University Of Bourgogne

Digital Signal Processing

Filters and Sampling

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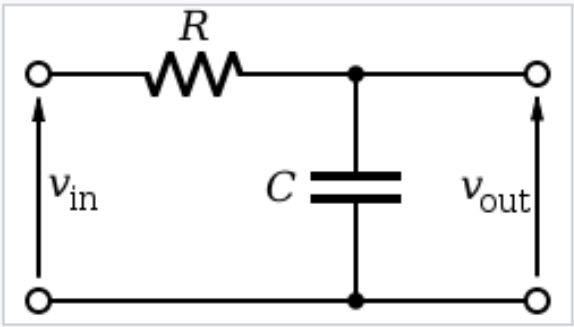
1. **Filtering:**

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 feature of filters being the complete or partial suppression of some aspect of the signal. Most often, this means removing some frequencies or frequency bands. However, filters do not exclusively act in the frequency domain; especially in the field of image processing many other targets for filtering exist.

1.1Low Filter:

A **low-pass filter** (**LPF**) is a filter that passes signals with a frequency lower than a selected cutoff frequency and attenuates signals with frequencies higher than the cutoff frequency. The exact frequency response of the filter depends on the filter design.



A simple low-pass RC filter

1.2 High Filter:

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. The amount of attenuation for each frequency depends on the filter design. A high-pass filter is usually modeled as a linear time-invariant system. Ialso called a **low-cut filter** or **bass-cut filter**.

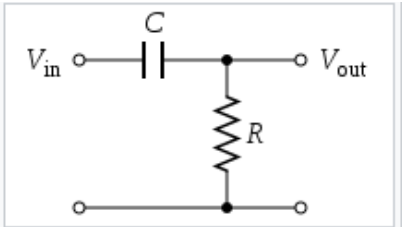
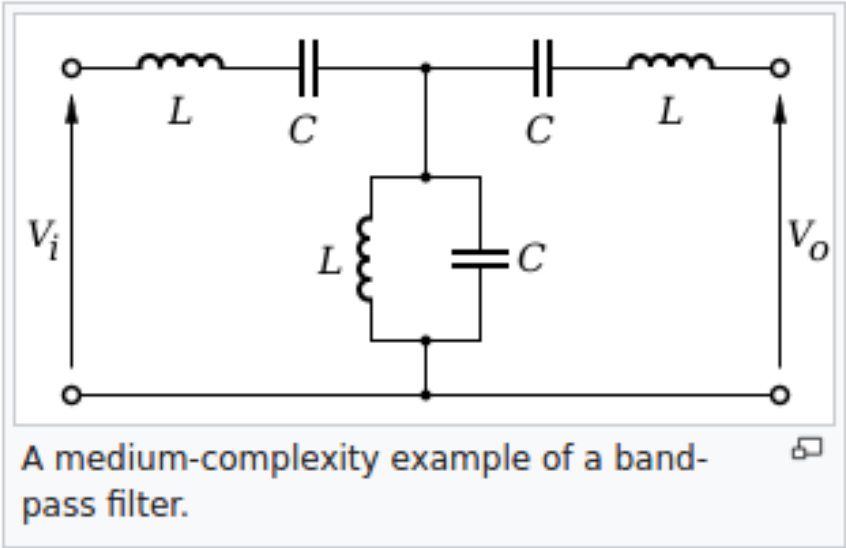


Figure 1: A passive, analog, first-order high-pass filter, realized by an RC circuit

1.3 Band pass:

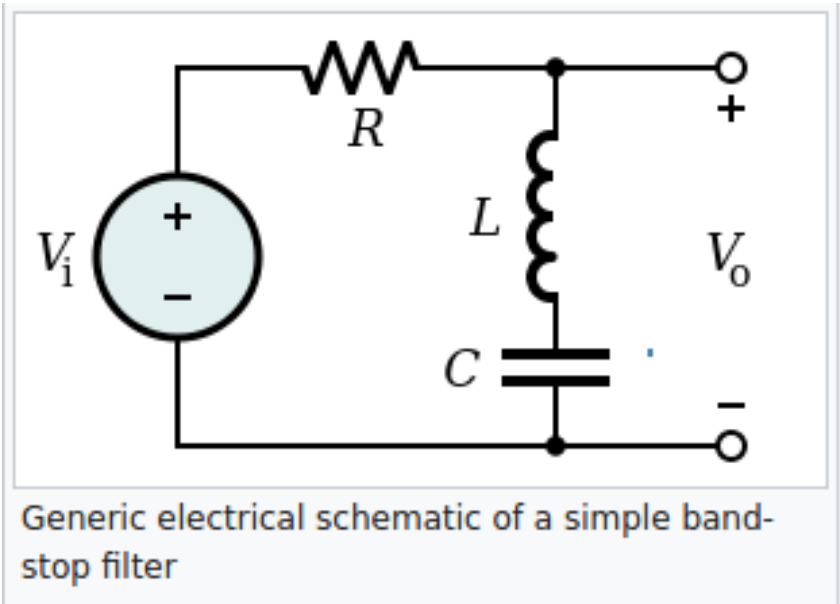
A **band-pass filter**, also **bandpass filter** or **BPF**, is a device that passes frequencies within a certain range and rejects (attenuates) frequencies outside that range.



