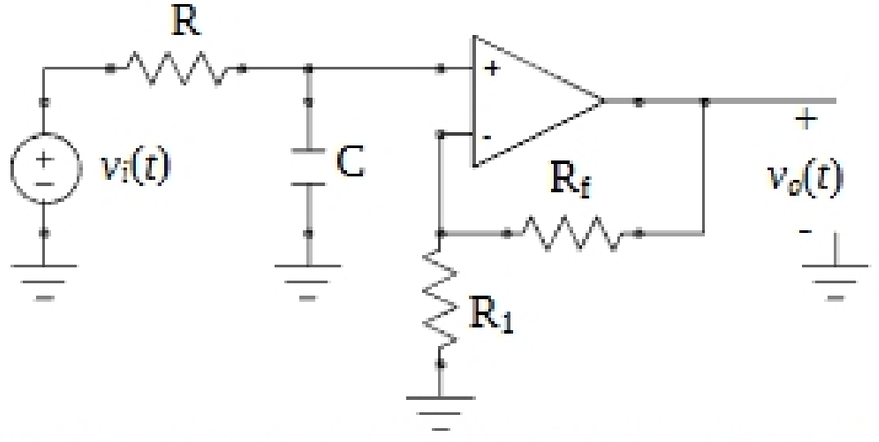
Filters:

Since capacitors and inductors result in frequency dependent impedance elements, it is possible to create circuits that filter out (or pass) signal energy over a specified frequency region.

Example:
Find the transfer function for the circuit below and sketch magnitude of the transfer function. Describe the filtering properties of this circuit with input $v_i(t)$ and output $v_o(t)$:



Show that this filter can be described as a low-pass filter.
(i.e. as □ □□, then $|H(j\omega)| \rightarrow$ 0, and as □ □0, then $|H(j\omega)| \rightarrow$ Gain at DC > 0).
Filtering Properties of Capacitive and Inductive Elements:

Consider the impedance magnitudes of the capacitor and inductor as a function of ω:

Capacitor: $|\hat{X}_C| = \frac{1}{|\omega C|}$ **Inductor:** $|\hat{X}_L| = |\omega L|$

- **For higher frequencies the capacitor impedance acts more like a short circuit while the inductor impedance acts more like an open circuit.**
- **For lower frequencies the inductor impedance acts more like a short circuit while the capacitor impedance acts more like an open circuit.**

Describe the capacitor impedance at DC.
Describe the inductor impedance at DC.

What kind of filtering goes on for current passing through a capacitor?
What kind of filtering goes on for a voltage drop across a capacitor?

What kind of filtering goes on for current passing through an inductor?
What kind of filtering goes on for a voltage drop across an inductor?

Four Basic Filter Types:

The most common types of filters are listed below:

- **Low-pass**
- **High-pass**
- **Band-pass**
- **Band-reject (or notch)**

Filter Terms:

The passband of the filter refers to a range of frequencies that pass through the filter relatively unimpeded. The stopband of the filter refers to a range of frequencies that pass through the filter with relatively strong attenuation.

The cut-off frequency refers to a frequency that determines the end of the passband region. For the band-pass and band-reject filters there are 2 cut-off frequencies. The 3 dB cut-off (or half power) frequency defines a cut-off frequency as the point where the magnitude to of the transfer function is 3 dB down from the maximum value of the transfer function.

Construction and Critical Design Parameters for the Four Basic Filter Types:

For all examples below assume voltage-input and voltage-output circuits: