المرحلة الثانية

اسس الاتصالات

المحاضرة رقم (12) : FILTERS

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Filters

Background:

- Filters may be classified as either digital or analog.

- ***Digital filters*** are implemented using a digital computer or special purpose digital hardware.

- ***Analog filters*** may be classified as either passive or active and are usually implemented with R, L, and C components and operational amplifiers.

Filters

Background:

. An ***active filter*** is one that, along with R, L, and C components, also contains an energy source, such as that derived from an operational amplifier.

. A ***passive filter*** is one that contains only R, L, and C components. It is not necessary that all three be present. L is often omitted (on purpose) from passive filter design because of the size and cost of inductors – and they also carry along an R that must be included in the design.

Filters

Background:

- **Filters are circuits that are capable of passing signals with certain selected frequencies while rejecting signals with other frequencies**
- **2 types of filter**

PASSIVE FILTER	ACTIVE FILTER
1. RC, RL, RLC circuits	1. Active components + passive Compnents (Transistors) or (op-amps + RC / Rl/RLC)
2. Provide frequency selectivity	2. Provide voltage gain
3. Advantage : simple design and used	3. Advantage: loading effect in minimal o/p independent of the load driven

Filters

Background:

- The ***analysis*** of analog filters is well described in filter text books. The most popular include Butterworth, Chebyshev and elliptic methods.

- The ***synthesis*** (realization) of analog filters, that is, the way one builds (topological layout) the filters, received significant attention during 1940 thru 1960. Leading the work were Cauer and Tuttle. Since that time, very little effort has been directed to analog filter realization.

Filters

Cut off Frequency

- Cut-off frequency: is the frequency at witch the gain on frequency –response plot is 3 dB less than at mid-band gain
- The cut-off frequency aften called 3-dB frequency.

Filters

Digital Filter

- **A digital filter**

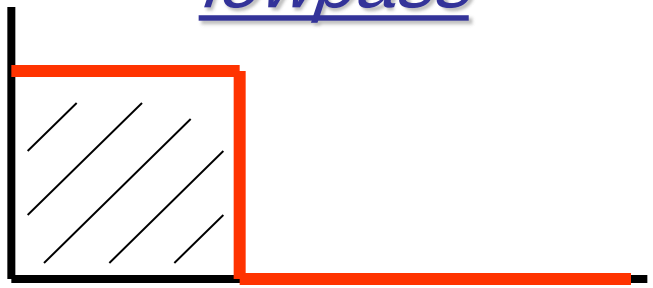
is simply the implementation of an equation(s) in computer software. There are no R, L, C components as such. However, digital filters can also be built directly into special purpose computers in hardware form. But the execution is still in software.

Passive Analog Filters

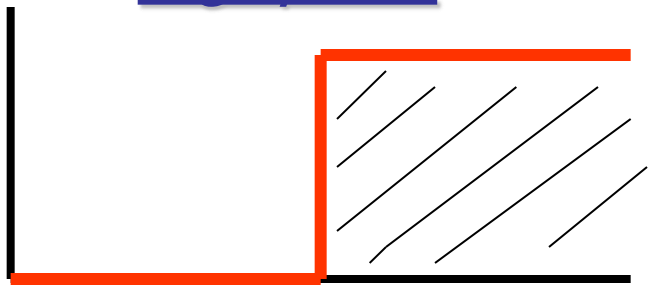
Filters Types

There are four types of filters- "Ideal"