A medium-complexity example of a band-pass filter.

1.4 Band stop

A **band-stop filter or band-rejection** filter is a filter that passes most frequencies unaltered, but attenuates those in a specific range to very low levels.[1] It is the opposite of a band-pass filter. A notch filter is a band-stop filter with a narrow stopband (high Q factor).



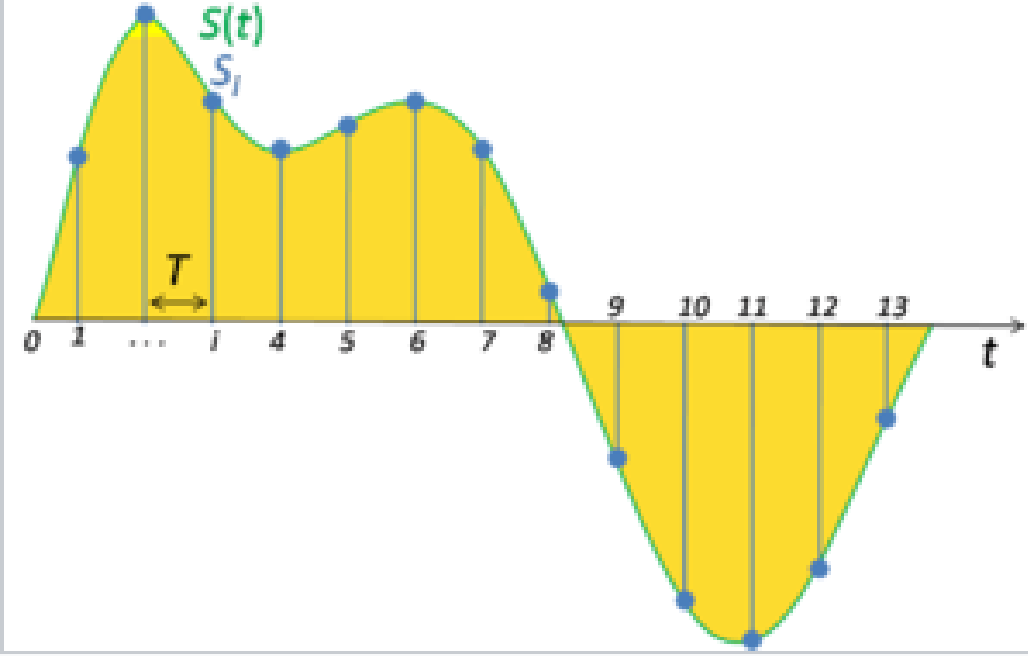
Generic electrical schematic of a simple band-stop filter

2. **Sampling:**

sampling is the reduction of a continuous-time signal to a discrete-time signal. A common example is the conversion of a sound wave (a continuous signal) to a sequence of samples (a discrete-time signal).

A sample is a value or set of values at a point in time and/or space. A sampler is a subsystem or operation that extracts samples from a continuous signal. A theoretical ideal sampler produces samples equivalent to the instantaneous value of the continuous signal at the desired points.

The original signal is retrievable from a sequence of samples, up to the Nyquist limit, by passing the sequence of samples through a type of low pass filter called a reconstruction filter.



Signal sampling representation. The continuous signal is represented with a green colored line while the discrete samples are indicated by the blue vertical lines.

DSP System (Filters and Sampling):

Add to The application the following features:

1. Filtering

   Implement FIR filters, ask the user for the input signal to be filtered, typeof filter he wants (low, high, band pass and band stop) and his specifications, according to it choose the appropriate window w (n), the appropriate infinite impulse response h(n), compute N and then compute the needed coefficients, finally convolve the input signal with the computed coefficients, draw the resulted signal and save the coefficients to text file.

2. varying the sampling rate

The user for the input signal, its maximum frequency, sampling rate and the values of M & L where M and L are the decimation and interpolation factors respectively.

The application will do up sampling by factor L, apply a low pass filter with cutoff frequency f max and finally the application will do down sampling by factor M.