FILTER

In signal processing, a filter is a device or process that removes some unwanted components or features from a signal. Filtering is a class of signal processing, the defining features of filters being the complete or partial suppression of some aspect of the signal. Filters are widely used in electronics and telecommunication, in radio, television, audio recording, radar, control systems, music synthesis, image processing and computer graphics.

Types of Filter:

Filters are essential building blocks in many systems, particularly in communication and instrumentation systems. A filter passes one band of frequencies while rejecting another. Typically implemented in one of three technologies,

- Passive RLC filters: work well at high frequencies, however, at low frequencies the required inductors are largers, bulky and non-ideal. Furthermore, inductors are difficult to fabricate in monolithic from and are incompatible with many modern assembly systems.
- Active RC filters: utilize op-amps together with resistors and capacitors and are fabricated using discrete, thick film and thin-film technologies.
- Switched capacitor filters: are monolithic filters which typically offer the best performance in the term of cost. Fabricated using capacitors, switched and op-amps.

Low pass filter:

A LPF is used in circuits that only allow low frequencies to pass through. It is often used to block high frequencies and AC current in a circuit. Given below is a sample LPF circuit using op-amp. Ideally, the frequency output of a LPF is like this,

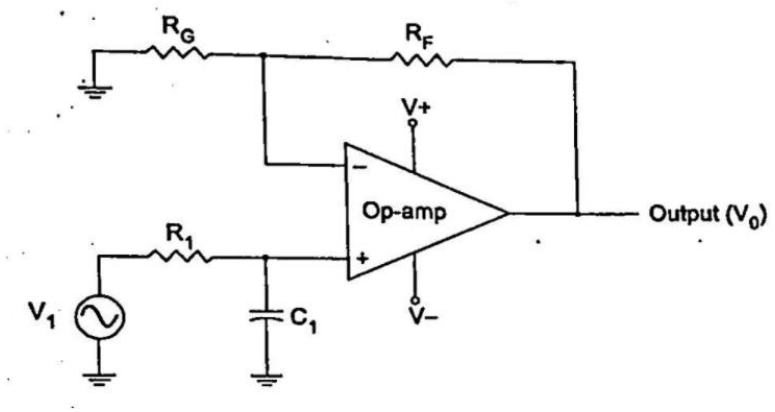

Fig: Low pass filter

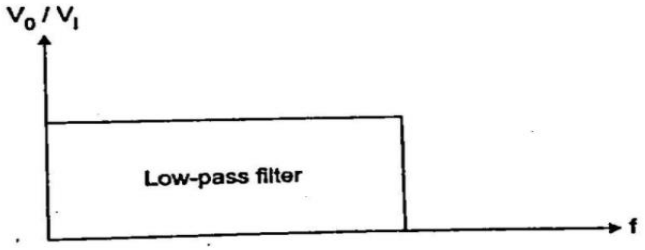

Fig: Output waveform of low pass filter

LPF is popular with speakers to block high pitches, some electric guitars and radio transmitters.

High pass filter:

A high pass filter is used in circuits that only require high frequencies to operate. It blocks most low frequencies and DC component. Give below is a sample high pass filter circuit using op-amp.

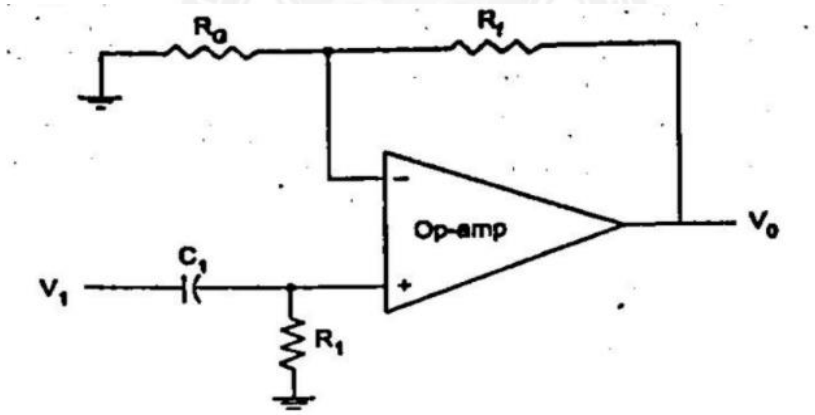

Fig: High pass filter

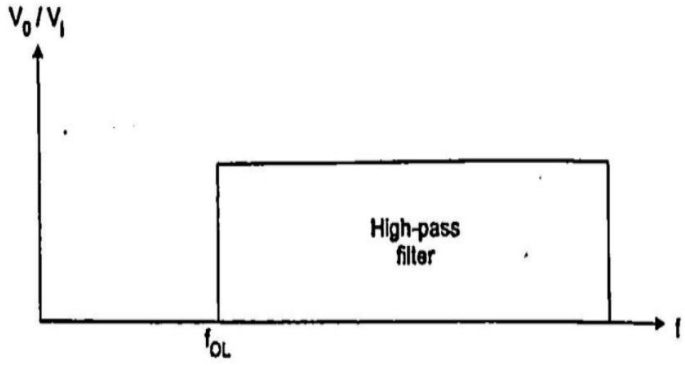

Fig: Output waveform of high pass filter

Band pass filter:

A band pass filter is an electronic device or circuit that allows signals between two specific frequencies to pass, but that discriminates against signals at other frequencies. Some band pass filters require an external source of power and employ active components such as transistors and integrated circuits, these are known as active band pass filters. Other band pass filters use no external source of power and consist only of passive components such as capacitors and inductors, these are called passive band pass filters.

A band pass filter is a combination of a high pass and a LPF. It allows only a select range of frequencies to pass through. It is designed such a way that the cut off frequency of the LPF is higher than the cut off frequency of the high pass filter, hence allowing only a select range of the frequencies to pass through. Presented here is a sample band pass filter circuit using op-amp.

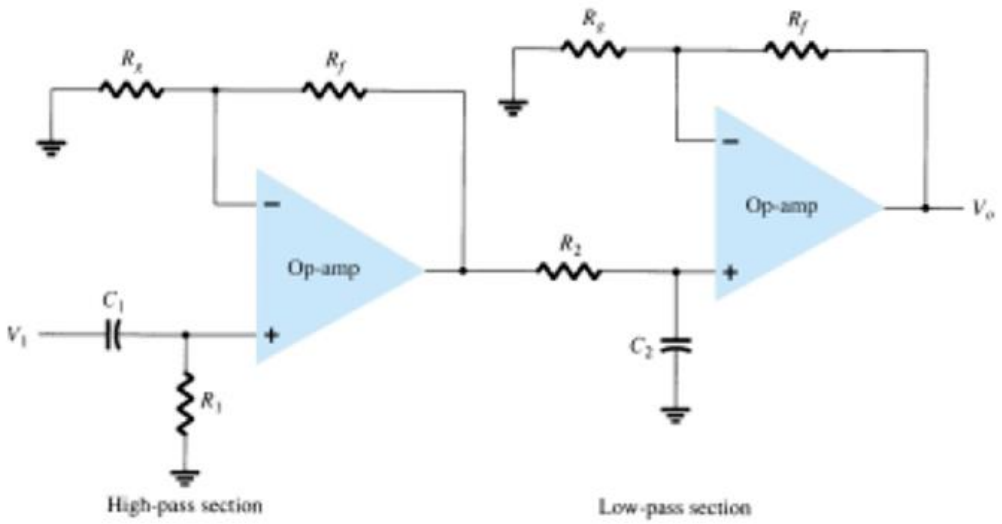

Fig: Band pass filter

The illustration is an amplitude-vs-frequency graph, also called a spectral plot, of the characteristic curve of a hypothetical band pass filter. The cutoff frequencies, f_1 and f_2 are the frequencies at which the output signal power falls to half of its level at f_0 the center frequency of the filter. The value f_2- f_1 expressed in hertz, kilohertz, megahertz or gigahertz is called the filter bandwidth. The range of frequencies between f_1 and f_2 is called the filter pass band.

Band pass filters are used primarily in wireless transmitters and receivers. The main function of such a filter in a transmitter is to limit the bandwidth of the output signal to the

minimum necessary to convey data at the desired speed and in the desired form. In a receiver, a band pass filter allows signals within a selected range of frequencies to be heard or decoded, while preventing signals at unwanted frequencies from getting through. A band pass filter also optimizes the signal-to-noise ratio of a receiver.

Frequency response of a band pass filter:

The frequency response bode plot curve for a 2nd order passive band pass filter is shown below in figure.

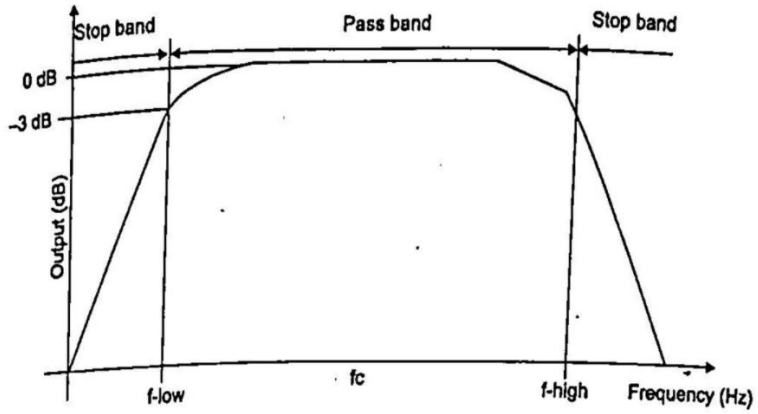

Fig: Frequency response of band pass filter

The graph is plotted against the input frequency in the X-axis and the output in decibels in the Y-axis. When the input frequency is less than the lower cut-off frequency (f-low) the output remains less than -3db and when it exceeds that frequency, the output reaches the maximum and stays there until the frequency exceeds the higher cut-off frequency (f-high). The peak at which the output gain stays maximum is called as the resonant frequency. It is simply the geometric mean of the upper higher cut-off frequency and the lower cut-off frequency. The formula to calculate the same is given below

$$\text{Resonant frequency (Fr)} = \sqrt{(f-low * f-high)}$$

The distance between the lower cut-off frequency and the higher cut-off frequency is called as bandwidth. So, the input frequency will be allowed to pass through only if it is within limit of the bandwidth.