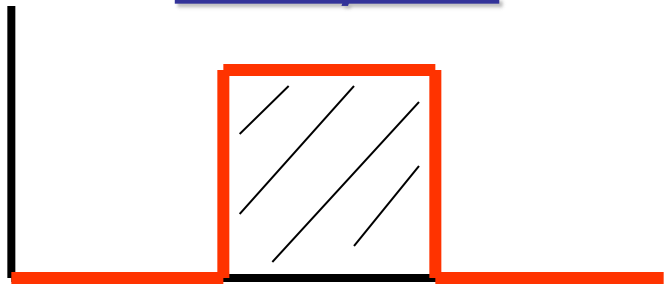
lowpass



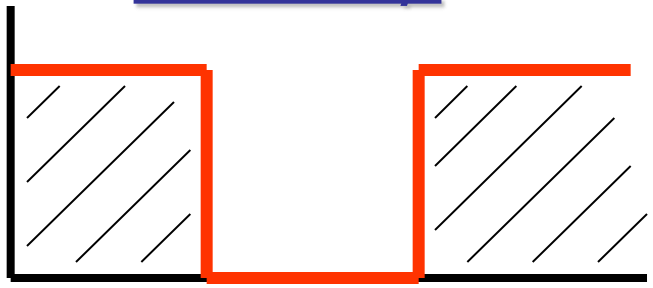
highpass



bandpass



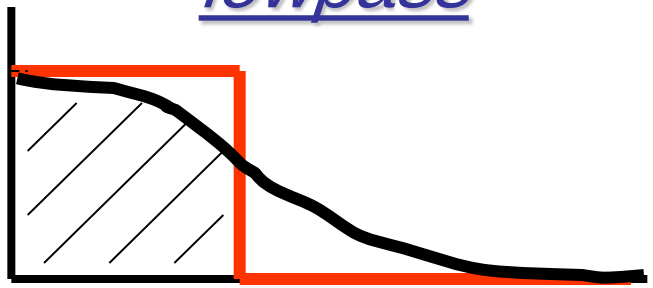
bandstop



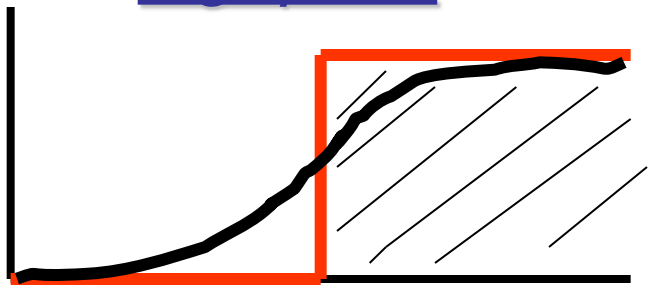
Passive Analog Filters

Background: *Realistic Filters:*

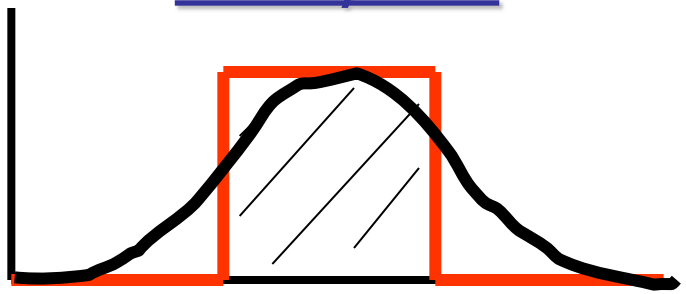
lowpass



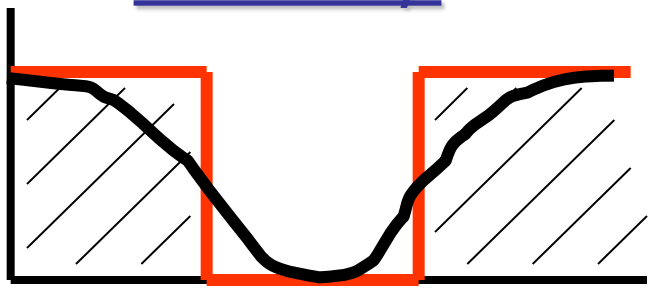
highpass



bandpass



bandstop



Passive Analog Filters

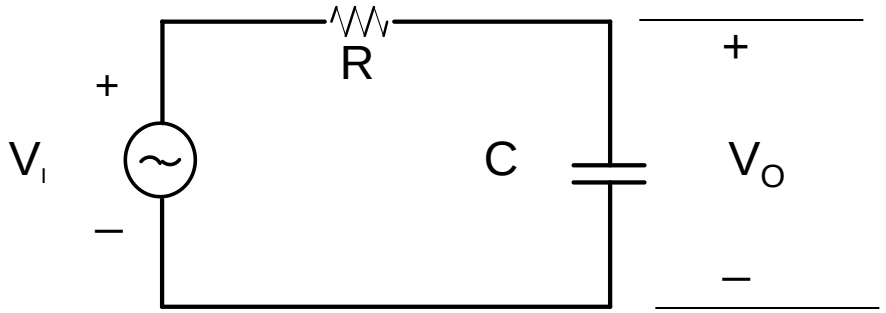
Background:

- It will be shown later that the ideal filter, sometimes called a "brickwall" filter, can be approached by making the order of the filter higher and higher.

- The order here refers to the order of the polynomial(s) that are used to define the filter.

Passive Analog Filters

1. Low Pass Filter



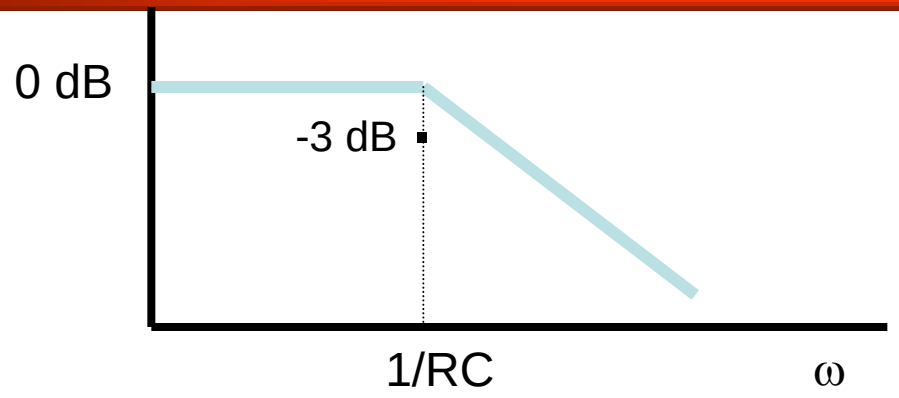
Low pass filter circuit

LPF : is a filter that pass low frequencies well, but attenuates or reduce frequencies higher than cut-off frequency.

$$\frac{V_o(jw)}{V_i(jw)} = \frac{\frac{1}{jwC}}{R+\frac{1}{jwC}} = \frac{1}{1+jwRC}$$

