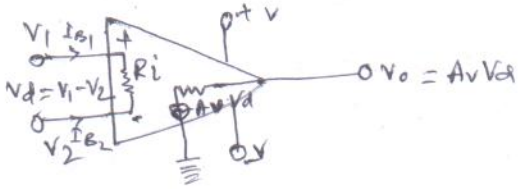
Characteristics of an ideal op-Amp :-

- The important characteristics of an ideal op-Amp. are as follows:

1. Infinite voltage gain ($A_v = \infty$) :- The open loop gain of an ideal op-Amp is denoted by A_v.

   The value of A_v for an ideal op-Amp is ∞.



Equivalent ckt diagram of an ideal op-Amp.

2. Infinite input resistance ($R_i = \infty$)
   - Input resistance is the total resistance measured b/w the two input terminals of op-Amp.
   - Due to this, the current flowing in each input terminal will be zero i.e $I_{B_1} = I_{B_2} = 0$

3. Zero output resistance ($R_o = 0$).
   - The output resistance of op-Amp is the resistance viewed from its output terminal.
   - The output resistance of an ideal op-Amp is zero.

4. Zero offset voltage.
   - The voltage which is produced at the output when both input voltages ($V_1 = V_2 = 0$) are zero is called offset voltage.
   - This means that for an ideal op-Amp output voltage is zero when input voltage is zero.

   $V_d = 0$, $V_o = A_v V_d = 0$.

5. Infinite Bandwidth :-
   - Bandwidth of an amplifier is the range of frequencies over which all the signal frequencies are amplified almost equally.
   - The bandwidth of an ideal op-Amp is ∞ so it can amplify any frequency signal from 0 to ∞ Hz.

6. Infinite CMRR :-
   The CMRR is the ability of op-Amp to reject common mode signal successfully

   ↑ Common mode signal arises due to noise at input terminal of op-Amp.

   - $CMRR = \frac{|A_v|}{|A_c|}$. For an ideal op-Amp CMRR is ∞ so that $A_c = 0$

7. Infinite slew rate ($S = \infty$)
   - Slew rate is defined as the maximum rate of change of output voltage with time i.e $S = \left.\frac{dV_o}{dt}\right|_{max}$.

     $V_o = A_v V_d$, $A_v = \infty$ for open loop gain. $\therefore V_o = \infty$,
     so, $S = \left.\frac{dV_o}{dt}\right|_{max} = \infty$.

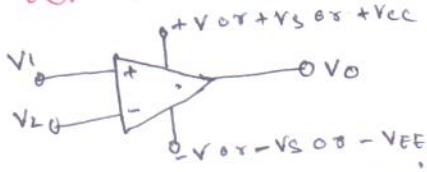
   - For an ideal op-Amp, slew rate is ∞.

However, a practical op-Amp deviates from these ideal characteristic. For exam. IC op-Amp - 741, open loop voltage gain $\simeq 2 \times 10^5$, input impedance $\simeq 2\,M\Omega$ output impedance $\simeq 75\,\Omega$, Unity gain freq. $\simeq 1$ MHz and input ~~off~~ offset voltage ~ 1 mV.

Operational Amplifier:-

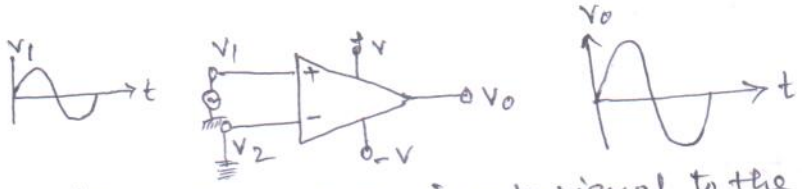
- The term op-Amp stands for "Operational Amplifier".
- An op-Amp is a high gain ($10^5 - 10^6$) amplifier which is used to perform variety of operations such as amplification, addition, subtraction, differentiation, integration etc.
- Advantages of op-Amp over conventional amplifier:-
  1. It has smaller size
  2. It has less power consumption
  3. It is easy to replace
  4. Low cost.
  5. High reliability.

Symbol & terminals:-



An op-Amp has atleast following 5 terminals:

1. The non-inverting input terminal marked as '+'.
2. The inverting input terminal marked as '−'.
3. The positive supply voltage +V.
4. The negative supply voltage −V.
5. The output terminal Vo.



- If we connect the input signal to the non-inverting terminal, then the amplified output signal is in phase with the input signal as shown in fig.

- If we connect the input signal to the inverting terminal, then the amplified output signal is 180° out of phase w.r.to the input signal as shown in fig.