UNIT-3 MPHYCC-7

Submitted by:

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Active Filters

Filters are electronic circuits that allow certain frequency components and / or reject some other. You might have come across filters in network theory. They are passive and are the electric circuits or networks that consist of passive elements like resistor, capacitor, and (or) an inductor. Here we will discuss about active filters in detail.

Types of Active Filters

Active filters are the electronic circuits, which consist of active element like op-amp(s) along with passive elements like resistor(s) and capacitor(s).

Active filters are mainly classified into the following four types based on the band of frequencies that they are allowing and / or rejecting −

Active Low Pass Filter

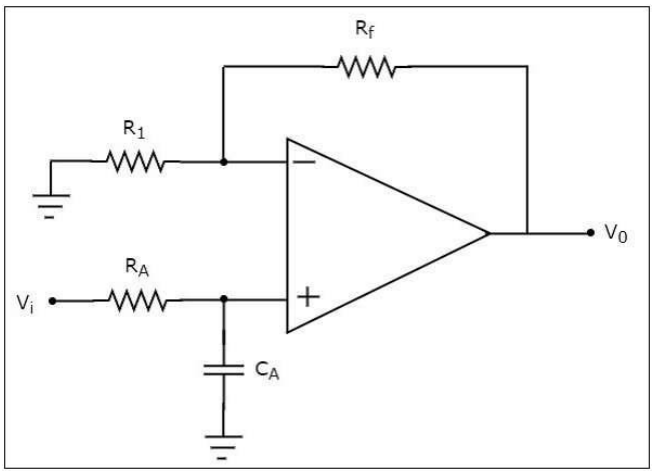
Active High Pass Filter

Active Band Pass Filter

Active Band Stop Filter

Active Low Pass Filter

If an active filter allows (passes) only **low frequency** components and rejects (blocks) all other high frequency components, then it is called as an **active low pass filter**. The **circuit diagram** of an active low pass filter is shown in the following figure -

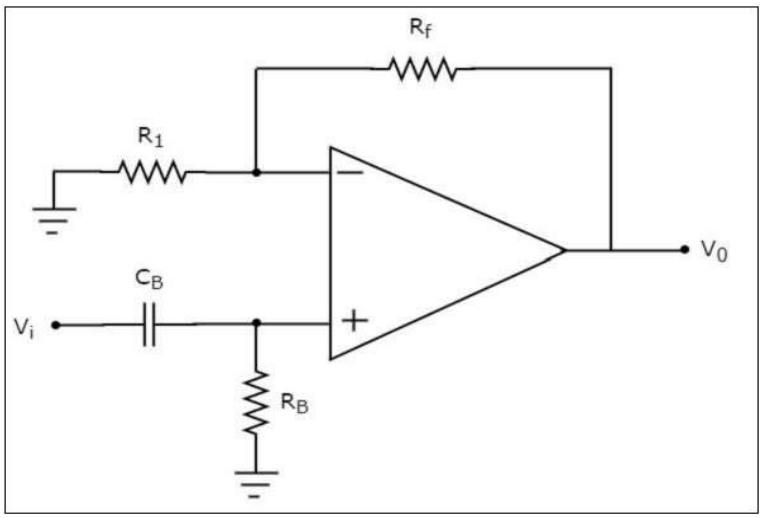


We know that the electric network, which is connected to the non-inverting terminal of an op-amp is a **passive low pass filter**. So, the input of a non-inverting terminal of an op-amp is the output of a passive low pass filter.

Observe that the above circuit resembles a **non-inverting amplifier**. It is having the output of a passive low pass filter as an input to the non-inverting terminal of op-amp. Hence, it produces an output, which is $\left(1+\frac{R_f}{R_1}\right)$ times the input present at the non-inverting terminal. We can choose the values of R_f and R_1 suitably in order to obtain the desired gain at the output. Suppose, if we consider the resistance values of R_f and R_1 as zero ohms and infinity ohms, then the above circuit will produce a unity gain low pass filter output.

Active High Pass Filter

If an active filter allows (passes) only high frequency components and rejects (blocks) all other low frequency components, then it is called an active high pass filter. The circuit diagram of an active high pass filter is shown in the following figure –

