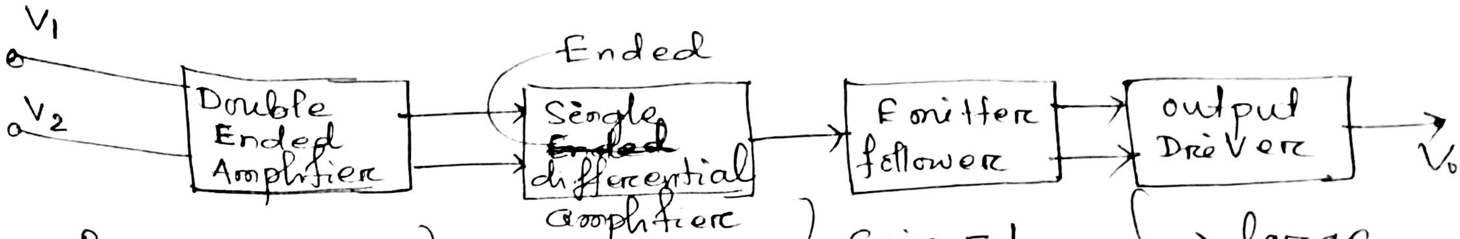
(1)

2 Mark

MODULE - III (BE)

BASI BLOCK-diagram of OP-AMP (operational amplifier)



Provide Maximum Voltage gain

i.e $\frac{V_o}{V_i}$ = very high

Provide differential gain.

→ Gain = 1
→ high input Resistance
→ low output ~~put~~ Resistance.

→ large output Voltage or, current

6 marks Parameters of OP-Amp

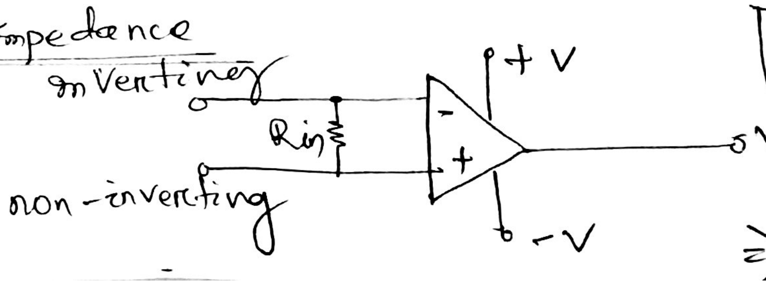
The parameters of op-Amps are

1) Voltage gain
2) Input resistance (impedence)
3) output impedance.
4) Input offset voltages
5) Input offset current
6) Input Bias current
7) Bandwidth.

(1) Votage gain :

$$\text{Gain} = \frac{\text{output Voltage}}{\text{Input Voltage}}$$

(2) Input Impedance

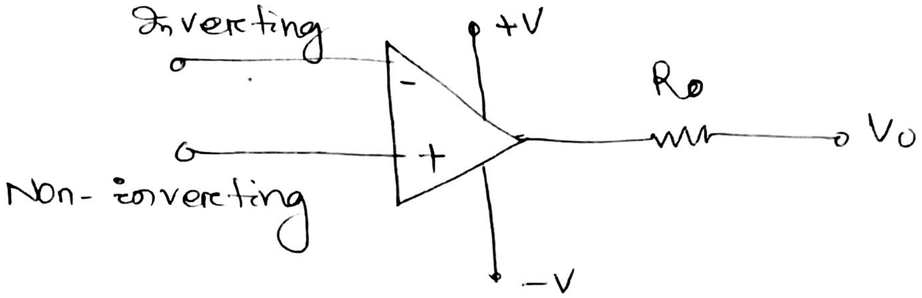


Votage drop at input is very high

$\boxed{R_{in} = \infty}$

since $V = IR$ = high
$\Rightarrow R \rightarrow$ very high

3 output Impedance



Ro = output Impedance.

→ The resistance offered by the output of an op-amp is called as ~~and~~ output impedance.

→ All the output of an Op-Amp must be passed to the next device.

