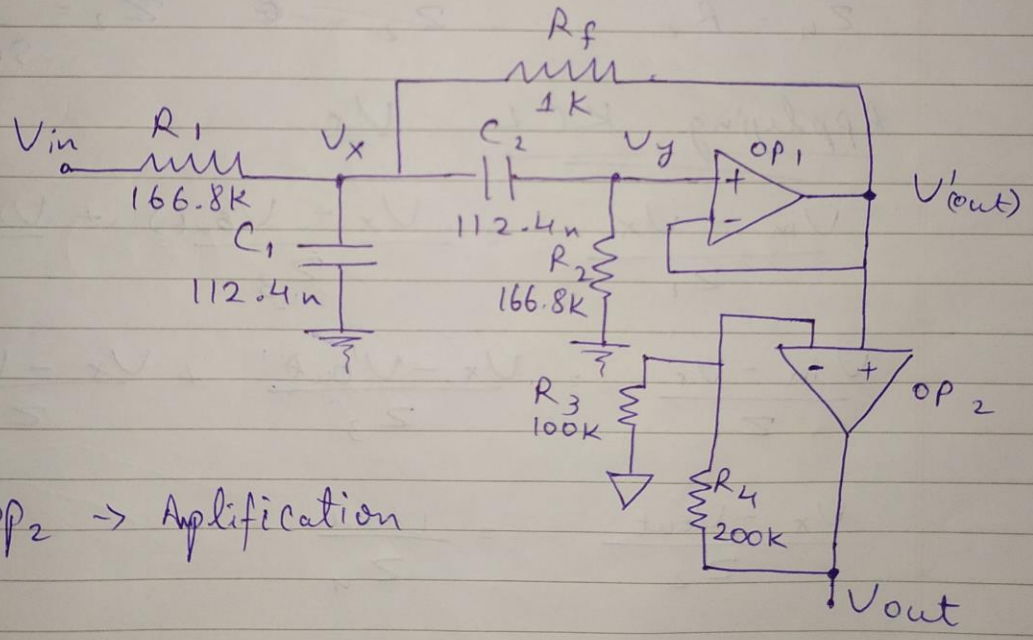
DAKSH AGARWAL IMT2019505

a) I studied different types of bandpass filter for my frequency the sallen key worked best.

In Sallen-Kay my f_3 & f_5 were already below 0.75V so no need for cascading.



op_2 → Application

b) No cascading needed because desired bode plot ie f_4→peak f_3 & f_5 below 0.75 was obtained.

c) $Z_1 = R_1$ $\quad Z_3 = R_f$

$Z_4 = R_2$ $\quad Z_2 = \infty$ $\quad Z_2 = \frac{1}{SC}$

Applying KCL $\quad V_x$

$$\frac{V_{in} - V_x}{Z_1} = \frac{V_x - V'_{out})}{Z_3} + \frac{V_x - V_y}{Z_2}$$

$$\frac{V_{in} - V_x}{Z_1} = \frac{V_x - V'_{out}}{Z_3} + \frac{V_x - V_{out}}{Z_2}$$

$$\frac{V_x - V_{out}}{Z_2} = \frac{V_{out}}{Z_4}$$

$$V_x = V'_{out}\left(\frac{Z_2}{Z_4} + 1\right)$$

$$V_{in} - V_{out}\left(\frac{Z_2}{Z_4} + 1\right)$$

$$\frac{V_{in} - V_{out}\left(\frac{Z_2}{Z_4} + 1\right)}{Z_1} = \frac{V'_{out}\left(\frac{Z_2}{Z_4} + 1\right) - V_{out}}{Z_3} + \frac{V'_{out}\left(\frac{Z_2}{Z_4} + 1\right) - V_{out}}{Z_2}$$

$$\frac{V'_{out}}{V_{in}} = \frac{Z_3 Z_4}{Z_1 Z_2 + Z_3(Z_1 + Z_2) + Z_3 Z_4}$$

Let $G_1 = 1 + \frac{R_b}{R_a}$ [where in our circuit $R_a \to \infty$ i.e $\frac{R_b}{R_a} = 0$]

On including

R_1 R_2 R_f C_1 C_2

we get

$$\Rightarrow \frac{\left(1 + \frac{R_b}{R_a}\right)\frac{s}{R_1 C_1}}{s^2 + \underbrace{\left(\frac{1}{R_1 C_1} + \frac{1}{R_2 C_1} + \frac{1}{R_2 C_2} - \frac{R_b}{R_a R_f C_1}\right)}_{\text{Q factor}} s + \frac{\left(1 + \frac{R_b}{R_a}\right)\frac{s}{R_1 C_1}}{\underbrace{\frac{R_1 + R_f}{R_1 R_2 R_f C_1 C_2}}_{\text{used for } f_o}}}$$

$$f_o = \frac{1}{2\pi}\sqrt{\frac{R_f + R_1}{C_1 C_2 R_1 R_2 R_f}} \qquad \left[\omega_o^2 = (2\pi f_o)^2\right]$$

$$Q \text{ factor} = \frac{\sqrt{\frac{R_1 + R_f}{R_1 R_f R_2 C_1 C_2}}}{\frac{1}{R_1 C_1} + \frac{1}{R_2 C_1} + \frac{1}{R_2 C_2} - \frac{R_b}{R_a R_b C_1}}$$

$$= \frac{\sqrt{(R_1 + R_f) R_1 R_f R_2 C_1 C_2}}{R_1 R_f (C_1 + C_2) + R_2 C_2 \left(R_f - \frac{R_b}{R_a} R_1\right)}$$

$$\left[\frac{R_b}{R_a} = 0\right]$$

$$\Rightarrow \frac{\sqrt{(R_1 + R_f) R_1 R_f R_2 C_1 C_2}}{R_1 R_f (C_1 + C_2) + R_2 C_2 (R_f)}$$