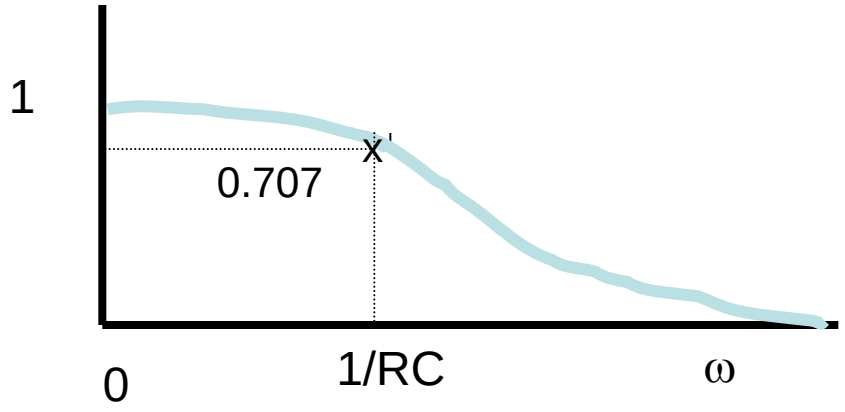
Passive Analog Filters

1. Low Pass Filter



Bode

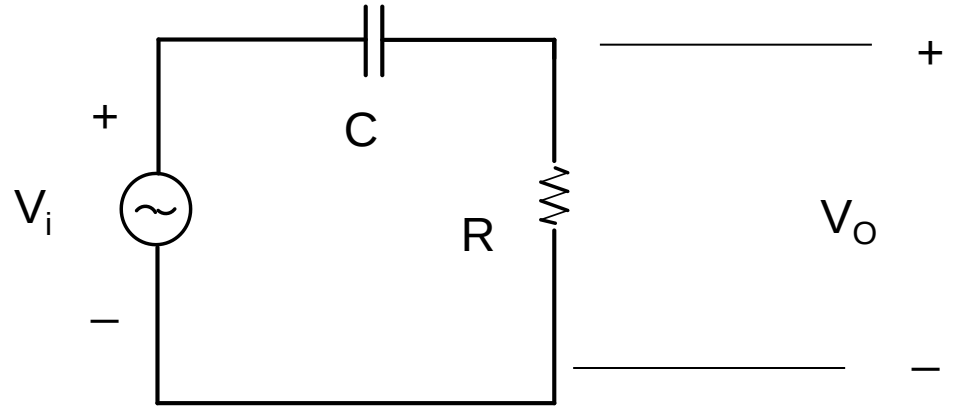
Passes low frequencies
Attenuates high frequencies



Linear Plot

Passive Analog Filters

2. High Pass Filter



High Pass Filter

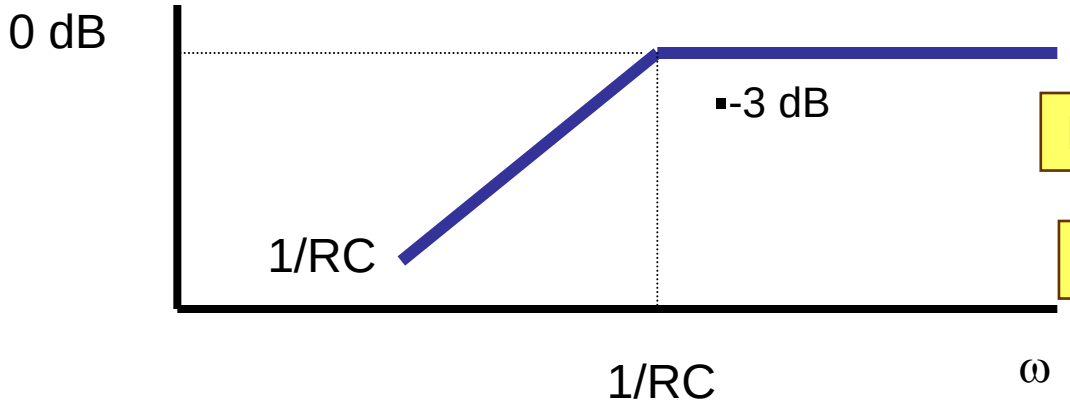
$$\frac{V_o(jw)}{V_i(jw)} = \frac{R}{R+\frac{1}{jwC}} = \frac{jwRC}{1+jwRC}$$

A **high-pass filter** (HPF) is an electronic **filter** that **passes** signals with a **frequency** higher than a certain cutoff **frequency,** and attenuates signals with frequencies lower than the cutoff **frequency**.