→ The voltage drop at output must be 0

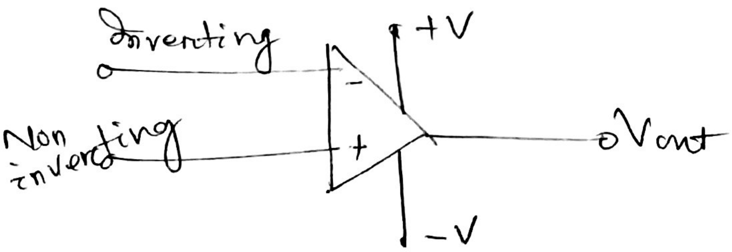
i.e, $V_{out} = 0$

$\Rightarrow V \times R = 0$

$\Rightarrow$ ~~R should~~ 1

$\Rightarrow$ R should be very very low

4 Input off set voltage



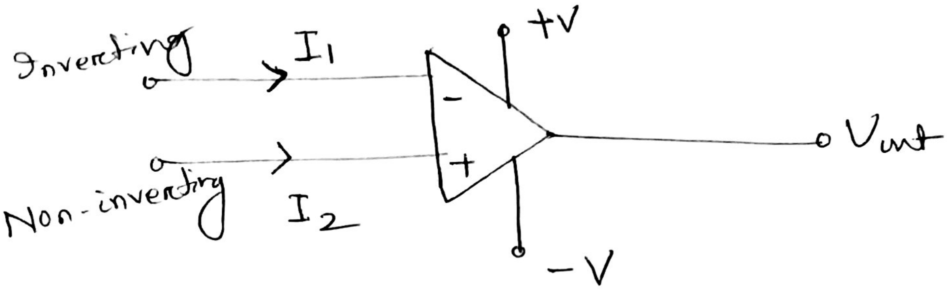
If i/p Voltage = 0 Volt

$\Rightarrow$ out voltage Should be zero voltage) (ideal)

(Practical Non zero)

$\Rightarrow$ we need to apply Some dc voltage at the input terminal to ~~for~~ force the output voltage to be Zero. This applied Voltage is called as input-off set voltage.

(5) Input off-set current



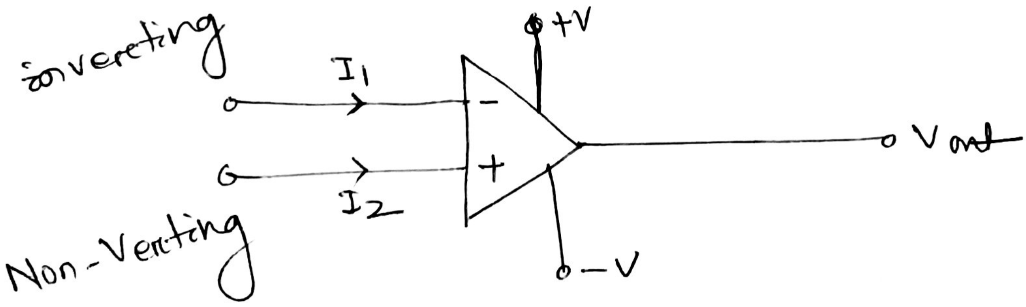
Input offset Current $= \boxed{I_1 - I_2}$

OR

$\boxed{I_2 - I_1}$

The difference between the currents into the two terminals when output is hold at zero is called as "input offset current"

(6) Input Bias Current



at $V_{out} = 0$

input offset current $= \frac{I_1 - I_2}{2}$

The average of the current into the two input terminals with the output at Zero volt is called as input Bias current.

(7) Bandwidth

The range of frequencies for which an op-Amp can be used is called as Bandwidth of an op-Amp

Parameter	Ideal op-Amp	Practical op-Amp
→ Voltage gain →	∞	→ very high
→ Input impedance →	∞	→ 2MΩ (very high)
→ Bandwidth →	∞	→ 1 MHz
→ output impedance →	Zero	→ 75 Ω
→ Input offset voltage →	zero volt	→ 2mV
→ Input offset current →	Zero Amp	→ 20 nAmp.
→ Input Bias current →	Zero	→ 80 nAmp

Q Write few properties of An Ideal-OPAmp

(Ans)

(i) infinite (∞) i/p impedance

(ii) Zero output impedance.

(iii) Infinite open-loop gain.

(iv) Infinite Bandwidth.

(v) Zero noise contribution

(vi) Zero DC output offset voltage and current

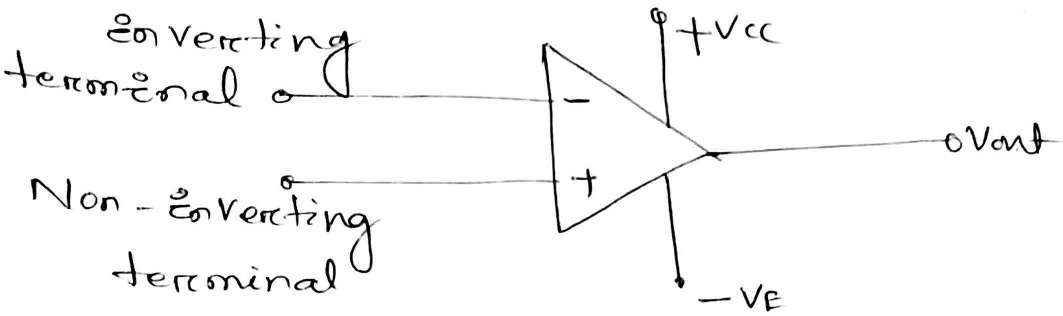
(vii) ∞ CMRR (common-mode Rejection Ratio)

12/6/10

What is OP-Amp ? write few application of OP-Amp

(Ans) OP-Amp stands for Operational Amplifier.

