New Mansoura University

جامعة المنصورة الجديدة

PHYSICS LAB

Filters

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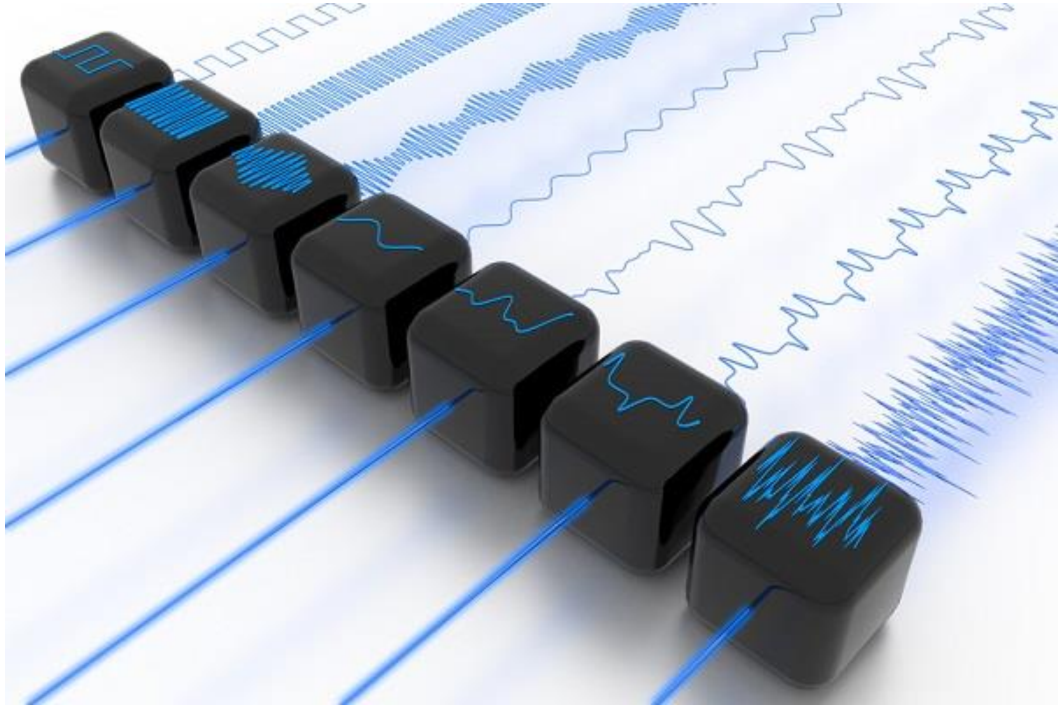
Filters

RF filter solutions play an important role to improve the quality of the received signals by avoiding (filtering out) unnecessary frequency components from the received spectrum. This is significant at receiving end since the signal strength is often too low at the receivers. Any noise could potentially impact the received signal quality and thus information loss.



Types of filters

The most important types of filters are Low pass filters and high pass filters.

1- High pass filters

This type of filters prevents low frequency range and passes high frequencies.

Applications of Low pass filters

- HPFs are used to reject any low-frequency components for the system
- In audio devices HPFs are used to filter low-frequency components below 2.5 kHz.
- RF laboratories use HPFs to build various test setups which require low-frequency isolation.
- High Pass Filters are used in harmonics measurements to avoid fundamental signals from the source and only allow high-frequency harmonics range.
- HPFs are used in radio receivers and satellite technology to attenuate low-frequency noise.

Types of filters

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2- Low pass filters

This type of filters prevents high frequency range and passes low frequencies.

Applications of Low pass filters

- Cut off high-frequency components in any system above its operating frequency range.
- Low pass filters are used in radio receivers to avoid high-frequency interference. Example: FM radio broadcasting operates at 88MHz to 108 MHz range, a low pass filter with a cut-off frequency just above 108MHz is used in FM radio receivers.
- In audio devices, low pass filters are used to filter treble sound from 2.5 kHz to 20 kHz (high-frequency components of the audio spectrum) to subwoofers. This frequency selection significantly improves the audio quality. Each speaker (subwoofer, mid-range speakers, and tweeter) is designed to operate within a specific frequency range.
- In RF test laboratories, low pass filters are used to construct complex test setups. The main purpose of low pass filters is to avoid high-frequency interference and improve test setup accuracy.

