ROHINI
COLLEGE OF ENGINEERING AND TECHNOLOGY
Approved by AICTE and affiliated to Anna University,(An ISO Certified Institution)
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DEPARTMENT OF BIOMEDICAL ENGINEERING

III Semester

BM3301 SENSORS AND MEASUREMENTS

UNIT – 4

4.3 Concept of Passive Filters

Passive filters are made of passive components (inductance, capacitance, and resistance). A filter is a circuit capable of passing (or amplifying) certain frequencies while attenuating other frequencies. Thus, a filter can extract important frequencies from signals that also contain undesirable or irrelevant frequencies.

Passive filters may be classified

1. A Low pass filters,
2. A High pass filters,
3. A Band pass filters and
4. A Band stop filters

4.3.1 Basic configuration of Filter:

Basic configuration of Filter is as shown in Fig. 4.3.1. The source is sinusoidal of variable frequency. The filter circuit may be so designed that some frequencies are passed from input to output of the filter with very little attenuation while other frequencies are greatly attenuated.

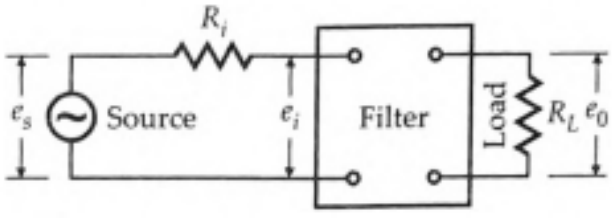

Fig. 4.3.1 Basic configuration of filter

The responses of various filters are shown in Fig. 4.3.2. These are ideal responses but cannot be achieved in actual practice.