Symbol



→ It is an electronic device that can perform various mathematical operations such as

→ addition
→ Subtraction
→ integration
→ differentiation

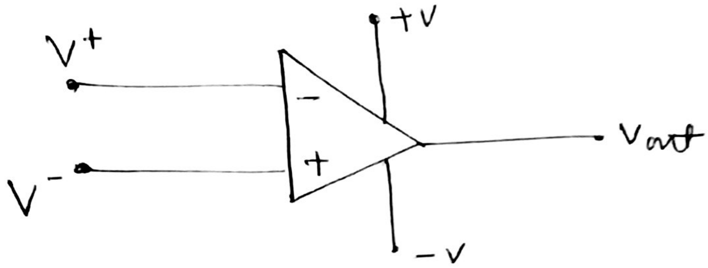
→ OP-Amp can also be used for a variety of applications such as

→ AC and DC signal amplification
→ in active filter
→ oscillators
→ Regulators,
→ Comparators
→ Converters.

2 marks

Q– Define CMRR (Common Mode Rejection Ratio)

$$CMRR = \frac{A_{OL}}{A_{CM}}$$

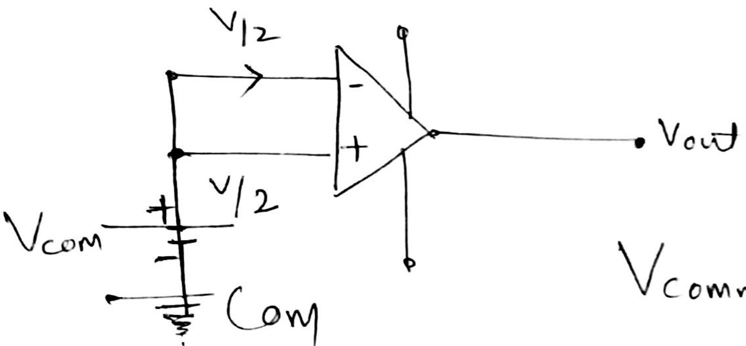


open loop gain

$$A_{OL} = \frac{V_{out}}{V^+ - V^-}$$

A_{OL} = open loop voltage gain

A_{CM} = common mode voltage gain.



V_{common} =

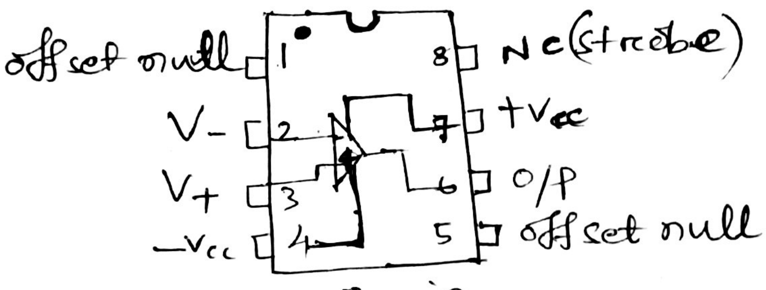
V_{common}

A_{CM} = commo mode gain

$$A_{CM} = \frac{V_{out}}{V_{com}}$$

Generally, the op-Amp as two input terminals Which ~~are~~ are positive and negative terminal and the two inputs are applied at the same point, Ther give the opposite polarity signals at the output ∴ Hence the +ve and -ve voltages of the terminals will cancel out and it will give the resultant output

OPAMP Pin configuration



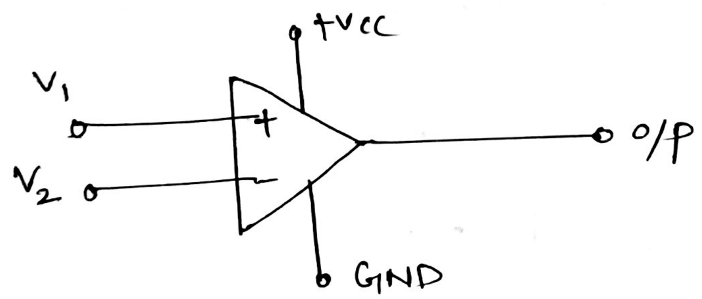
→ The output of OP AMP should be zero, when the voltage difference between the input is zero.