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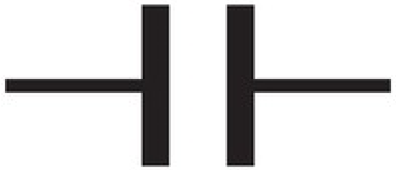
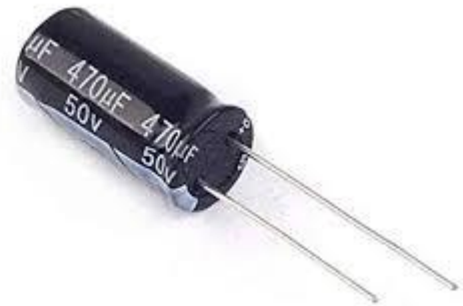
Note

In AC Circuits

For capacitors

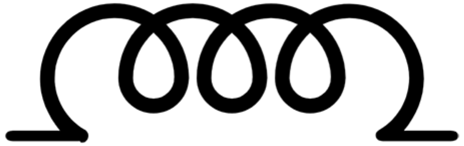


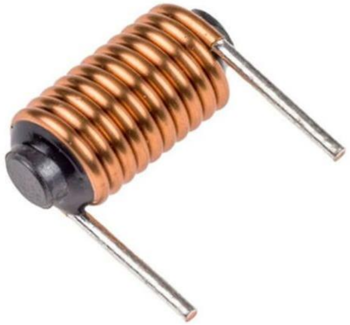


Capacitor: $X_C = \dfrac{1}{\omega C} = \dfrac{1}{2\pi f C}$

- When F increase → Xc decrease

For inductors





Inductor: $X_L = \omega L = 2\pi f L$

- When F increase → XL increase

Aim.

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- ✓ Recognize the meaning of electronic filters and their usages.
- ✓ Recognize the meaning of Gain.
- ✓ Calculation the cutoff frequency in RC circuits by connecting low and high pass filter circuit.
- ✓ Calculation of Attenuation factor.

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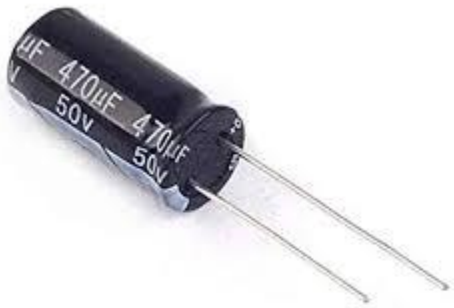
Apparatus.

- *Function Generator.*

- *Oscilloscope.*

- *Capacitor.*



- *Bread board.*

- *Resistor.*

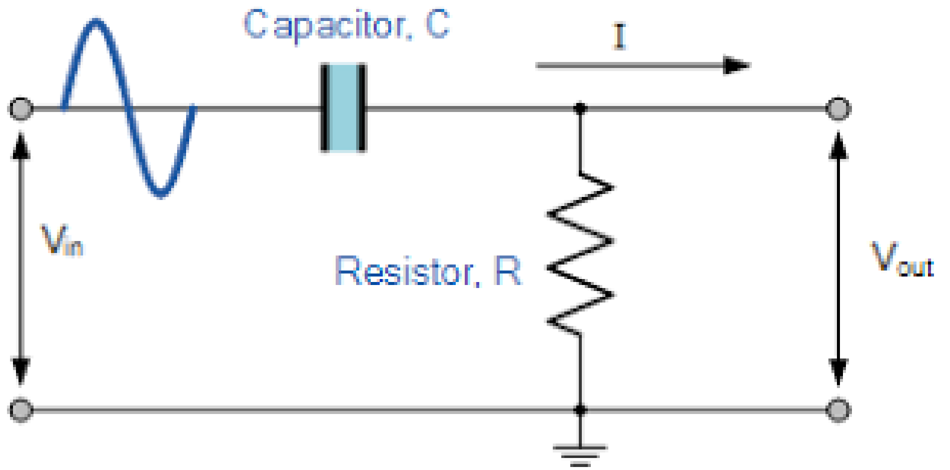
Theory

High Pass filter using RC circuit.