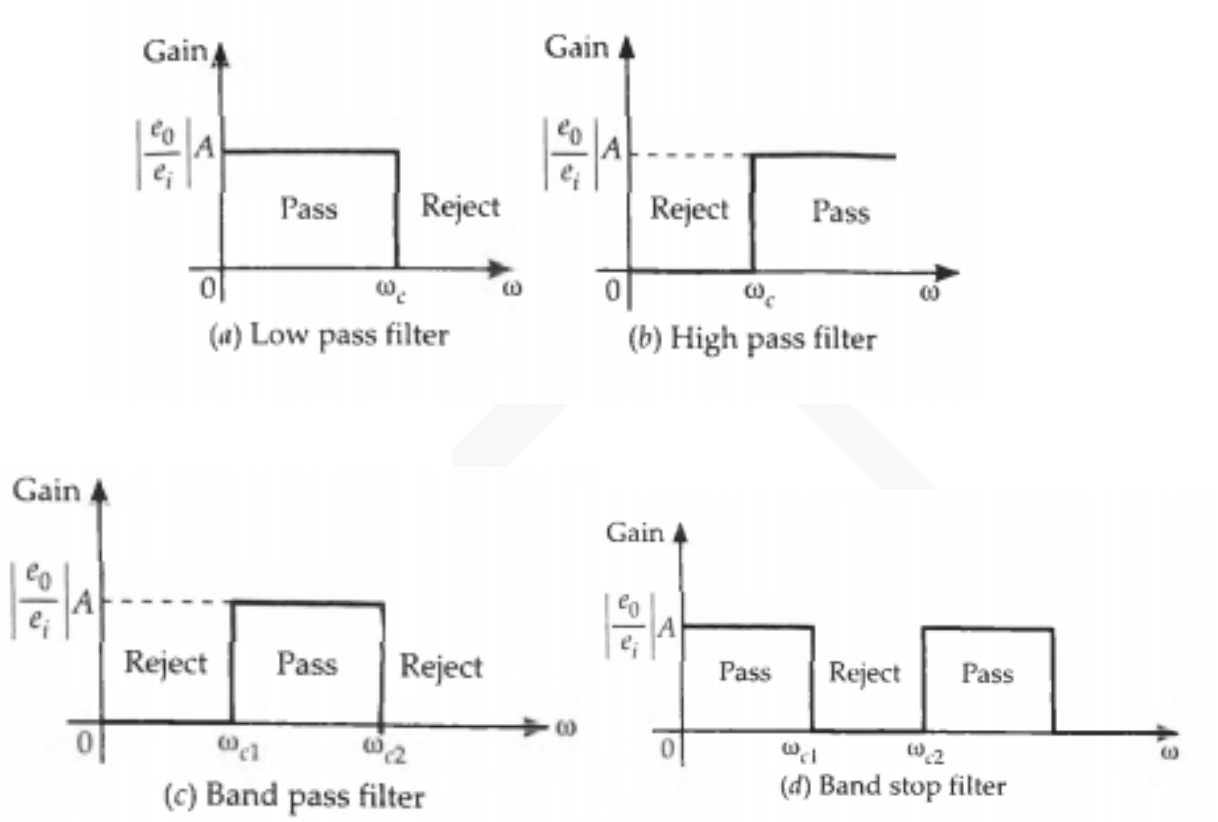

Fig. 4.3.2 Ideal characteristics of filters

4.3.2 Low-pass filters (LPF):

Allows low-frequency signals to pass through while attenuating higher frequencies. Commonly used to eliminate high-frequency noise or to smooth out signals.

At low frequencies, the capacitive reactance is very high and therefore the capacitor circuit can be considered as an open circuit. Under these conditions $e_o = e_i$ or the voltage again is equal to unity. At very high frequencies, the capacitive reactance is very low and therefore the output voltage e_o is very small as compared with the input voltage e_i Thus the gain is low and drops off gradually as the frequency is increased.

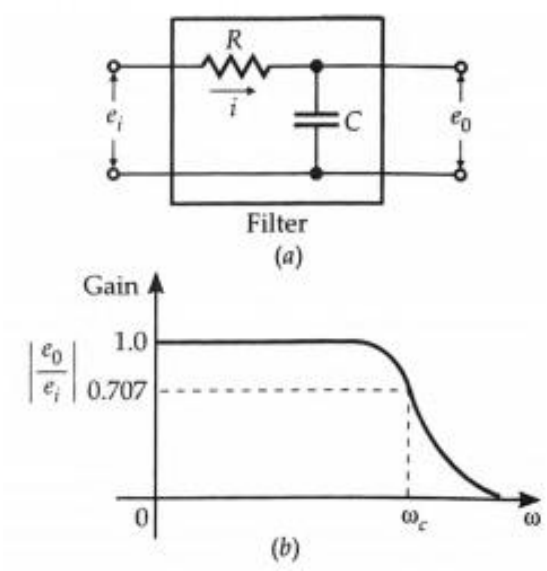

Fig. 4.3.3 Low pass R-C filter and its characteristic

4.3.3 High-pass filters (HPF):

Allows high-frequency signals to pass through while attenuating lower frequencies. Often used to remove low-frequency noise or separate high-frequency components from a signal.

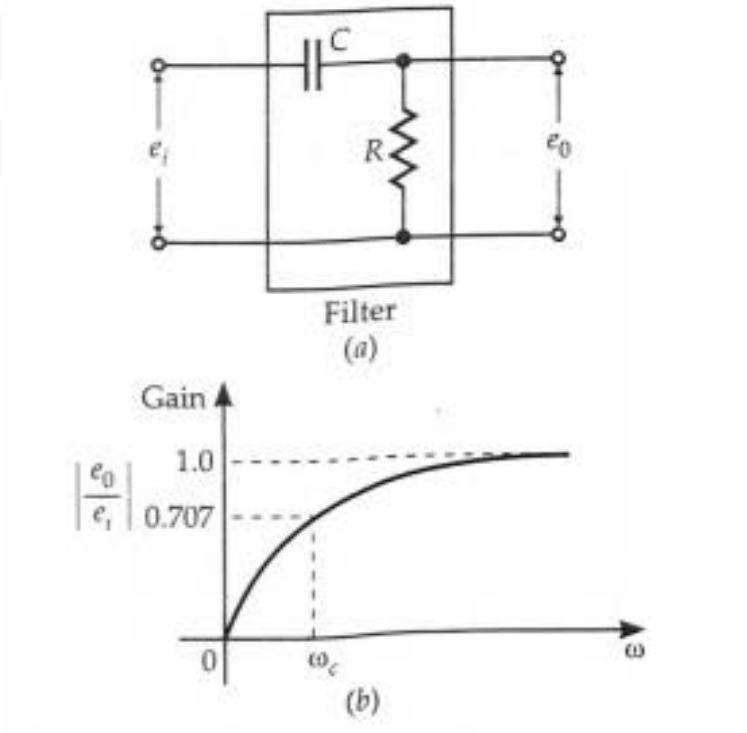

Fig. 4.3.5 A high-pass filter and its response

Cut off frequency is defined as, frequency at which the output (load) voltage equals 70.7% of the input (source) voltage.