→ But in most of OP-Amps, the output will not be zero, when off there will be a minute voltage from it.

→ 4 Types of gain in OPAMP's

1) voltage gain – voltage in and voltage out
2) Current gain – Current in and current out.
3) Transconductance – Voltage in and current out.
4) Trans-resistance – Current in and voltage out.

OPAMP - Amplification



→ The amplified output signal from the output Amp is the difference between the two input signals.

If both the inputs are supplied with the same voltage the Op-Amp will then takes the difference between the two voltages and it will be Zero

→ The Op-Amp will then takes the difference between the two voltages and it will be Zero

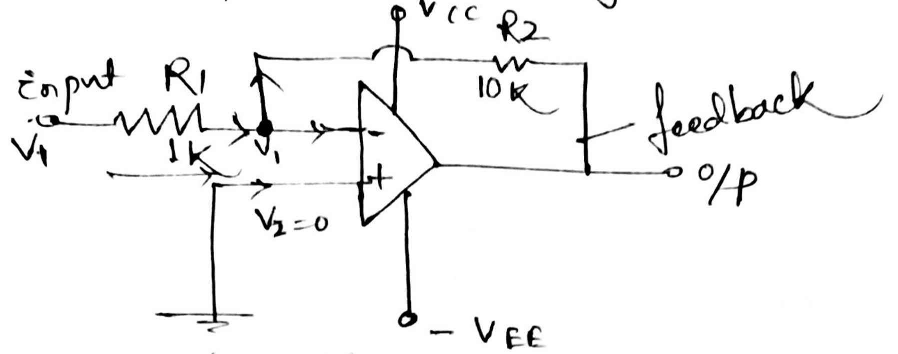
→ $A_v = \frac{V_o}{V_i} = \frac{\cancel{\infty}}{\Delta V_i} \cancel{\infty} = \frac{V_o}{0} = \infty$

→ The op Amp will multiply with ~~this~~ its gain 1,000000

So the output voltage is zero

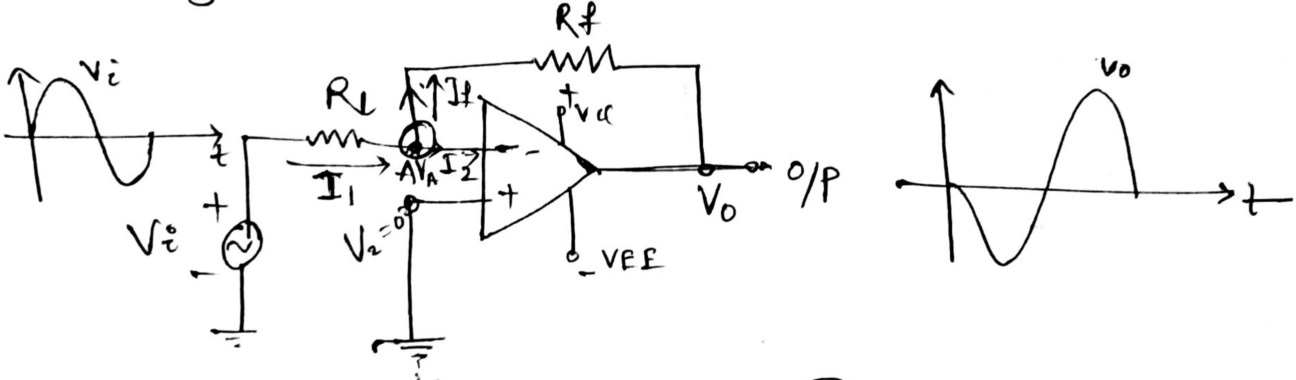
When 2 volts is given to one input, and 1 volt in the other, then the op-Amp will takes its difference and multiply with gain. that is also ~~yeat~~ yeild 1 Volt X 1,000000, But this gain is also very high.

→ So to reduce the gain, feedback from the output to the input is usually done through a resistor



Inverting Amplifier :—

An op-Amp circuit that produces a amplified output signal that is 180° out of phase with the input signal.



Applying KCL at node (A)

$$I_1 = I_F + \cancel{I_2}^{\,0} \qquad \because V_A = 0 \text{ Virtual}$$

$$\Rightarrow I_1 = I_F$$

$$\Rightarrow \frac{V_i - V_A}{R_1} = \frac{V_A - V_0}{R_f} \quad \text{——— (1)}$$

In ideal op-amp $V_1 = V_2$

$V_1 = 0$, $\Rightarrow V_1 = V_2 = 0 = V_A$.

