TOPIC:- Active Filter
P.G-III sem

A filter is a device that transmits freely through it signals having frequencies in a certain band and severely attenuates signals having frequencies outside this band. The band of frequencies passing freely through the filter is called the "pass-band" and the band of frequencies highly attenuated is termed the "stop band."

Passive filters are constructed with passive circuit elements such as resistors, capacitors and inductors. In active filters, active components like OP AMPs are employed along with passive components resistors and capacitors only but not inductors.

A first order filter has one resistor R and one capacitor C. A 2nd order filter will contain two resistors and two capacitors, a third order filter will contain three & three, and so on. Second-order filters are also known as "Biquads." Active filters can have several configuration. Here we are dealing only 'Butterworth configuration'.

Second-order Butterworth Low pass Active filter:— Fig (1) shows a 2nd-order Butterworth LP active filter. The voltages V_i, V_x, V_y and V_o are measured with respect to ground.

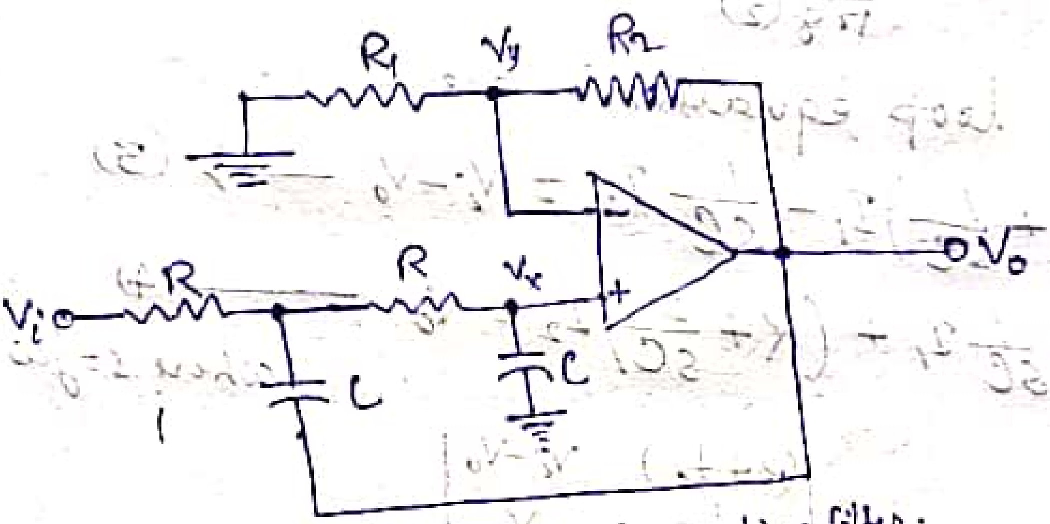

Fig (1) LP 2nd order active filter.

The input impedance of the OPAMP being infinite, no current flows into its input terminals. So, we have

$$V_x = V_y \quad \longrightarrow (1)$$

and the voltage V_y is obtained by Krichhoff's current rule as

$$\frac{V_y}{R_1} = \frac{V_o}{R_1+R_2}$$

$$\therefore V_y = \left(\frac{V_o}{R_1+R_2}\right)R_1 \quad \longrightarrow (2)$$

The equivalent circuit for fig (1) is shown in fig. (2).

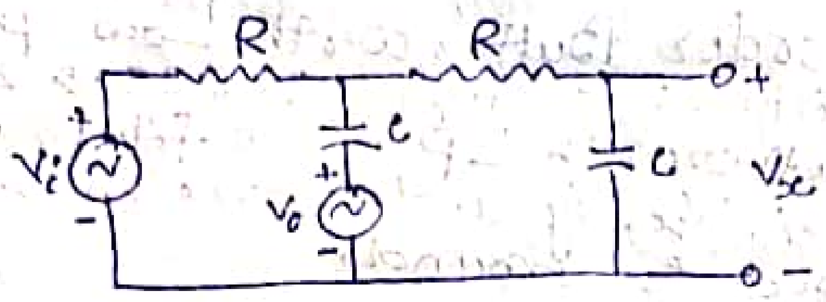

Fig (2)

The loop equations are

$$\left(R+\frac{1}{sC}\right)I_1 - \frac{1}{sC}I_2 = V_i - V_o \longrightarrow (3)$$

and $$-\frac{1}{sC}I_1 + \left(R+\frac{2}{sC}\right)I_2 = V_o \longrightarrow (4)$$

where $s = j\omega$

Hence $$I_2 = \frac{\begin{vmatrix} \left(R+\frac{1}{sC}\right) & V_i - V_o \\ -\frac{1}{sC} & V_o \end{vmatrix}}{\begin{vmatrix} \left(R+\frac{1}{sC}\right) & -\frac{1}{sC} \\ -\frac{1}{sC} & \left(R+\frac{2}{sC}\right) \end{vmatrix}}$$

$$= \frac{V_o\left(R+\frac{1}{sC}\right)+\frac{(V_i-V_o)}{sC}}{\left(R+\frac{1}{sC}\right)\left(R+\frac{2}{sC}\right)-\frac{1}{s^2C^2}} \longrightarrow (5)$$

∴ The voltage V_x is given by

$$V_x = \frac{I_2}{sC} = \frac{V_o(sRC+1)+V_i-V_o}{(sRC+1)(sRC+2)-1}.$$

$$= \frac{V_o(sRC)+V_i}{s^2R^2C^2+3sRC+1} \longrightarrow (6)$$

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