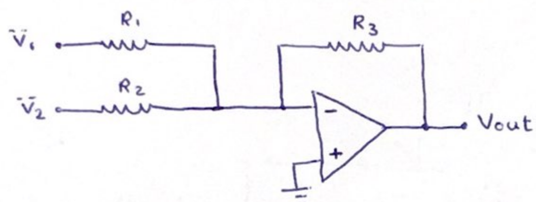
In the name of God

Assignment 10 :

1. Design a circuit which its output voltage is according to the following relation. V_1 and V_2 are the input voltage.

$$V_{out} = 4\bar{V}_1 + 3\bar{V}_2$$

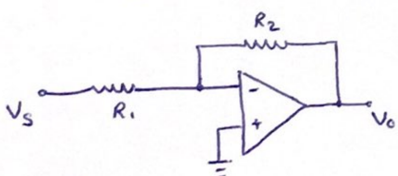
می داریم :



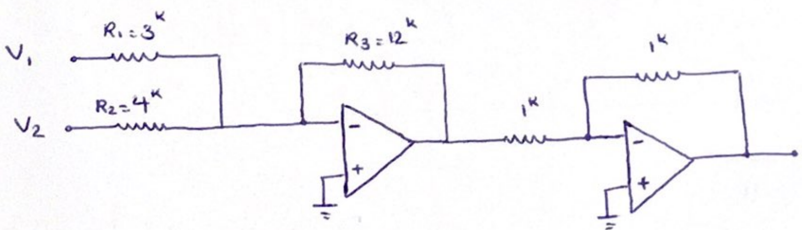
$$V_{out} = (-)\left(\frac{R_3}{R_1}V_1 + \frac{R_3}{R_2}V_2\right) \longrightarrow \begin{cases} \frac{R_3}{R_1} = 4 \Rightarrow R_3 = 4R_1 \\ \frac{R_3}{R_2} = 3 \Rightarrow R_3 = 3R_2 \end{cases} \Rightarrow R_1 = \frac{3}{4}R_2$$

با فرض : $R_2 = 4^k \Rightarrow R_1 = 3^k \;,\; R_3 = 12^k$

با سری کردن یک بافر با گین ۱- در خروجی مدار : خنثی کردن ⊖



می داریم : $\frac{V_o}{V_s} = \frac{-R_2}{R_1} \xrightarrow{R_2 = R_1 = 1^k} \boxed{A_v = -1}$



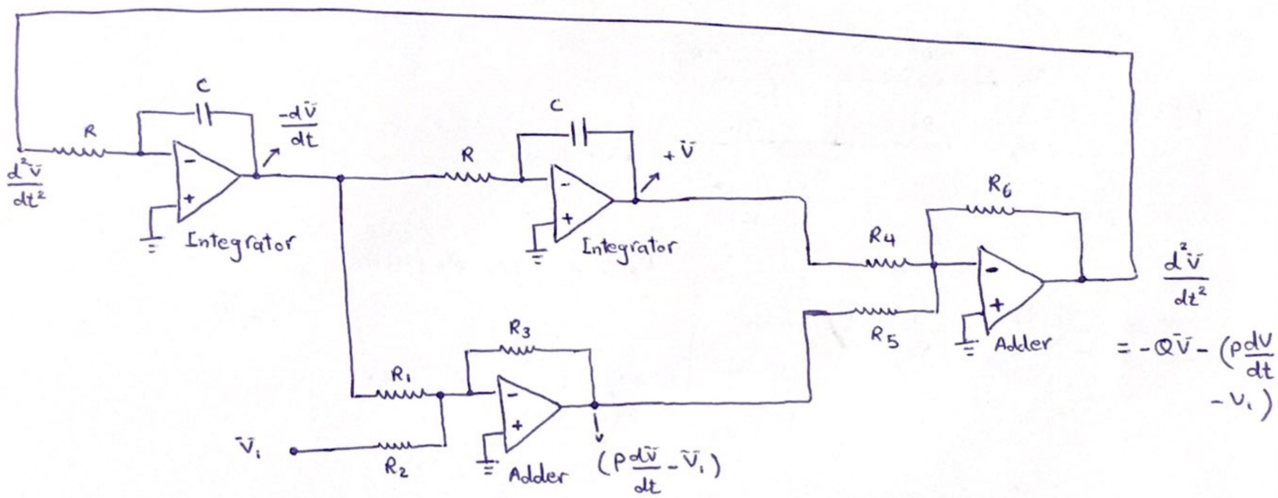
$\boxed{V_{out} = 4\bar{V}_1 + 3\bar{V}_2}$

2. Design a circuit wich solves the following diffrential equation.

$$\frac{d^2\bar{V}}{dt^2} = -20\frac{d\bar{V}}{dt} - 100\bar{V} + 25$$

در حالت کلی داریم : $\frac{d^2\bar{V}}{dt^2} + P\frac{d\bar{V}}{dt} + Q\bar{V} = \bar{V}_1 \implies \frac{d^2\bar{V}}{dt^2} = \bar{V}_1 - Q\bar{V} - P\frac{d\bar{V}}{dt}$