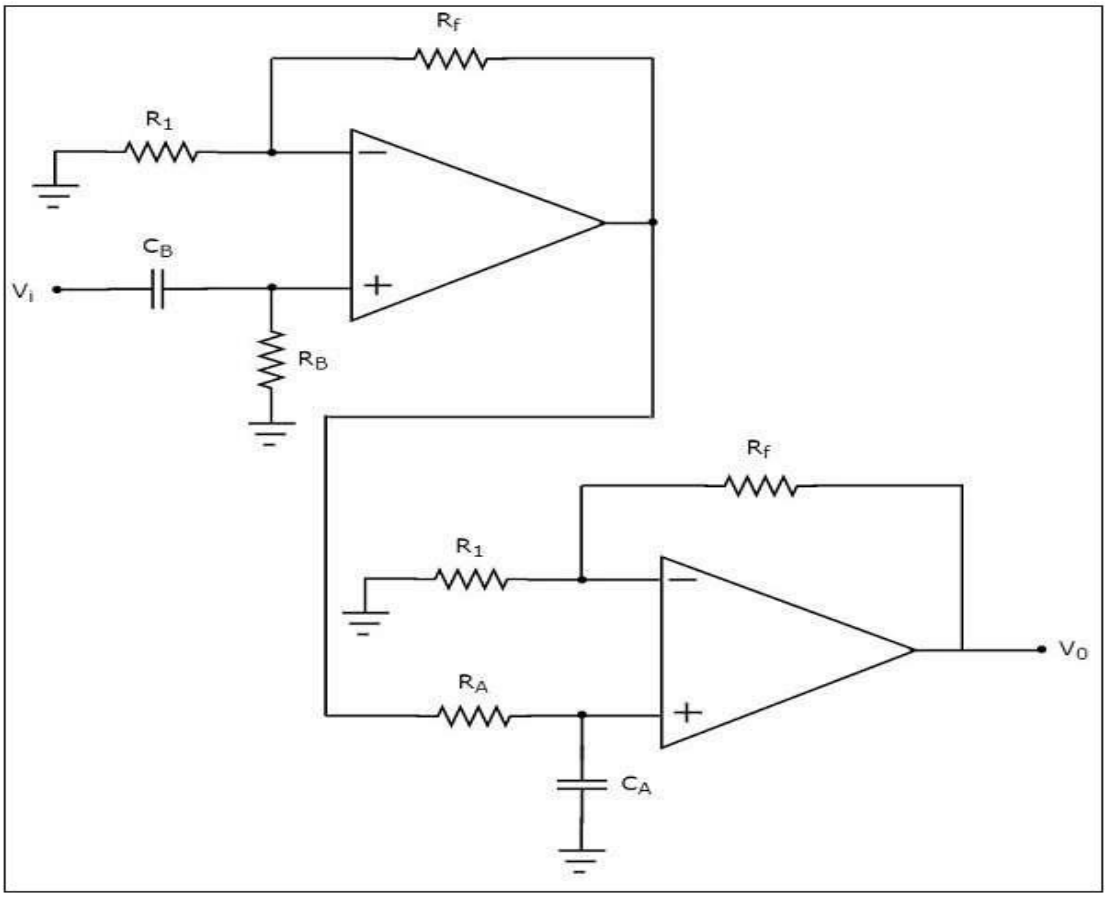


We know that the electric network, which is connected to the non-inverting terminal of an op-amp is a passive high pass filter. So, the input of a non-inverting terminal of op-amp is the output of passive high pass filter. Now, the above circuit resembles a non-inverting amplifier. It is having the output of a passive high pass filter as an input to non-inverting terminal of op-amp. Hence, it produces an output, which is $\left(1+\frac{R_f}{R_1}\right)$ times the input present at its non-inverting terminal. We can choose the values of R_f and R_1 suitably in order to obtain the **desired gain** at the output. Suppose, if we consider the resistance values of R_f and R_1 as zero ohms and infinity ohms, then the above circuit will produce a **unity gain** high pass filter output.

Active Band Pass Filter

If an active filter allows (passes) only one band of frequencies, then it is called as an **active band pass filter**. In general, this frequency band lies between low frequency range and high frequency range. So, active band pass filter rejects (blocks) both low and high frequency components.

The **circuit diagram** of an active band pass filter is shown in the following figure

