

# Plant Implementation through OP-Amps

$$G = \frac{1}{s^2 + 3s + 4}$$

differential Eqns:

$$G = \frac{Y}{X} = \frac{1}{s^2 + 3s + 4}$$

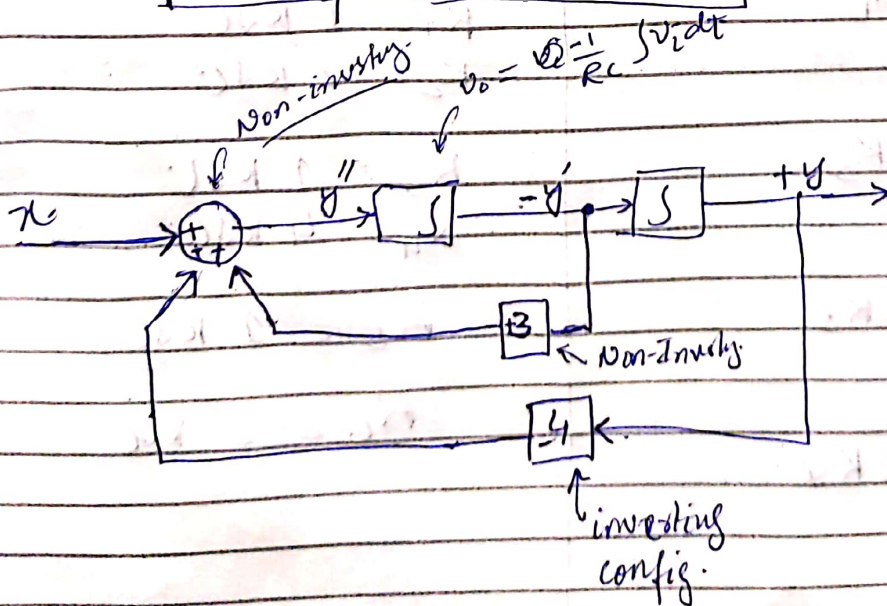
$$Y(s^2 + 3s + 4) = X$$

$$s^2 Y + 3sY + 4Y = X$$

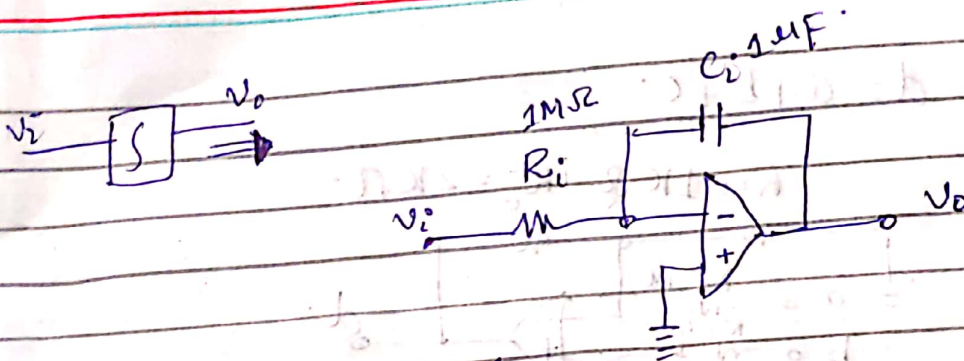
$$y'' + 3y' + 4y = x$$

$$y'' = x - 3y' - 4y$$

$$y = \frac{1}{4} (x - y'' - 3y')$$



## Blocks.

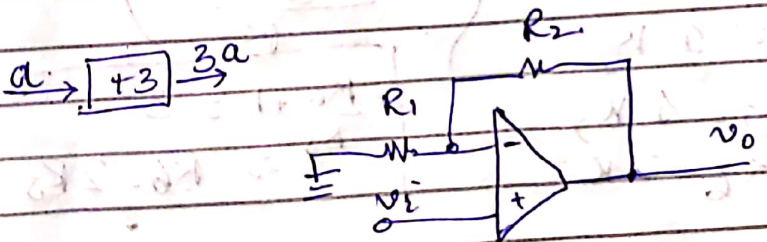


$$v_o = -\frac{1}{R_i C_i} \int v_i dt$$

in our case

$$\frac{1}{R_i C_i} = 1 \Rightarrow R_i C_i = 1$$

$$\text{Let } C_i = 1\mu F, \Rightarrow R_i = 1M\Omega$$

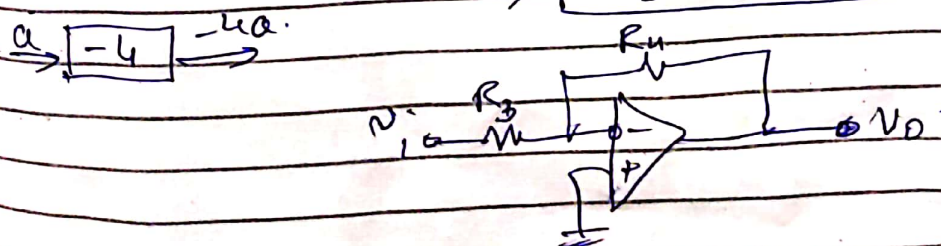


$$v_o = v_i \left( \frac{R_2 + 1}{R_1} \right) \text{ in our case.}$$

$$v_o = 3v_i \Rightarrow \frac{R_2 + 1}{R_1} = 3$$

$$\Rightarrow R_2 = 2R_1$$

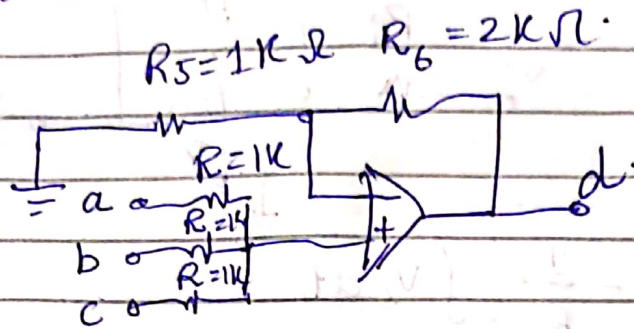
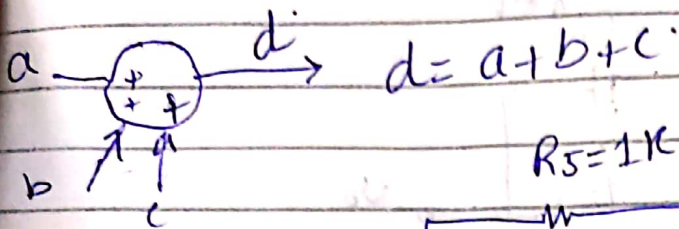
$$\text{Let } \boxed{R_1 = 3k\Omega,} \\ \Rightarrow \boxed{R_2 = 6k\Omega}$$



$$v_o = -\frac{R_4}{R_3} v_i \text{ here } v_o = -4 v_i$$

