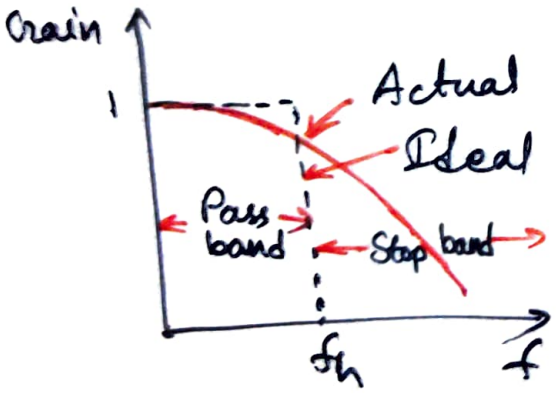
Active Filters

→ A freq. selective electric circuit that passes electric signals of specified band of freq.'s & attenuates the signals of freq.'s outside the band is called an electric filter.

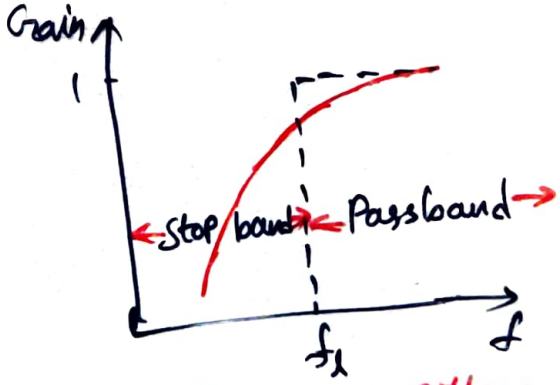
→ Filters are widely used in communication & signal processing

→ Filters can be built from (i) passive RLC components, (ii) crystals, or (iii) resistors, capacitors & op-amps (active filters)

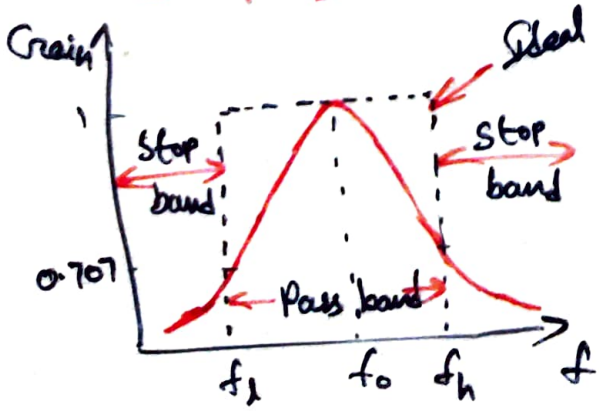
→ Most commonly used filters are:
- Low Pass Filter (LPF)
- High Pass Filter (HPF)
- Band Pass Filter (BPF)
- Band Reject Filter or Band stop Filter (BSF)



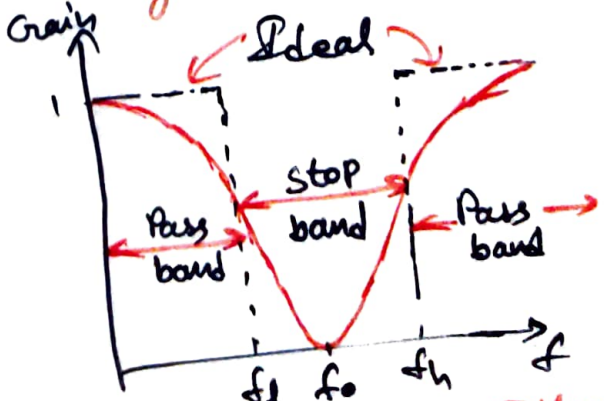
Low pass Filter



High pass Filter



Band Pass Filter

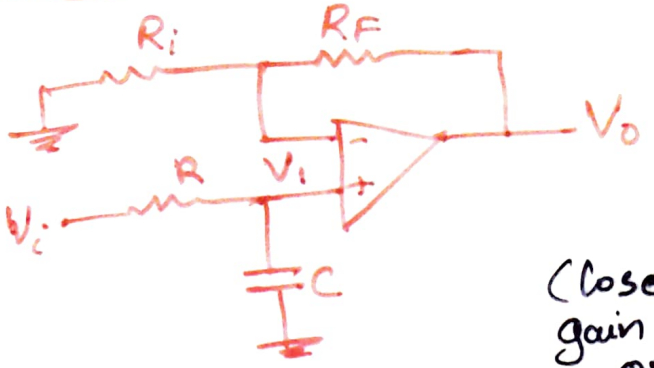


Band Reject Filter

→ Active filters are specified by voltage transfer function

$$H(s) = V_o(s) / V_i(s)$$

First Order Low Pass Filter



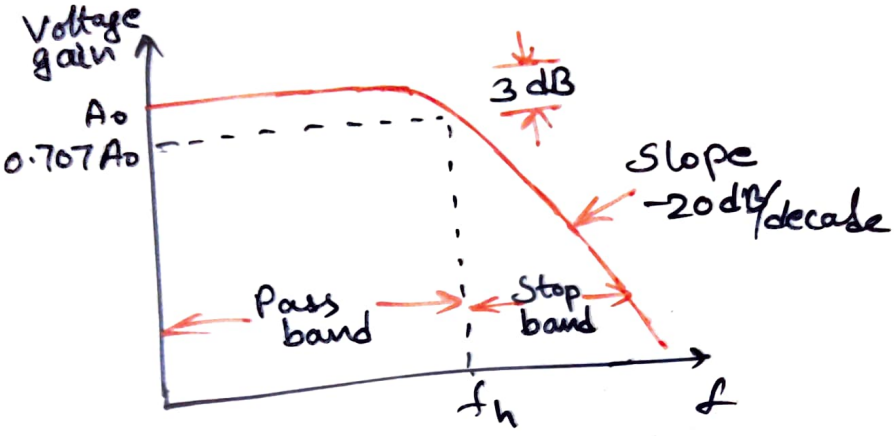
$$V_1(s) = \frac{1/sC}{R + 1/sC} V_i(s)$$

$$\frac{V_1(s)}{V_i(s)} = \frac{1}{RCs+1}$$

(Closed loop gain of op-amp $A_o = \frac{V_o(s)}{V_1(s)} = 1 + \frac{R_F}{R_i}$

→ Overall transfer function $H(s) = \frac{V_o(s)}{V_i(s)} = \frac{V_o(s)}{V_1(s)} \cdot \frac{V_1(s)}{V_i(s)}$

$$= \frac{A_o}{RCs+1}$$



$$H(s) = \frac{V_o(s)}{V_i(s)}$$

$$= \frac{A_o}{\frac{s}{\omega_h} + 1} = \frac{A_o \omega_h}{s + \omega_h}$$

where $\omega_h = \frac{1}{RC}$

→ To determine freq. response put $s = j\omega$

$$H(j\omega) = \frac{A_o}{1 + j\omega RC} = \frac{A_o}{1 + j(f/f_h)}$$ where $f_h = \frac{1}{2\pi RC}$

& $f = \frac{\omega}{2\pi}$

→ At very high freq. i.e. $f >> f_h$

$$|H(j\omega)| << A_o \simeq 0$$

→ At very low freq. i.e. $f << f_h$

$$|H(j\omega)| \simeq A_o$$

→ At $f = f_h$ $|H(j\omega)| = \frac{A_o}{\sqrt{2}} = 0.707 A_o$