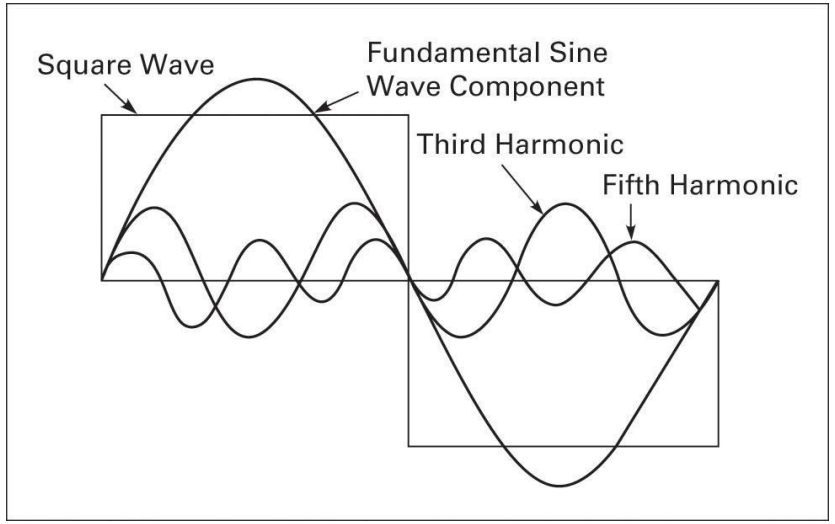
ECE132: Basic Electrical and Electronics Engineering Lab

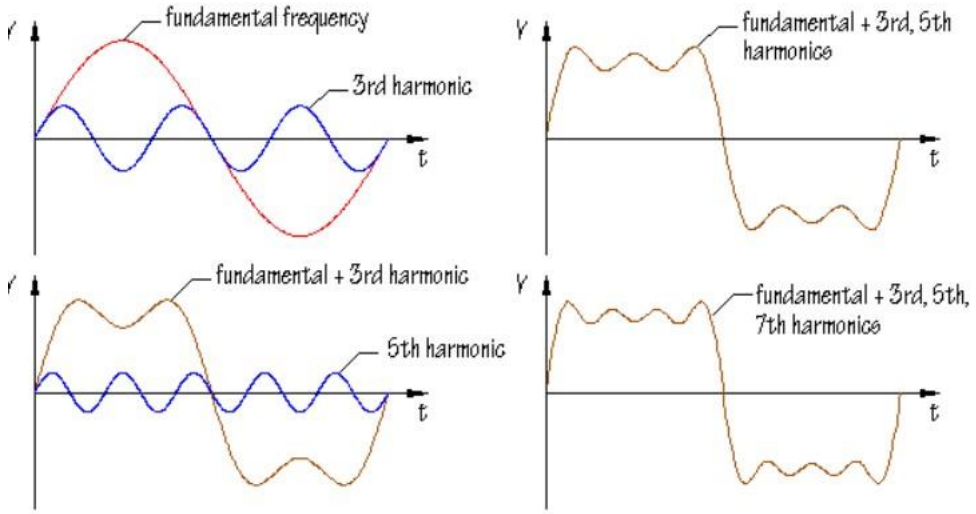
Experiment 8:

To study the effect of frequency on the output voltage in low-pass and high-pass filters

Introduction

A filter is a device or process that removes some unwanted components or features from a signal. The defining feature of filters being the complete or partial suppression of some aspects of the signal.





Introduction

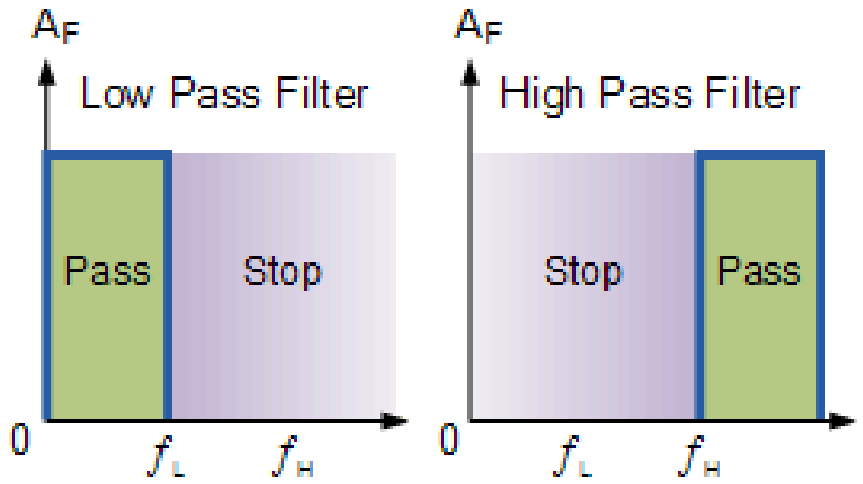
Depending on the type of element used in their construction, filters are classified into two types, such as:

- **Passive Filters:** A passive filter is built with passive components such as resistors, capacitors and inductors.
- **Active Filters:** An active filter makes use of active elements such as transistors, op-amps in addition to resistor and capacitors.

Introduction

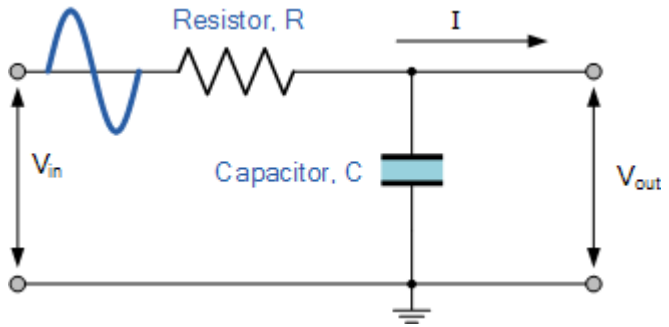
According to the operating frequency range, filters may also be classified as:

1. **Low Pass Filter:** The low pass filter only allows low frequency signals from 0 Hz to its cut-off frequency, f_L point to pass while blocking any higher frequency signals.
2. **High Pass Filter:** The high pass filter only allows high frequency signals from its cut-off frequency, f_L point and higher to infinity to pass through while blocking those any lower.



Low Pass filter

A simple passive RC Low Pass Filter or LPF, can be easily made by connecting together in series a single Resistor with a single Capacitor as shown below. In this type of filter arrangement the input signal (V_{IN}) is applied to the series combination (both the Resistor and Capacitor together) but the output signal (V_{OUT}) is taken across the capacitor only.



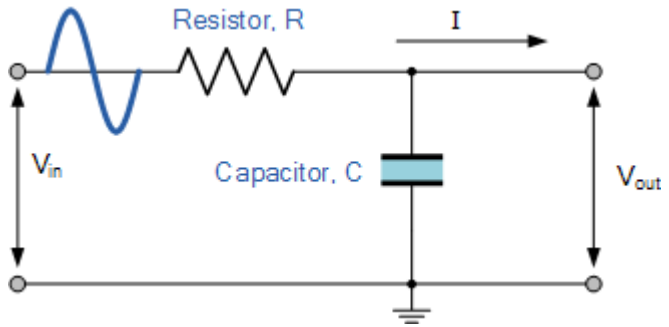
Low Pass filter

$$V_{out} = V_{in} \times \frac{R_2}{R_1 + R_2}$$

where: $R_1 + R_2 = R_T$, the total resistance of the circuit

$$X_C = \frac{1}{2\pi f C} \text{ in Ohm's}$$

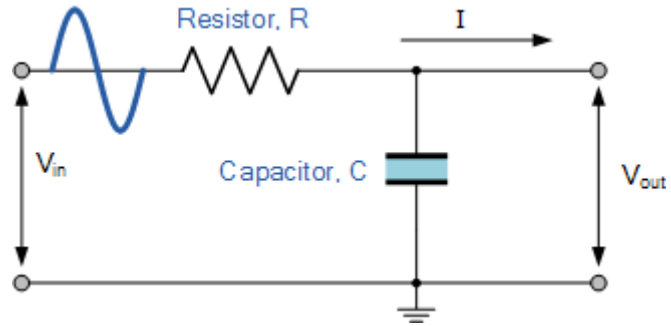
$$Z = \sqrt{R^2 + X_C^2}$$



$$V_{out} = V_{in} \times \frac{X_C}{\sqrt{R^2 + X_C^2}} = V_{in} \frac{X_C}{Z}$$

Low Pass filter

A Low Pass Filter circuit consisting of a resistor of 4.7kΩ in series with a capacitor of 47nF is connected across a 10v sinusoidal supply. Calculate the output voltage (VOUT) at a frequency of 100Hz and again at frequency of 10,000Hz or 10kHz.

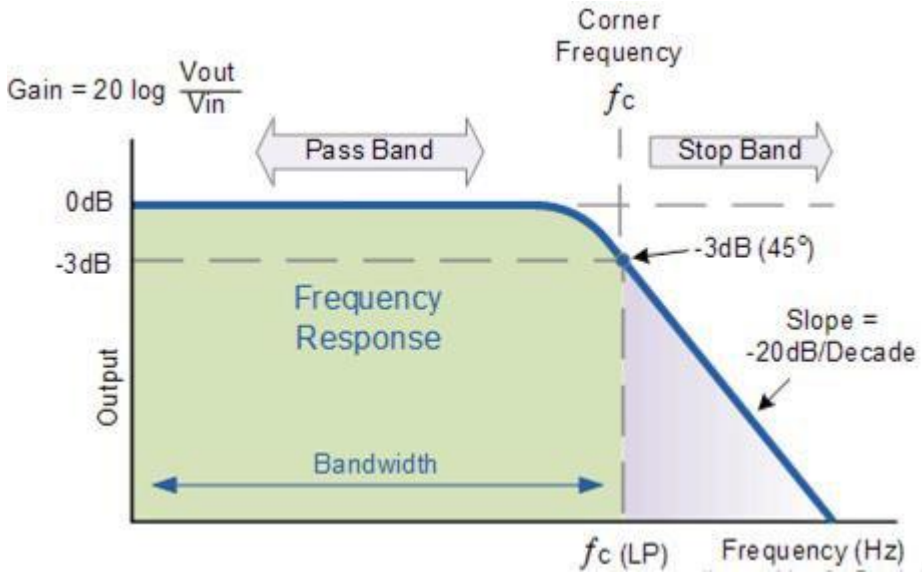


$$Xc = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 100 \times 47 \times 10^{-9}} = 33{,}863\Omega$$

$$V_{OUT} = V_{IN} \times \frac{Xc}{\sqrt{R^2 + X_C^2}} = 10 \times \frac{33863}{\sqrt{4700^2 + 33863^2}} = 9.9v$$

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 10{,}000 \times 47 \times 10^{-9}} = 338.6\Omega$$

$$V_{OUT} = V_{IN} \times \frac{X_C}{\sqrt{R^2 + X_C^2}} = 10 \times \frac{338.6}{\sqrt{4700^2 + 338.6^2}} = 0.718v$$



Low Pass filter

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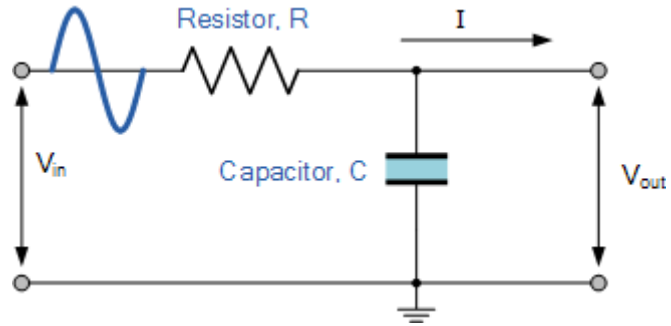
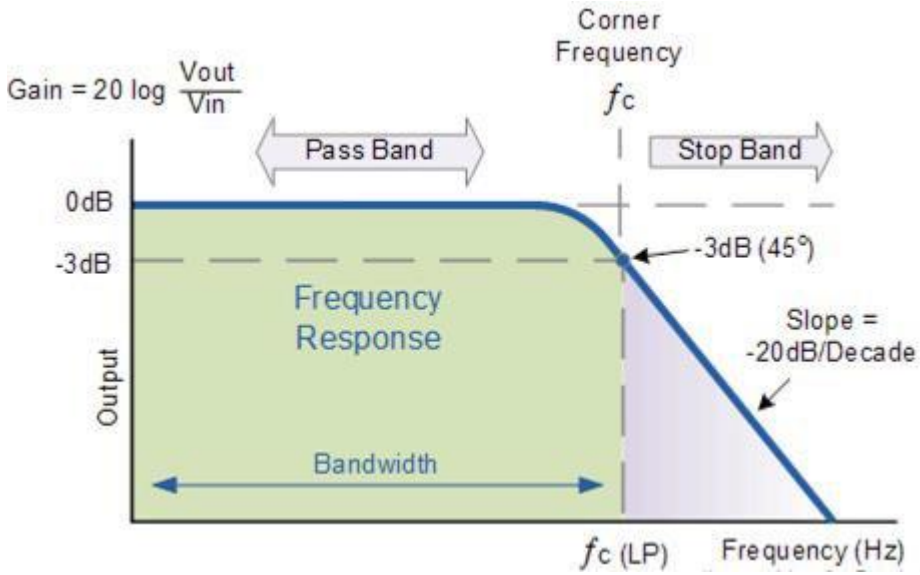
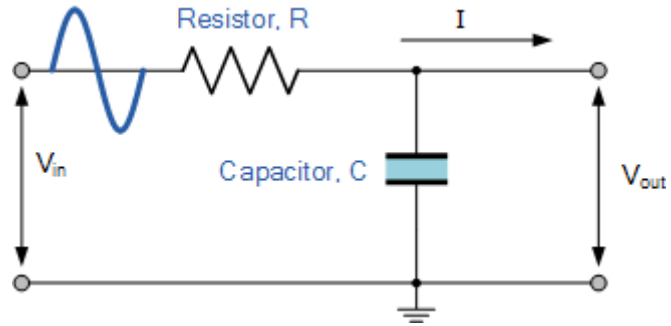


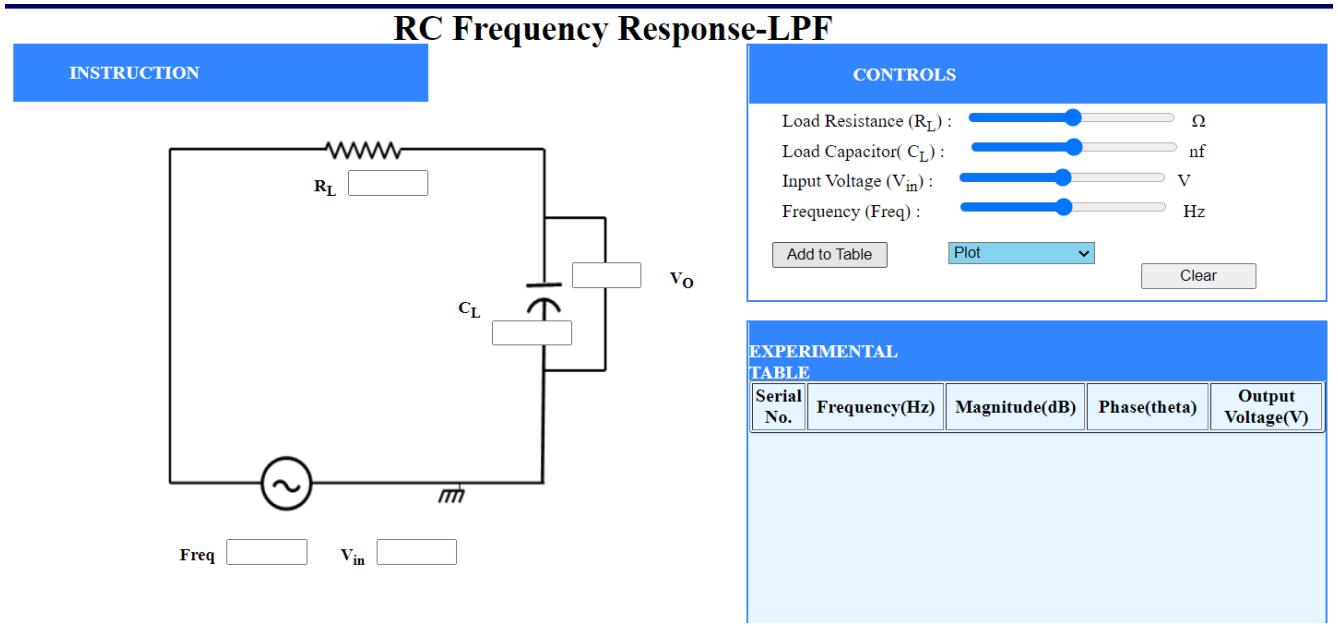
$$f_c = \frac{1}{2\pi RC} = \frac{1}{2\pi \times 4700 \times 47 \times 10^{-9}} = 720\text{Hz}$$



Low Pass filter

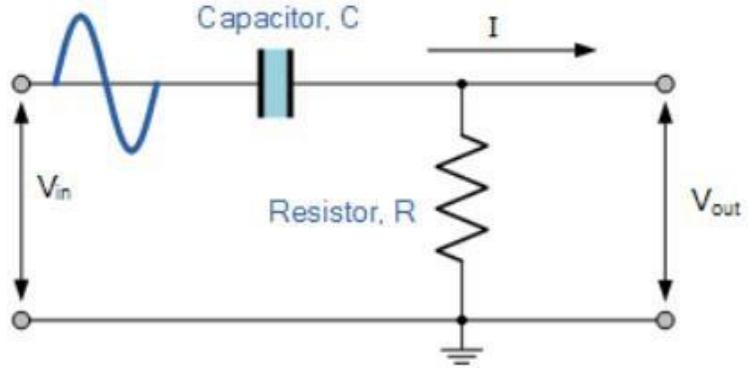
A Low Pass Filter circuit consisting of a resistor of 4.7kΩ in series with a capacitor of 40nF is connected across a 10v sinusoidal supply. Calculate the output voltage (VOUT) at a frequency of 100Hz and again at frequency of 100Hz or 10kHz.

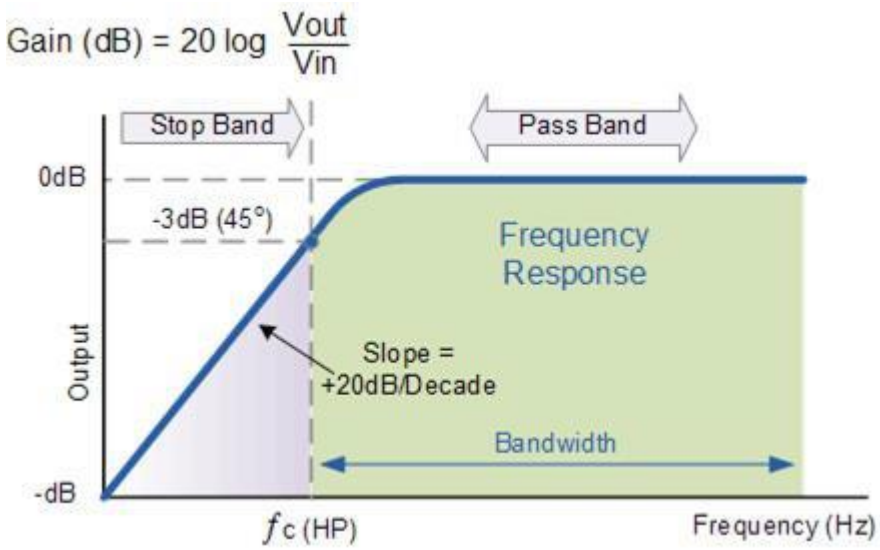




High Pass filter

In this circuit arrangement, the reactance of the capacitor is very high at low frequencies so the capacitor acts like an open circuit and blocks any input signals at VIN until the cut-off frequency point is reached.

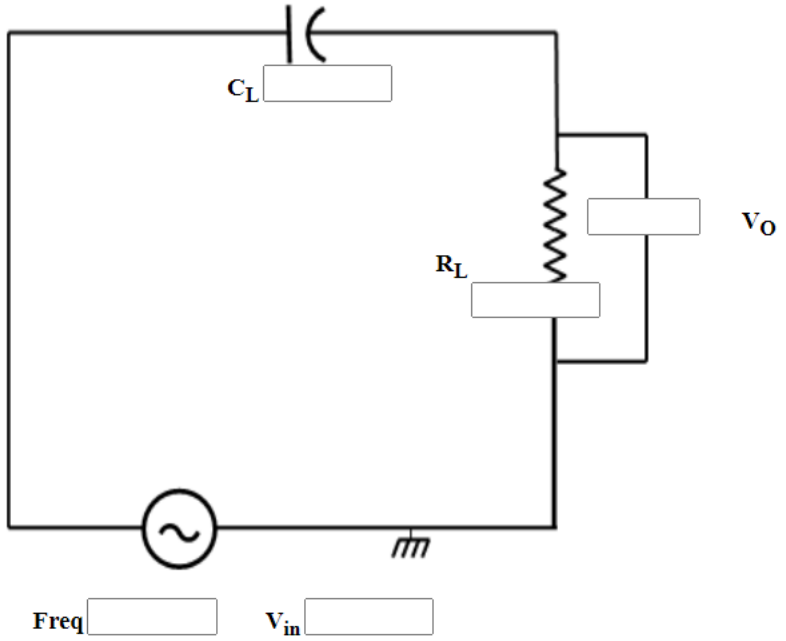




High Pass filter

RC Frequency Response-HPF

INSTRUCTION



CONTROLS

Load Resistance (R_L) : Ω

Load Capacitor(C_L) : nf

Input Voltage (V_{in}) : V

Frequency (Freq) : Hz

Add to Table | Plot | Clear

EXPERIMENTAL TABLE

Serial No.	Frequency(Hz)	Magnitude(dB)	Phase(theta)	Output Voltage(V)

THANKS TO ALL