Cutoff frequency is : f = 1 /2πRC

4.3.5 Band-pass filters (BPF):

The band pass filter is obtained by cascading a low pass and high pass filter.

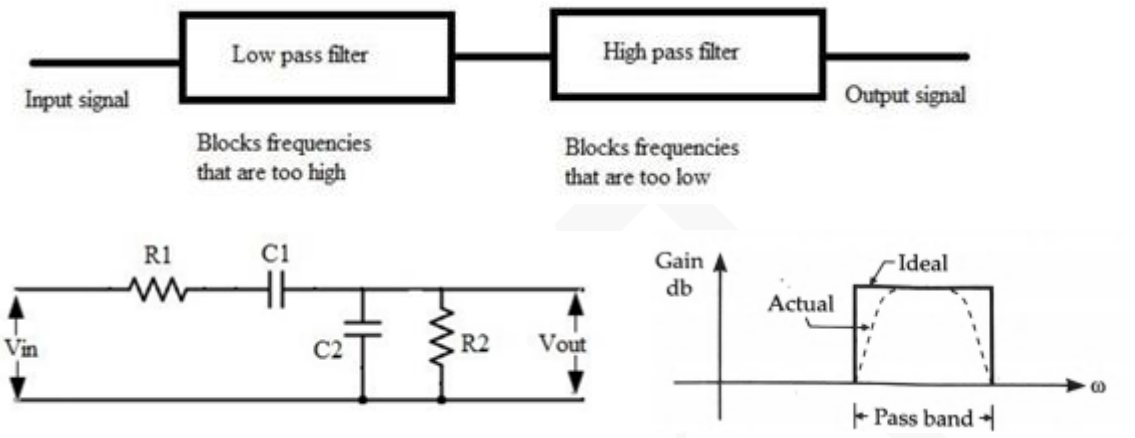

Fig. 4.3.6 Band Pass Filter

- Permits a specific range or "band" of frequencies to pass through while attenuating frequencies outside that range. Useful in applications where a specific frequency range needs to be isolated or extracted.
- The cut-off frequency of the circuit can be calculated as follows. $f_c = 1/(2\pi RC)$.
- By adjusting the cut-off frequencies of the high pass and low pass filters we can obtain the appropriate width of the pass band for the band pass filter.
- Since this filter passes a band of frequencies this filter contains two cut off frequencies, lower cut-off frequency ' f_L ' and higher cut-off frequency 'f_H '. Thus the range of the frequencies which are passed through the filter is called as Band Width of the filter.

$$\text{Bandwidth BW} = f_H - f_L$$

4.3.6 Band-Stop filters:

The band stop filter is formed by the combination of low pass and high pass filters with a parallel connection instead of cascading connection. The name itself indicates that

it will stop a particular band of frequencies. Since it eliminates frequencies, it is also called as band elimination filter or band reject filter or notch filter.

We know that unlike high pass and low pass filters, band pass and band stop filters have two cut-off frequencies. It will pass above and below a particular range of frequencies whose cut off frequencies are predetermined depending upon the value of the components used in the circuit design. Any frequencies in between these two cut-off frequencies are attenuated. It has two pass bands and one stop band.