Passive Analog Filters

2. High Pass Filter

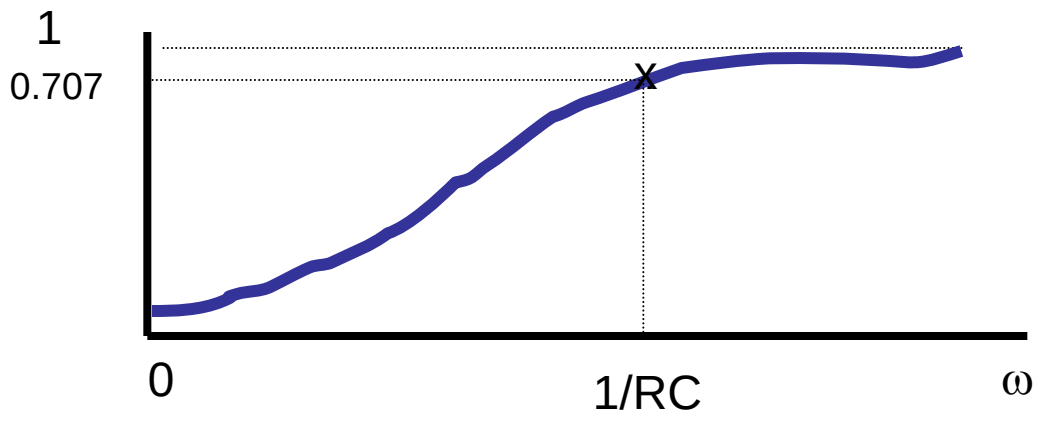
Bode



Passes high frequencies

Attenuates low frequencies

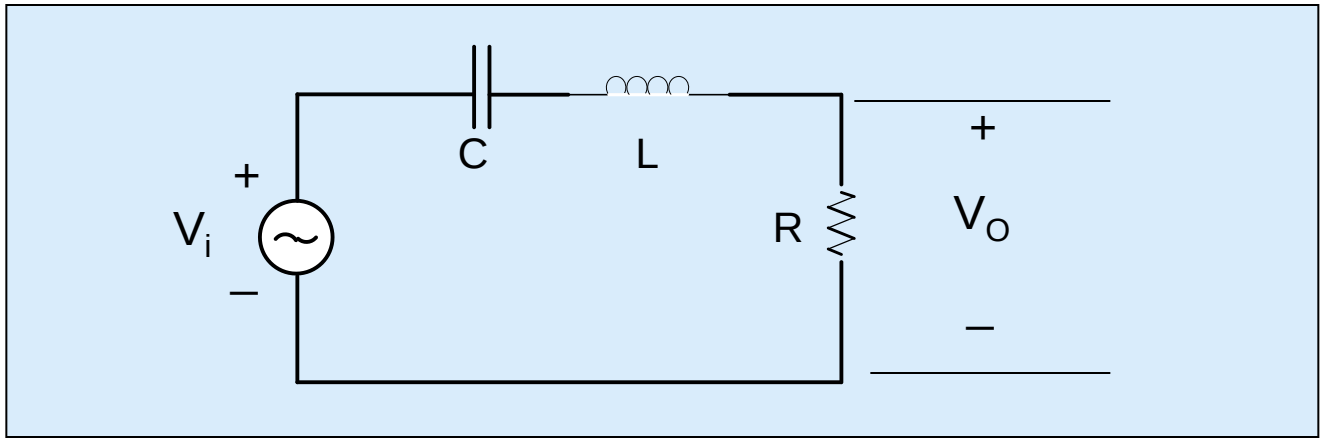
Linear



Passive Analog Filters

3. Bandpass Pass Filter

Consider the circuit shown below:

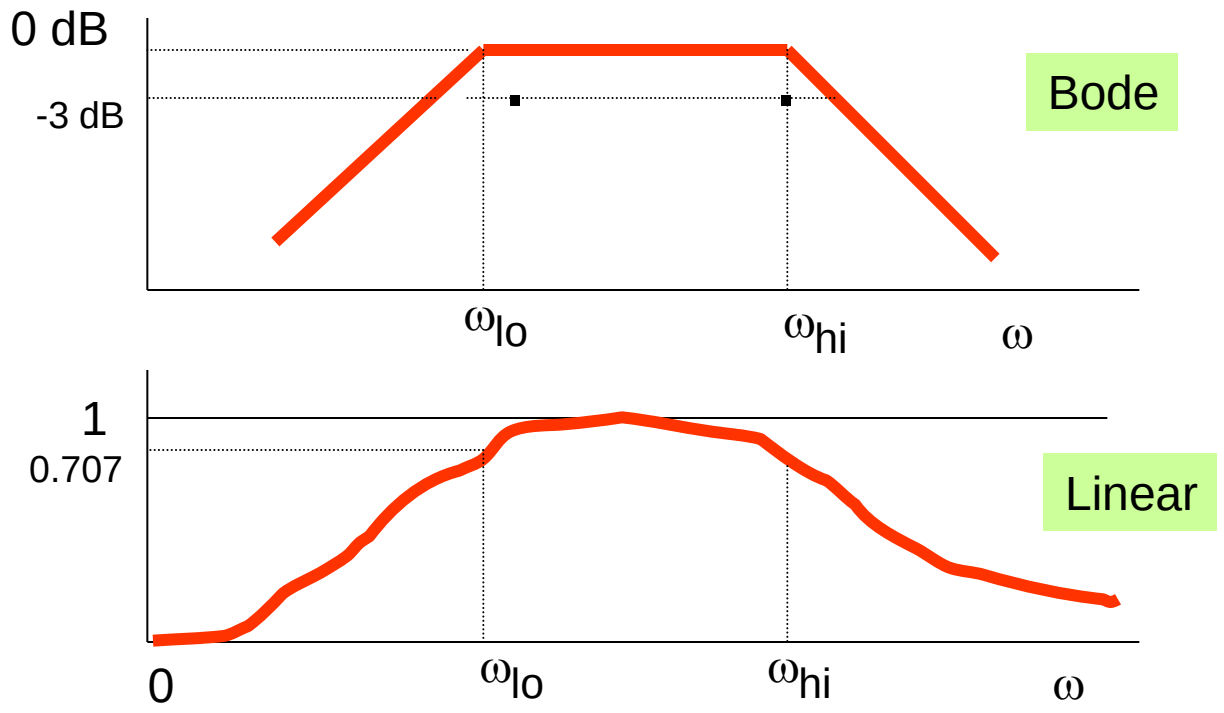


When studying series resonant circuit we showed that;

$$\frac{V_O(s)}{V_i(s)} = \frac{\frac{R}{L}s}{s^2 + \frac{R}{L}s + \frac{1}{LC}}$$

Passive Analog Filters

3. Bandpass Pass Filter



A **band-pass filter** **or** **bandpass filter** (BPF) :

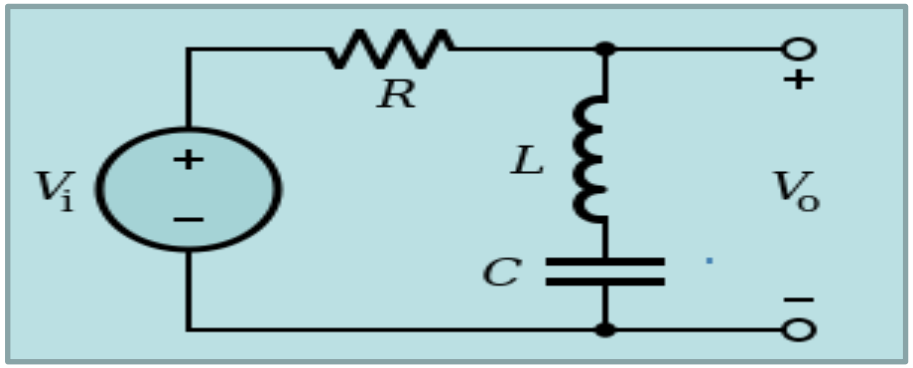
is a device that passes frequencies within a certain range and rejects (attenuates) frequencies outside that range

Passive Analog Filters

4. Bandstop Pass Filter

Generally **band-pass filters** are constructed by combining a low **pass filter** (LPF) in series with a high **pass filter** (HPF).

BPF : allows a specific range of frequencies to not **pass** to the output, while allowing lower and higher frequencies to **pass** with little attenuation. In an other word, The range of frequency blocked by the filter. These frequency are not seen in the filter output.



Passive Analog Filters

4. Bandstop Pass Filter

Band stop filters are created by combining together the low **pass** and high **pass filter** sections in a "parallel" type configuration as shown.