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

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

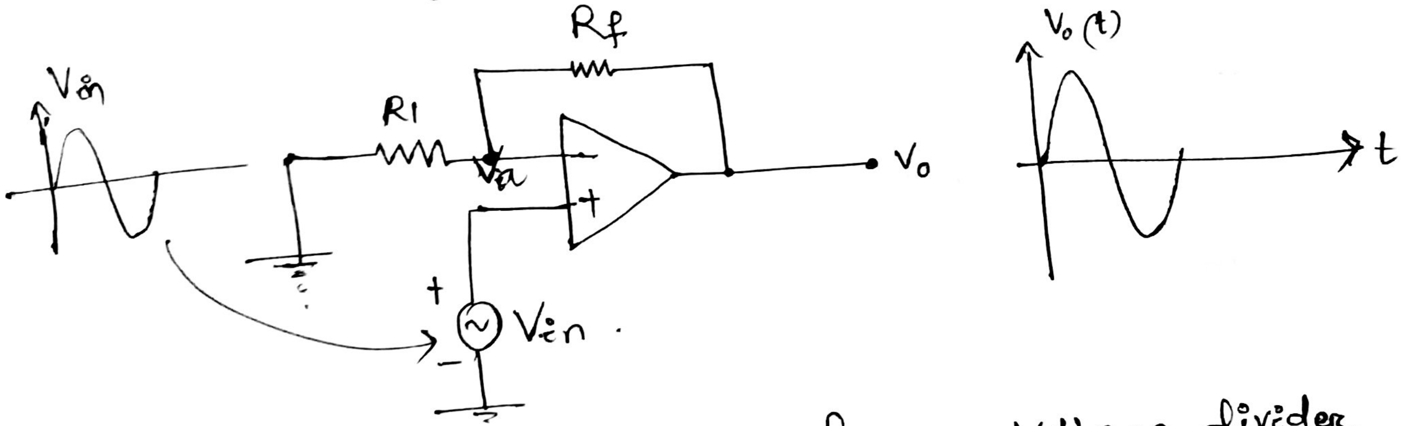
$$\Rightarrow \boxed{\frac{V_o}{V_i} = \frac{-R_f}{R_1}}$$

$$= \quad A_v = \text{voltage gain} = \frac{V_o}{V_i}$$

$$\Rightarrow \boxed{A_v = \frac{-R_f}{R_1}}$$

2 Non-Inverting Amplifier

A non-inverting amplifier is an op-Amp circuit designed to Provide positive gain. The input is directly applied to non-inverting terminal



→ The Resistance Rf and R_1 form a Voltage divider

$$\Rightarrow \quad V_a = \frac{V_o \times R_1}{R_1 + R_f}$$

From concept of Virtual ground.

$$\boxed{V_{in} = V_a}$$

$$\Rightarrow V_{in} = \frac{V_o \times R_1}{R_1 + R_f} \quad \Rightarrow \quad V_o = \frac{V_{in}(R_1 + R_f)}{R_1}$$

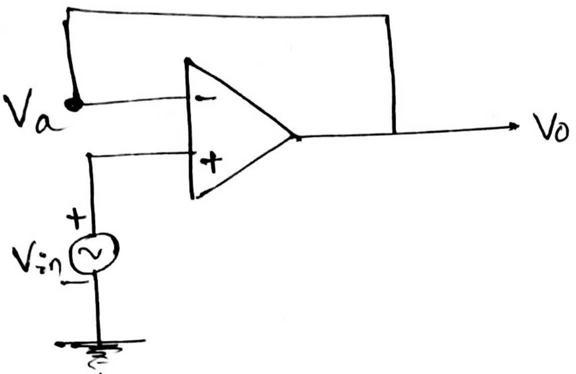
$$\Rightarrow V_o = \left(1 + \frac{R_f}{R_1}\right) V_{in}$$

$$\Rightarrow \frac{V_o}{V_{in}} = \boxed{A_v = 1 + \frac{R_f}{R_1}}$$

Application of Non-inverting Amplifier as

Voltage follower

A voltage follower is an op-Amp circuit in which output follows the input. It is also called as unity gain Buffer amplifier



due to physical short circuit

$\rightarrow V_a = V_o$

due to Virtual ~~ground~~ ground concept

$$V_a = V_{in}$$

$$\Rightarrow V_{in} = V_o$$

$$\Rightarrow A_v = \frac{V_o}{V_{in}} = 1$$

→ It is used as buffer

→ It is also used in instrumentation amplifier.