, which makes them suitable for interfacing with other electronic circuits. They can be configured in various ways, such as inverting amplifier, non-inverting amplifier, differential amplifier, integrator, differentiator, etc



Op-Amps are essential components in electronic circuits as they help in designing complex circuits and systems.

The diagram shows the basic components of an Op-Amp: the non-inverting input terminal (V+), the inverting input terminal (Vin), the output terminal (Vout), and the power supply terminals. The OpAmp amplifies the difference between the voltage applied to the non-inverting input terminal and the voltage applied to the inverting input terminal and outputs the amplified difference at the output terminal.

working

1. working of an Op-Amp can be explained in a few simple steps:

(a) Input voltage: The Op-Amp takes in two input voltages, one at the non-inverting input (V+) and the other at the inverting input (Vin).

(b) Amplification: The Op-Amp amplifies the voltage difference between the two input voltages by a factor called the voltage gain (A). The output voltage (Vout) is equal to the voltage gain by the voltage difference between the two input voltages (V+ - Vin).

(c) Feedback: The output voltage is fed back to the inverting input through a feedback network, which adjusts the input voltage to reduce the difference between the two input voltages. The feedback network can be in the form of a resistor or a combination of resistors and capacitors.

(d) Output voltage: The Op-Amp continues to amplify and adjust the input voltages until the difference between the two input voltages is reduced to zero. At this point, the output voltage reaches its maximum value and stabilizes.

TYPES OF OP-AMP

: Inverting Amplifier:

Input Voltage: In an inverting amplifier configuration, the input voltage is applied to the inverting input terminal (Vin) of the Op-Amp.

Feedback: A feedback resistor (Rf) is connected between the output terminal (Vout) and the inverting input terminal (Vin) of the Op-Amp.

Gain: The voltage gain of the inverting amplifier is equal to the ratio of the feedback resistor (Rf) to the input resistor (Rin), and is given by the formula: Vout/Vin = -Rf/Rin.

Phase Shift: The inverting amplifier introduces a 180-degree phase shift between the input and output signals.

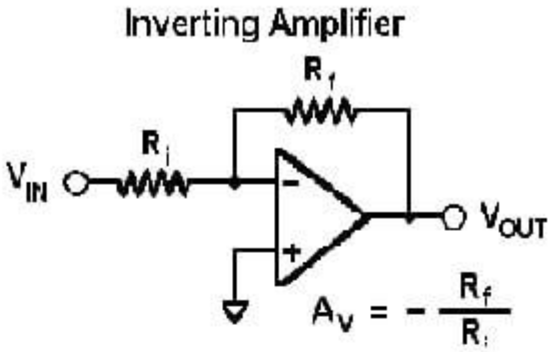
Non-inverting Amplifier:

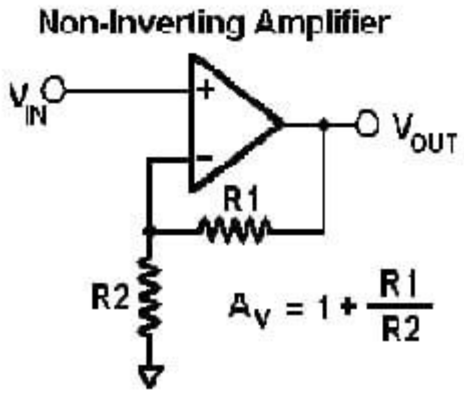
Input Voltage: In a non-inverting amplifier configuration, the input voltage is applied to the noninverting input terminal (V+) of the Op-Amp.

Feedback: A feedback resistor (Rf) is connected between the output terminal (Vout) and the noninverting input terminal (V+) of the Op-Amp.

Gain: The voltage gain of the non-inverting amplifier is equal to the ratio of the feedback resistor (Rf) to the input resistor (Rin) plus 1, and is given by the formula: Vout/Vin = 1 + Rf/Rin.

Phase Shift: The non-inverting amplifier does not introduce any phase shift between the input and output signals.





Advantages:

High gain: Op-Amps have very high voltage gain, which makes them suitable for amplifying weak signals.

Low output impedance: Op-Amps have low output impedance, which allows them to drive low impedance loads.

Flexibility: Op-Amps can be configured in various ways to suit different applications.

Stability: Op-Amps are highly stable and have predictable performance over a wide range of conditions.

Disadvantages:

Limited output voltage range: Op-Amps have a limited output voltage range, which can be a disadvantage in applications that require high output voltage.

Limited output current: Op-Amps have a limited output current, which can be a disadvantage in applications that require high output current.

Noise: Op-Amps can introduce noise into the signal, which can be a problem in applications that require low noise levels.

Cost: Op-Amps can be relatively expensive compared to other components.

Applications:

Signal conditioning: Op-Amps are commonly used for signal conditioning in sensor applications, such as temperature, pressure, and light sensors.

Amplifiers: Op-Amps are commonly used as voltage amplifiers in audio and other signal processing applications.

Filters: Op-Amps are commonly used to build various types of filters, such as low-pass, high-pass, band-pass, and notch filters.

Oscillators: Op-Amps are commonly used to build oscillators for generating sine, square, and triangle waves

Output Voltage Swing Curve: Shows the maximum and minimum output voltages that the Op-Amp can produce, as a function of the power supply voltage.

Slew Rate Curve: Shows the maximum rate of change of the output voltage

Offset Voltage Curve: Shows the relationship between the input offset voltage and the output voltage.

conclusion, op amps are highly versatile and widely used electronic components that are essential in modern electronics. Their high input impedance, high gain, and differential input make them suitable for a variety of applications, including amplification, filtering, and signal conditioning

https://github.com/Ashishpanwar123/OP-Amp/blob/main/Operational%20Amplifier.pdf