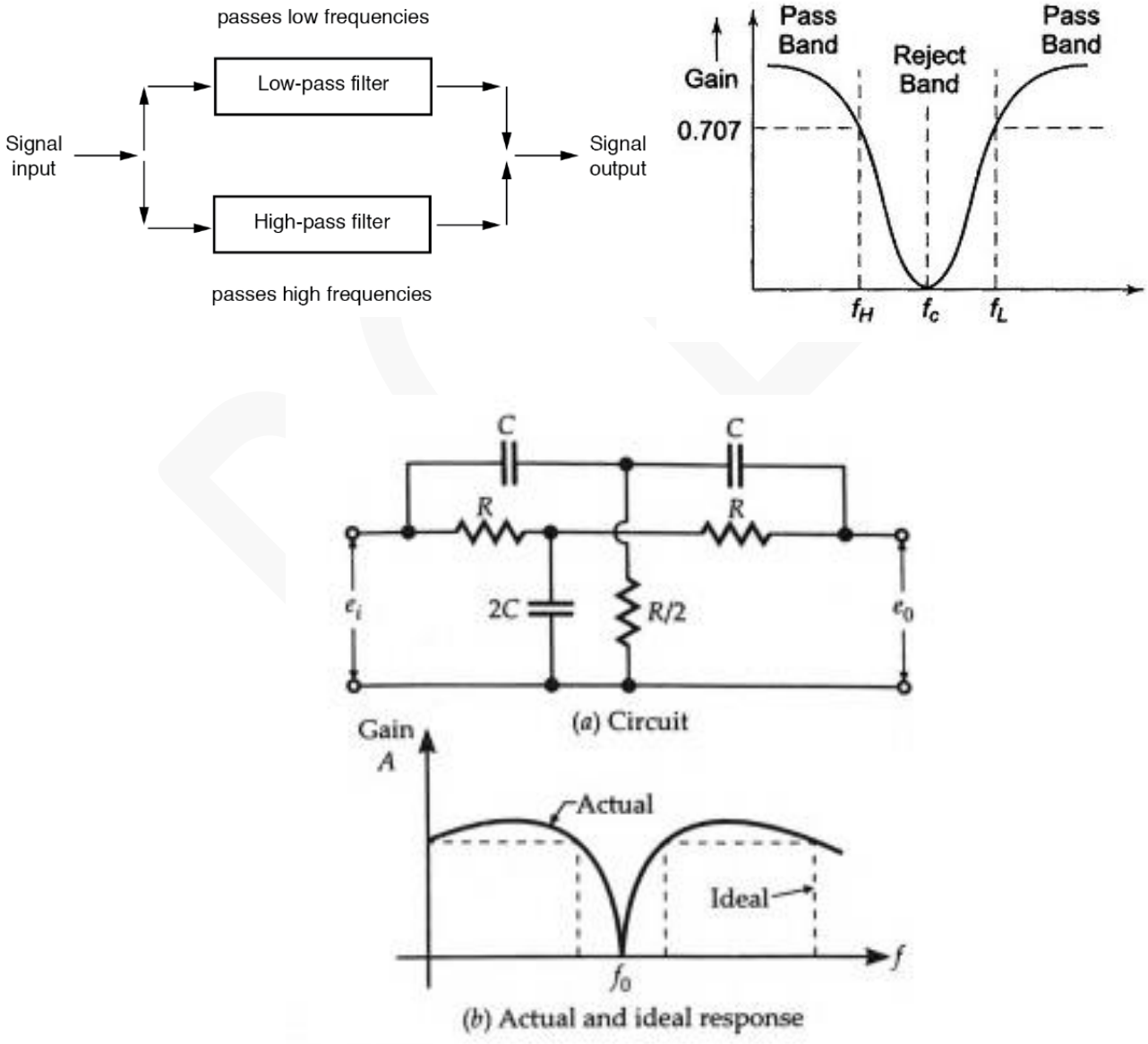

Figure: Twin 'T' Band Stop / Notch Filter

Notch filters are designed to provide high attenuation at and near a single frequency with little or no attenuation at all other frequencies. Notch filters use a twin-T parallel resistance-capacitance (RC) network to obtain a deep notch. The frequency of maximum attenuation is called the notch frequency.

4.3.7 Applications of Passive Filters:

1. Audio frequency (AF) filtering
2. Radio frequency (RF) Communications
3. Power Supply filtering
4. Signal Conditioning in sensors
5. Television and video systems
6. Interference Rejection
7. Medical Imaging Systems
8. Patient Monitoring Systems
9. Sleep Monitoring
10. Biomedical Research Instrumentation

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