# 16. RLC Circuits and Filters (Chapter 16) - NOTES

**TOPIC 1: Resonance**

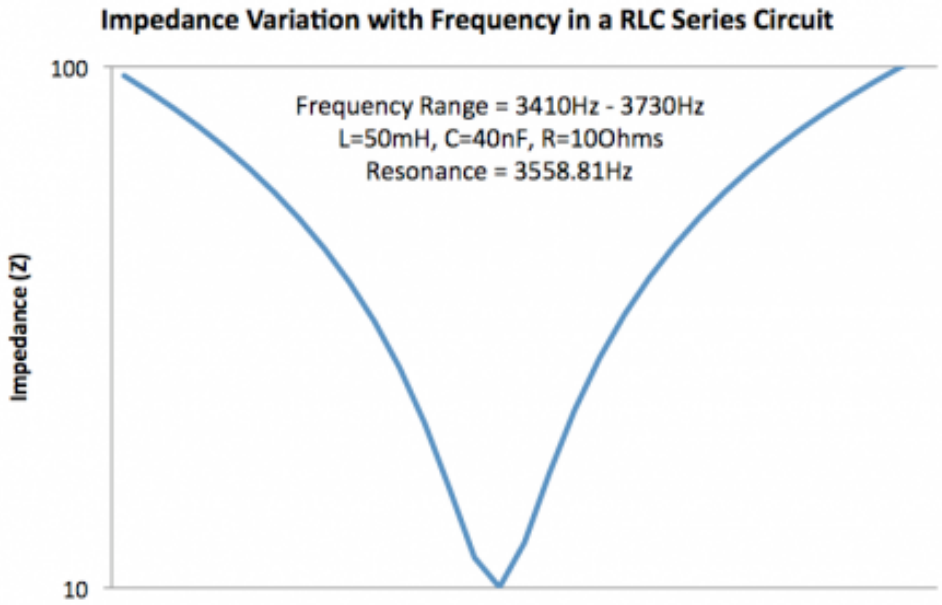
When an inductor and a capacitor are used in a series circuit their associated reactance works against each other and can operate at a certain frequency as if there were no inductor or capacitor in the circuit at all.

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

When $X_L = X_C$ resonance occurs

$$f_o = \frac{1}{2\pi\sqrt{LC}}$$

This phenomenon is commonly used to function as a filter either only letting through a certain range of frequencies or only blocking a certain range of frequencies.

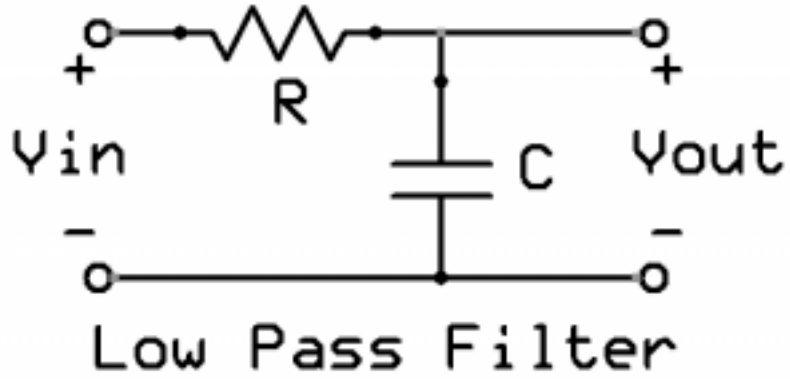



In this situation, the frequencies near resonance are not affected by the reactance in the circuit but when the frequencies are far away from resonant frequency the impedance is much higher and they are affected greater. These component values could be used in a circuit to filter out all frequencies below 3500Hz and above 3600Hz.

**TOPIC 2: Low Pass Filters**

However, many filter as even simpler than the RLC circuit. A simple low pass filter consists of a resistor and a capacitor and all frequencies below a specified frequency are allowed to "pass" through the filter, while all frequencies greater than the specified frequency are "blocked".

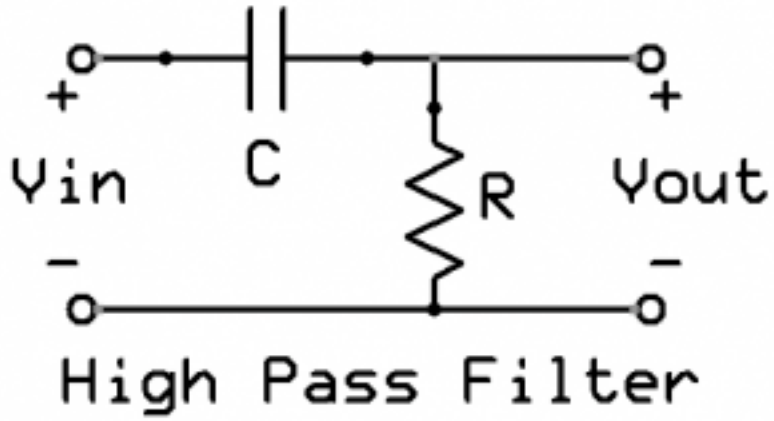
$$\text{Corner Frequency} = f = \frac{1}{2\pi RC}$$




