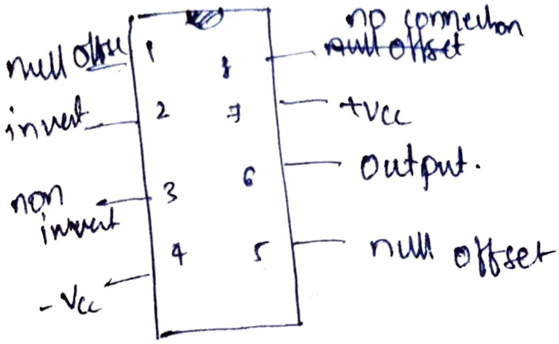
Assignment - I

62014 4.

1). Amplifiers which performs operations like addition, subtraction, division, multiplication, integration, differention many more on applied input voltage are known as Operational amplifers.



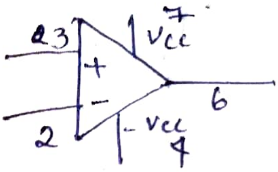
Ideal conditions:

→ $A_d = \infty$ (differential gain)

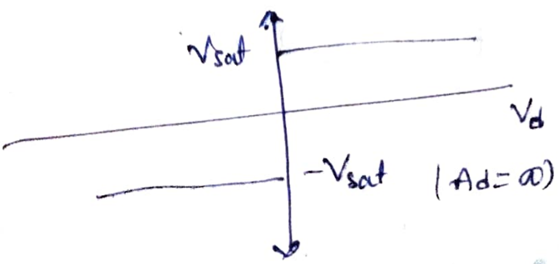
→ CMRR = ∞. Slew rate = ∞

→ $R_{input} = \infty$, Bandwidth = ∞

→ $R_o = 0$. → output voltage will be zero if offset voltage is zero.

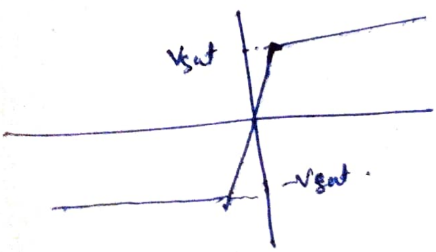


2) Ideal Transfer characteristic of OPMP



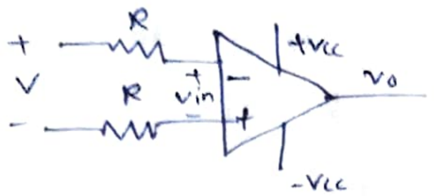
Here (ideally) whenever there is -ve V_d. V_o will be -Vsat and when there is +ve V_d. V_o will change +Vsat.

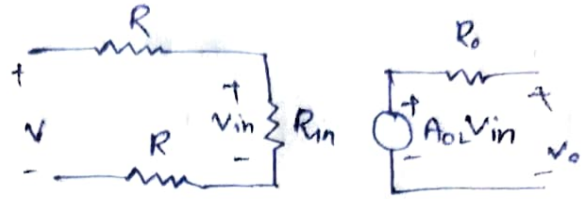
Practical OPAMP:



But in practical there will not be any sudden change to -Vsat to +Vsat. it will take some time to change.

3). measurement of input Resistance of OPAMP.





(equivalent circuit)

case 1: $R=0 \Rightarrow V=Vin$

$$V_o = A_{OL}V \Rightarrow A_{OL} = \frac{V_o}{V}$$

case 2: $R \neq 0$

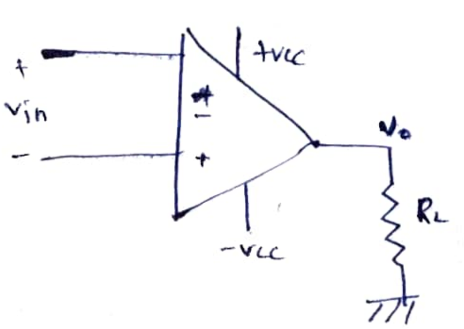
$$Vin = \frac{V}{Rin+2R} \times Rin \qquad \left(\because I \text{ in loop} = \frac{V}{Rin+2R}\right)$$

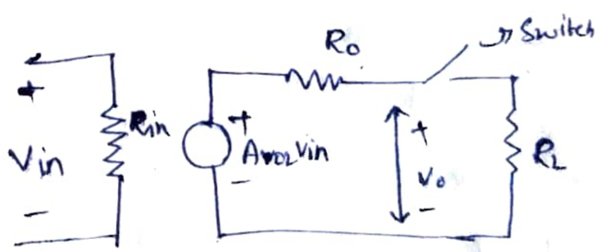
$$V_o' = \frac{A_{OL} \times V Rin}{Rin+2R} \qquad \left(\because V_o' = A_{OL} Vin\right)$$

$\Rightarrow \quad V_o' Rin + 2RV_o' = A_{OL} V Rin$

$$\boxed{Rin = \frac{2RV_o'}{A_{OL}V - V_o'}}$$ input resistance of OPAMP.

measurement of output resistance of OPAMP:





(equivalent ckt)

case 1: (switch is open)

$$V_o = A_{OL} Vin \Rightarrow A_{OL} = \frac{V_o}{Vin}$$

case 2 (switch is closed)

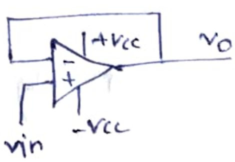
$$\frac{A_{OL} V_{in}}{R_o + R_L} \times R_L = V_o'$$

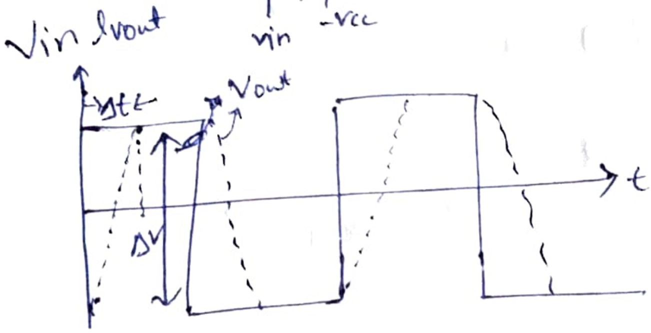
$$\Rightarrow A_{OL} V_{in} R_L = V_o' R_o + V_o' R_L$$

$$\boxed{R_L = \frac{V_o' R_o}{A_d V_{in} - V_o'}}$$

output Resistance of OPAMP.

4) measurement of slew rate:

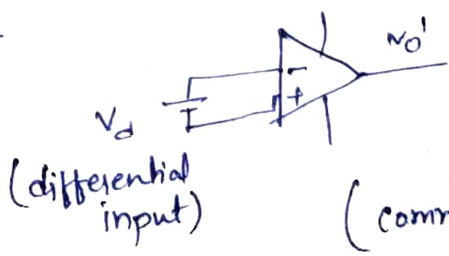




$$S.R = \frac{dV_o}{dt} = \frac{\Delta V}{\Delta t}$$

→ measurement of CMRR:

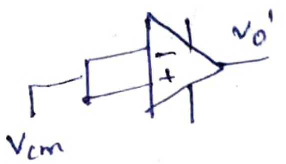
case-1



$$CMRR = \frac{A_d}{A_c}$$

(common mode input = 0, $\frac{V_1 + V_2}{2} = 0$)

case-2



(common mode input)

(Same o/p. as in case 1)

(Differential i/p = 0)

$$\therefore CMRR = \frac{A_d}{A_c} = \frac{V_o'/V_d}{V_o'/V_{cm}} = \frac{V_{cm}}{V_d}$$

(V_o' is a constant).

w.r.t $V_o = A_d V_d + A_c V_c$

in case ① → $V_o' = A_d V_d$. ($\because V_c = 0$)

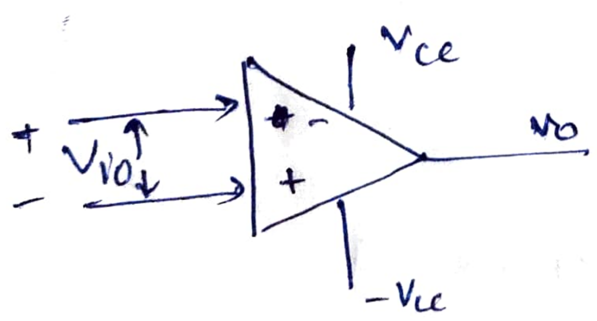
case ② → $V_o' = A_c V_{cm}$ ($\because V_d = 0$)

$$\boxed{CMRR = \frac{A_d}{A_c} = \frac{V_{cm}}{V_d}.}$$

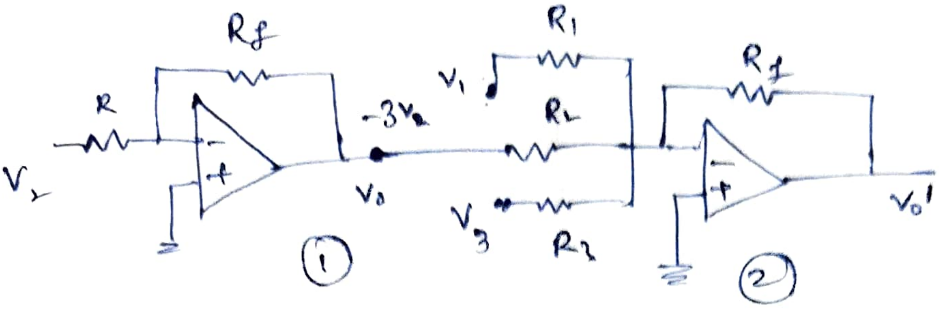
5) → let us take V_{cc1} corresponding to input offset voltage V_{io1}

→ let us take V_{cc2} corresponding to input offset voltage ~~Vio~~ V_{io2}

now $PSRR = \frac{dV_{io}}{dV_{cc}} = \frac{V_{io2} - V_{io1}}{V_{cc2} - V_{cc1}}$ //



6). $V_o' = -2V_1 + 3V_2 - 4V_3$



$\frac{R_f}{R} = 3$

$R_f = 3R$

$R = 10k$

$R_f = 30k$

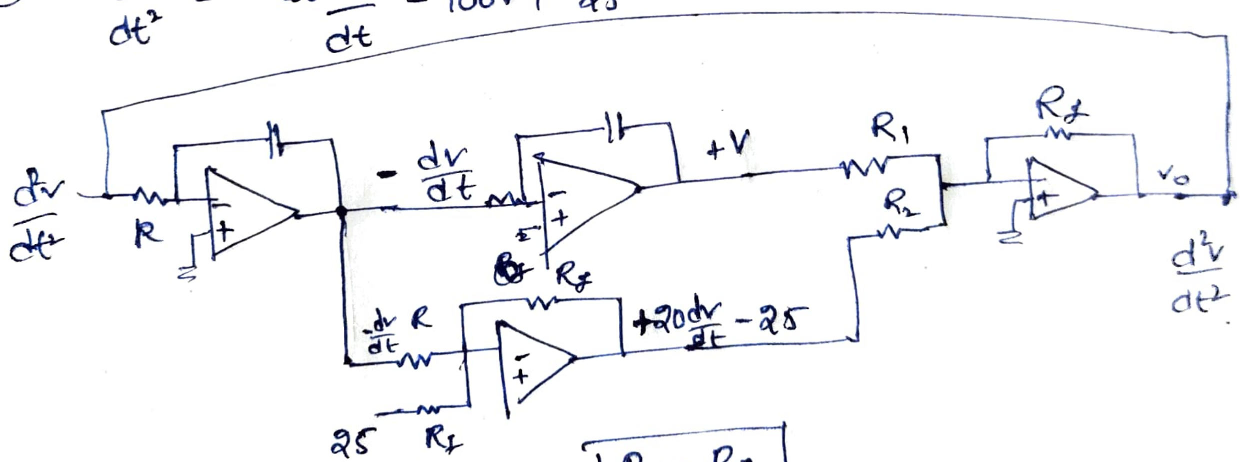
$V_o' = -\frac{R_f}{R_1} V_1 + \frac{-R_f}{R_2} V_o - \frac{V_3 R_f}{R_3}$

$-2V_1 + 3V_2 - 4V_3 = -\frac{R_f}{R_1} V_1 + \frac{R_f}{R_2} \cdot 3V_2 - \frac{V_3 R_f}{R_3}$

$\frac{R_f}{R_1} = 2$ | $\frac{R_f}{R_2} = 1$ | $\frac{R_f}{R_3} = 4$

$R_1 = 15k$ | $R_2 = 30k$ | $R_3 = 7.5k$

(7) $\frac{d^2 v}{dt^2} = -20\frac{dv}{dt} - 100v + 25$



$\boxed{R_2 = R_f}$

$\frac{R_f}{R} = 20$

$R_f = 10k\,\Omega$

$R = 0.5k\,\Omega$

$\frac{R_F}{R_1} = 100$

$R_1 = 100\,\Omega$