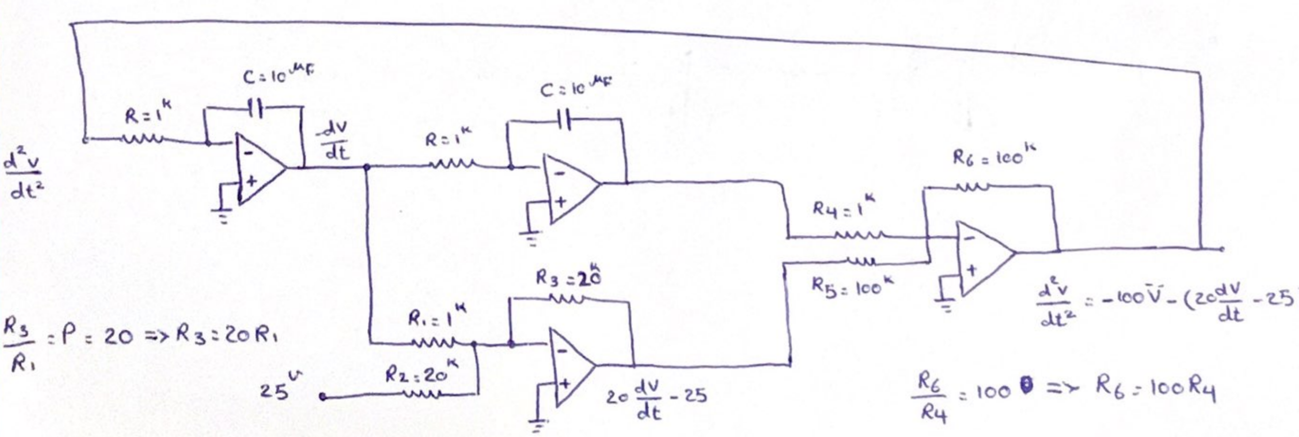
$$= (-Q\bar{V}) - \left(P\frac{d\bar{V}}{dt} - \bar{V}_1\right)$$



$$\begin{cases} \frac{R_3}{R_1} = P \\ R_2 = R_3 \end{cases} \qquad \begin{cases} \frac{R_6}{R_4} = Q \\ R_5 = R_6 \end{cases}$$

$$\frac{d^2\bar{V}}{dt^2} = 25 - \underbrace{100}_{Q}\bar{V} - \underbrace{20}_{P}\frac{d\bar{V}}{dt}$$

$$= -100\bar{V} - \left(20\frac{d\bar{V}}{dt} - 25\right)$$

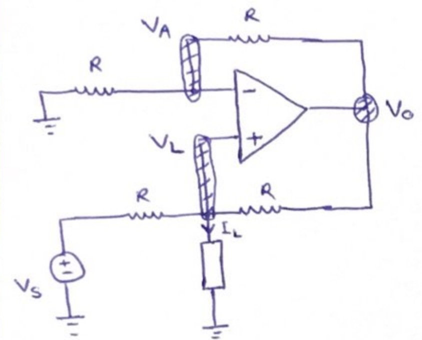


$\frac{R_3}{R_1} = P = 20 \Rightarrow R_3 = 20R_1$

$\frac{R_6}{R_4} = 100 \Rightarrow R_6 = 100R_4$

3. In the following Circuit which acts as a current Source, determine V_s and R such that the output current (I_L) will be 5^{mA}. Assume Ideal op Amp.

b) Considering $V_s = 1^V$ and $R = 1^K$, if the output resistance of the opAmp equal $1^{K\Omega}$, determine A_v (voltage gain of the opAmp) so that the output resistance of the Current Source will be $1^{M\Omega}$.



$$\text{KCL @ } V_A: \frac{V_A - 0}{R} + \frac{V_A - V_o}{R} = 0 \Rightarrow \boxed{V_o = 2V_A}$$

$$V_A = V_L \longrightarrow \boxed{V_o = 2V_L}$$

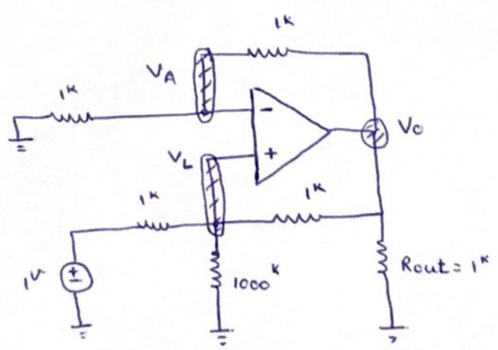
$$\text{KCL @ } V_L: \frac{V_L - V_s}{R} + \frac{V_L - V_o}{R} + I_L = 0$$

$$\Rightarrow \frac{V_L}{R} - \frac{V_s}{R} + \frac{V_L}{R} - \frac{V_o}{R} + I_L = 0$$

$$\frac{2V_L}{R} - \frac{V_s}{R} - \frac{V_o}{R} + I_L = 0 \xrightarrow{V_o = 2V_L} \boxed{I_L = \frac{V_s}{R}}$$

$$\Rightarrow 5^{mA} = \frac{V_s}{R} \xrightarrow{\text{Assume } R = 1^K} \boxed{V_s = 5^V}$$

b) $\begin{cases} V_s = 1^V \\ R = 1^K \end{cases}$



$$\text{KCL @ } V_A: \frac{V_A - V_o}{1^K} + \frac{V_A - 0}{1^K} = 0 \Rightarrow \boxed{\frac{2V_A}{1^K} = \frac{V_o}{1^K}} \Rightarrow V_A = V_L = \tfrac{1}{2} V_o \quad (I)$$

$$\text{KCL @ } V_L: \frac{V_L - 1}{1^K} + \frac{V_L - 0}{1000^K} + \frac{V_L - V_o}{1^K} = 0 \Rightarrow V_L\left(\frac{1}{1^K} + \frac{1}{1000^K} + \frac{1}{1^K}\right) - \frac{1}{1^K} = \frac{V_o}{1^K}$$

$$\xrightarrow{(I)} \tfrac{1}{2} V_o (2.001) - 1 = V_o \Rightarrow 0.0005 V_o = 1 \Rightarrow V_o = \frac{1}{0.0005} = \boxed{2000}$$

$$A_v = \frac{V_o}{V_s} = \frac{2000}{1^V} = \boxed{2000}$$