$$\Rightarrow \frac{R_4}{R_3} = 4 \quad \text{Let } \boxed{R_3 = 1k\Omega} \\ \Rightarrow \boxed{R_4 = 4k\Omega}$$





$$\text{hence } d = \left( \frac{R_6 + 1}{R_5} \right) \left( \frac{\frac{a}{R} + \frac{b}{R} + \frac{c}{R}}{\frac{1}{R} + \frac{1}{R} + \frac{1}{R}} \right)$$

$$d = \left( \frac{R_6 + 1}{R_5} \right) \left( \frac{\frac{a+b+c}{R}}{3/R} \right)$$

$$\text{Let } R = 1k$$

$$R_5 = 1k$$

$$R_6 = 2k$$

$$\frac{R_6 + 1}{R_5} = 3$$

$$\Rightarrow R_6 = 2R_5$$

$$\therefore d = 3 \left( \frac{a+b+c}{3} \right)$$

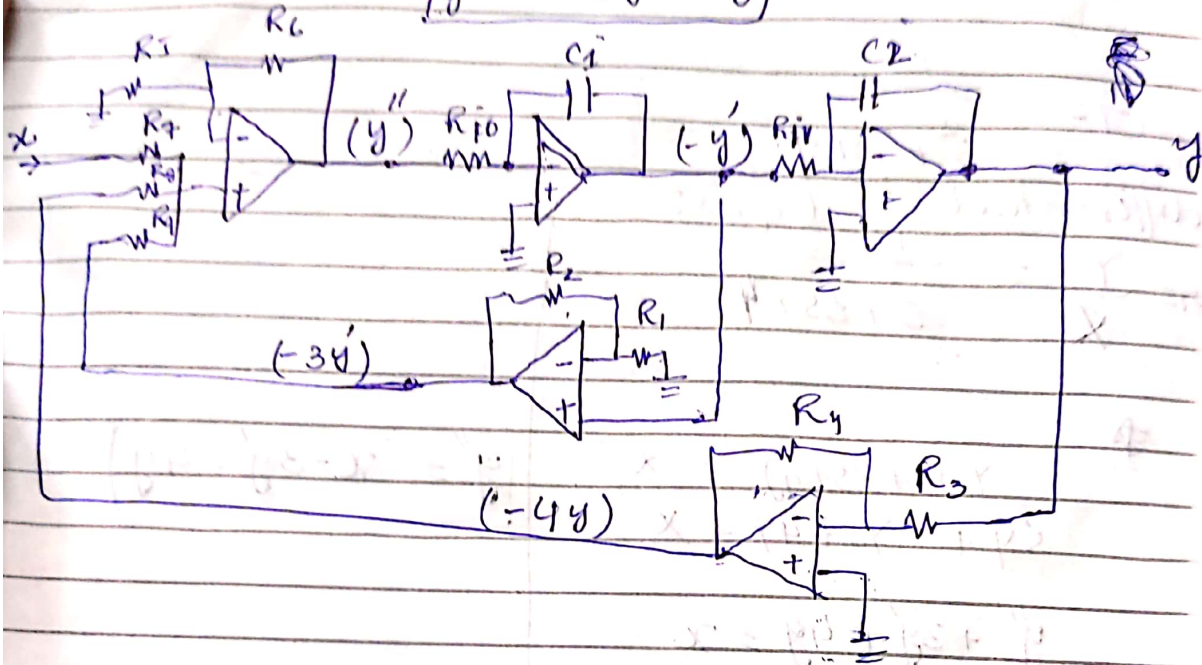
$$\boxed{d = a + b + c}$$

(4)

# Circuit of plant

$$y'' = x + (-3y') + (-4y)$$

$$[y'' = x - 3y' - 4y]$$



~~$R_1 = 1$~~

$R_2 = 2 R_1$

$R_4 = 4 R_3$

$R_6 = 2 R_5$

~~$R_7 = 1 K\Omega$~~   
 $R_6 = R_7 = R_8 = R_9$

$R_{10} C_1 = 1$   
 $R_{11} C_2 = 1$

~~$R_1 = 1 M\Omega$~~   
 ~~$C_1 = 1 \mu F$~~

$R_1 = 1 K\Omega$

$R_2 = 2 K\Omega$

$R_3 = 1 K\Omega$

$R_4 = 4 K\Omega$

$R_5 = 1 K\Omega$

$R_6 = 2 K\Omega$

$R_7 = 1 K$

$R_8 = 1 K$

$R_9 = 1 K$

$R_{10} = R_{11} = 1 M, C_1 = C_2 = 1 \mu F$