**TOPIC 3: High Pass Filters**

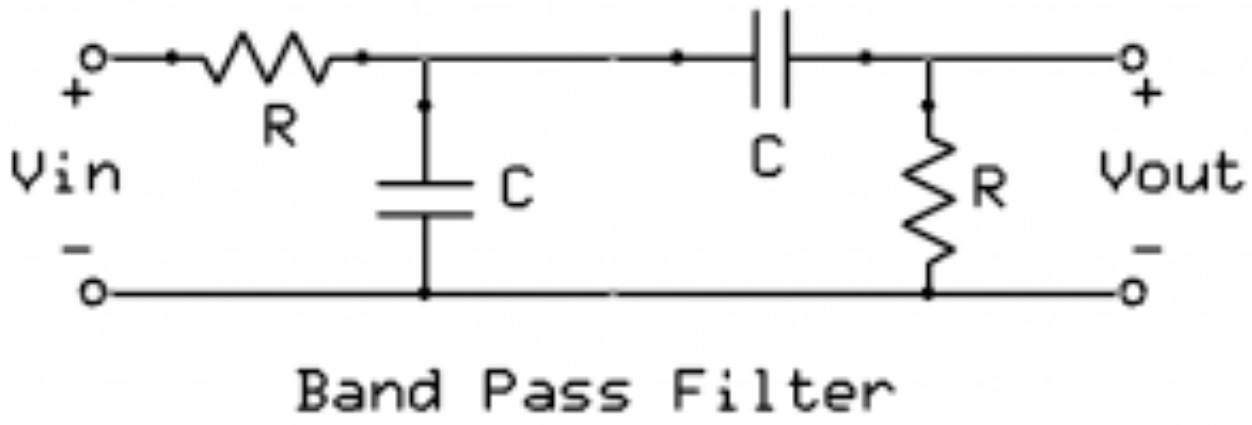
A High Pass Filter is the opposite of the Low Pass Filter because it allows all frequencies above a specified frequency to "pass" through and blocks all frequencies lower.

$$\text{Corner Frequency} = f = \frac{1}{2\pi RC}$$



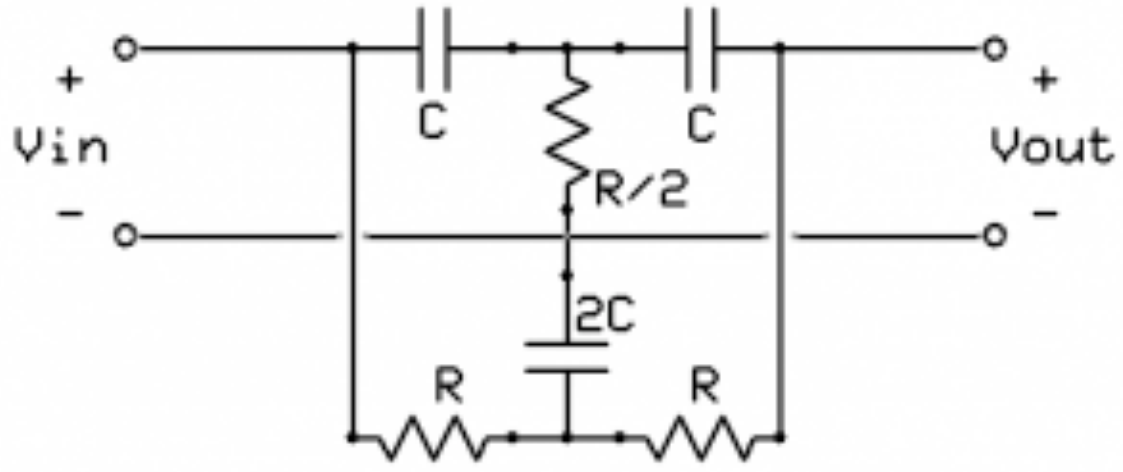
**TOPIC 4: Band Pass and Band Reject Filters**

The Band Pass Filter allows a small window of frequencies to pass through and blocks all frequencies above and below this window. The Band Pass Filter is just a simple combination of the Low Pass and High Pass filters. The corner frequency of the low pass filter must be chosen high than the frequency of the high pass filter. The same equation applies to determine each corner frequency.




Band Pass Filter

A Band Reject Filter will reject all frequencies in a window and allow all frequencies greater or lesser than the window to pass. The center of the reject window is determined by the corner frequency equation from the low pass or high pass filter.




Band Reject Filter

You should now be prepared to answer the following questions.

1. If an inductor of 100mH and a capacitor of 100nF where used in a series circuit together give the resonant frequency.

2. If a resistor (1000 Ohms), an inductor (250mH), and a capacitor (180nF) where placed in series with one another what is the change in impedance that would occur if an AC power source applied to the circuit was changed from 1000Hz to 2000Hz?

3. A low pass filter is needed to filter a signal coming from a microphone to eliminate high frequency electrical noise. You decide to filter out everything above 18kHz and you are stuck using a 10nF capacitor but have an array of different resistors to choose from. Give the resistance you need to complete the circuit.

4. A certain vibration sensor produces a frequency as its output based on the frequency of the vibration. This sensor is then sent to a computer for processing but along the way it picks up high frequency electrical noise through crosstalk with other signals in the computer. Additionally the sensor picks up some low frequency vibrations that you want to ignore in your results. Both the high frequency noise and the low frequency vibrations need to be filtered out with a Band Pass Filter. The area of interest to your test ranges between 10kHz and 25kHz. Once again you are stuck with using a 10nF capacitor. Give the two values of resistors needed for the circuit.