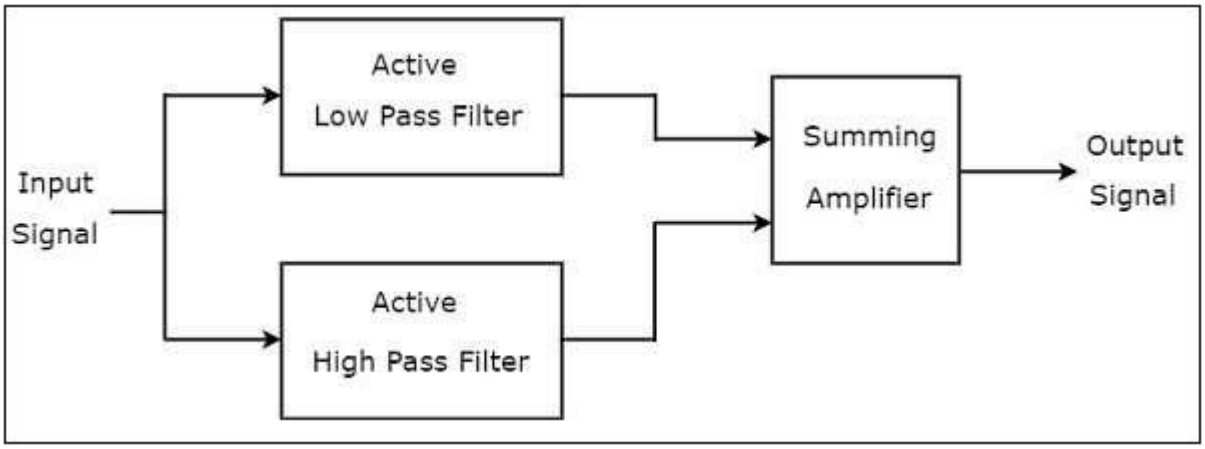


Observe that there are two parts in the circuit diagram of active band pass filter: The first part is an active high pass filter, while the second part is an active low pass filter. The output of the active high pass filter is applied as an input of the active low pass filter. That means, both active high pass filter and active low pass filter are cascaded in order to obtain the output in such a way that it contains only a particular band of frequencies. The active high pass filter, which is present at the first stage allows the frequencies that are greater than the lower cut-off frequency of the active band pass filter. So, we have to choose the values of R_B and C_B suitably, to obtain the desired lower cut-off frequency of the active band pass filter.

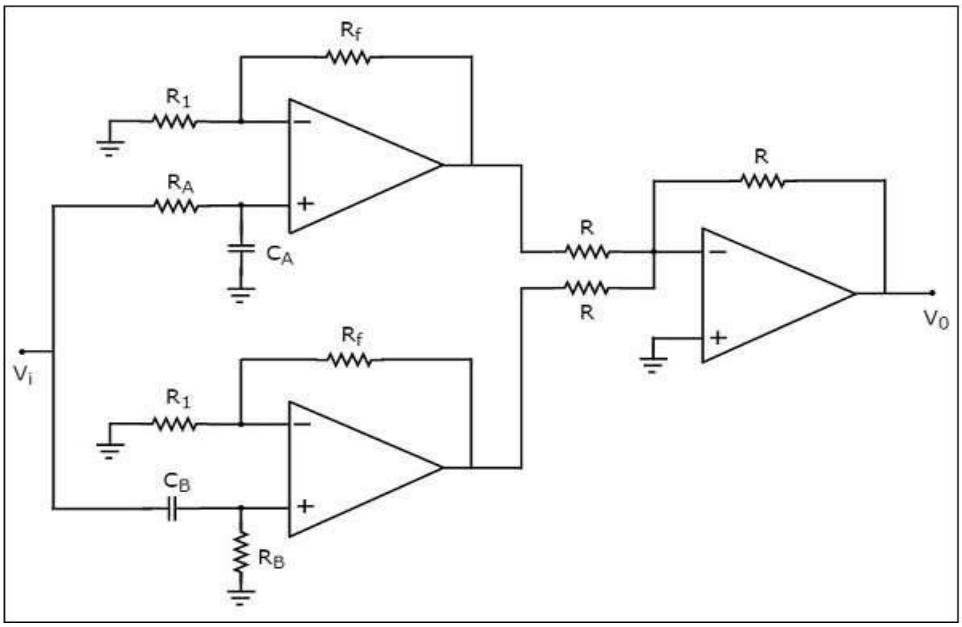
Similarly, the active low pass filter, which is present at the second stage allows the frequencies that are smaller than the higher cut-off frequency of the active band pass filter. So, we have to choose the values of R_A and C_A suitably in order to obtain the desired higher cut-off frequency of the active band pass filter. Hence, the circuit in the diagram discussed above will produce an active band pass filter output.

Active Band Stop Filter

If an active filter rejects (blocks) a particular band of frequencies, then it is called as an active band stop filter. In general, this frequency band lies between low frequency range and high frequency range. So, active band stop filter allows (passes) both low and high frequency components. The block diagram of an active band stop filter is shown in the following figure –



Observe that the block diagram of an active band stop filter consists of two blocks in its first stage: an active low pass filter and an active high pass filter. The outputs of these two blocks are applied as inputs to the block that is present in the second stage. So, the summing amplifier produces an output, which is the amplified version of sum of the outputs of the active low pass filter and the active high pass filter. Therefore, the output of the above block diagram will be the output of an active band stop, when we choose the cut-off frequency of low pass filter to be smaller than cut-off frequency of a high pass filter. The circuit diagram of an active band stop filter is shown in the following figure –



We have already seen the circuit diagrams of an active low pass filter, an active high pass filter and a summing amplifier. Observe that we got the above circuit diagram of active band stop filter by replacing the blocks with the respective circuit diagrams in the block diagram of an active band stop filter.