$$V_{out} = \frac{R}{\sqrt{R^2+(X_L-Xc)^2}}\; V_{in}$$

X_L here is not applicable i.e. equal zero

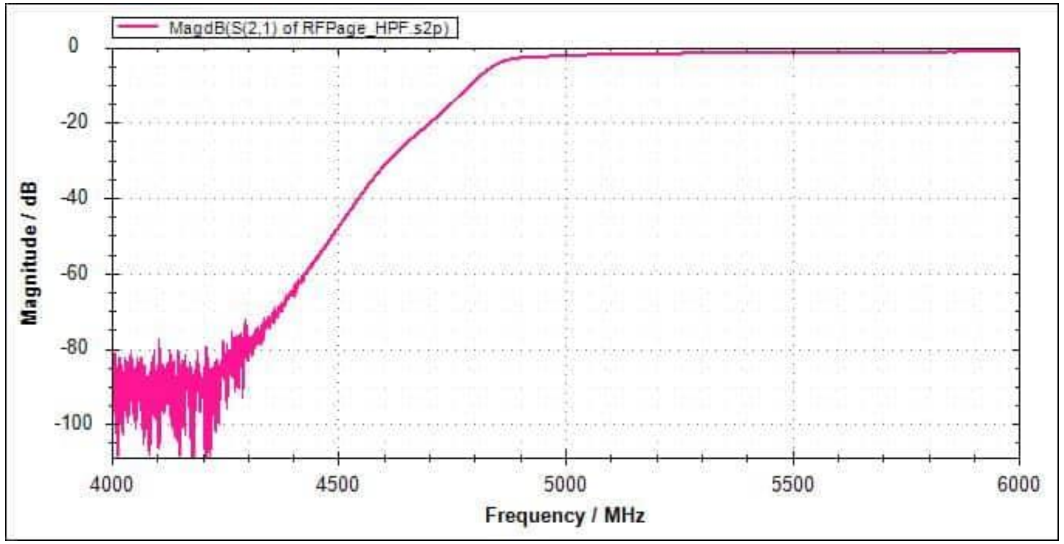
$$Xc = \frac{1}{2\pi f C}$$



Only High frequencies are allowed to pass

So, if frequency f increases ↑ ⇒ Xc decreases ↓

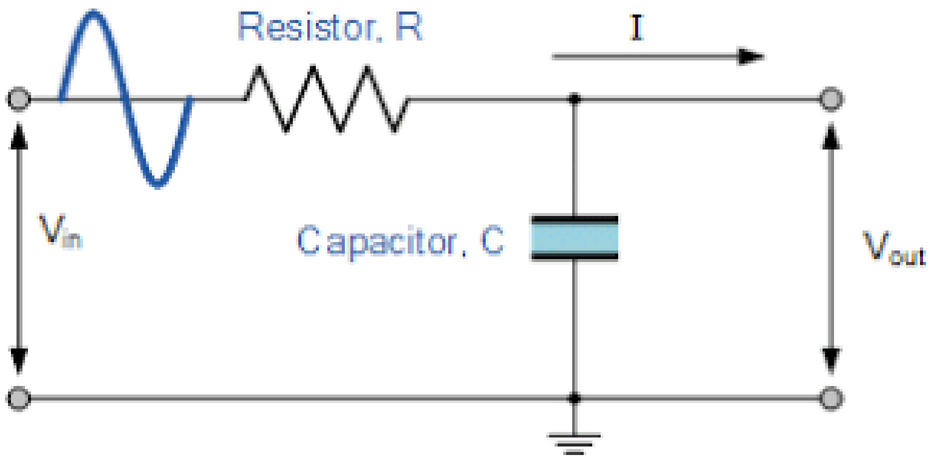
V_{out} will increase ↑



Note that $Gain(dB) = 20 \log \left(\frac{V_{out}}{V_{in}}\right)$

Low Pass filter using RC circuit.

$$V_{out} = \frac{X_c}{\sqrt{R^2 + (X_L - Xc)^2}} V_{in}$$



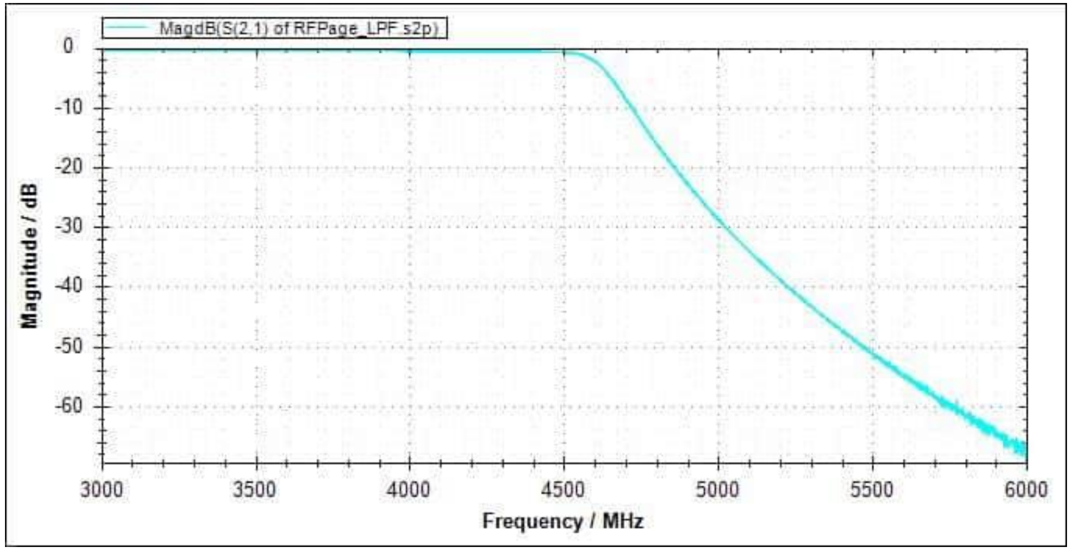
Only low frequencies are allowed to pass

X_L here is not applicable i.e. equal zero

$$Xc = \frac{1}{2\pi f C}$$

So, if frequency f increases ↑ ➡ Xc decrease ↑

V_{out} will decreases ↓



Note that

$$Gain(dB) = 20 \log \left(\frac{V_{out}}{V_{in}}\right)$$

If two curves (High and low pass) are plotted together, the intercept of the two curves will denotes on the cutoff frequency.

At cutoff frequency.

$V_R = V_C$

$I\,R = I\,Xc$

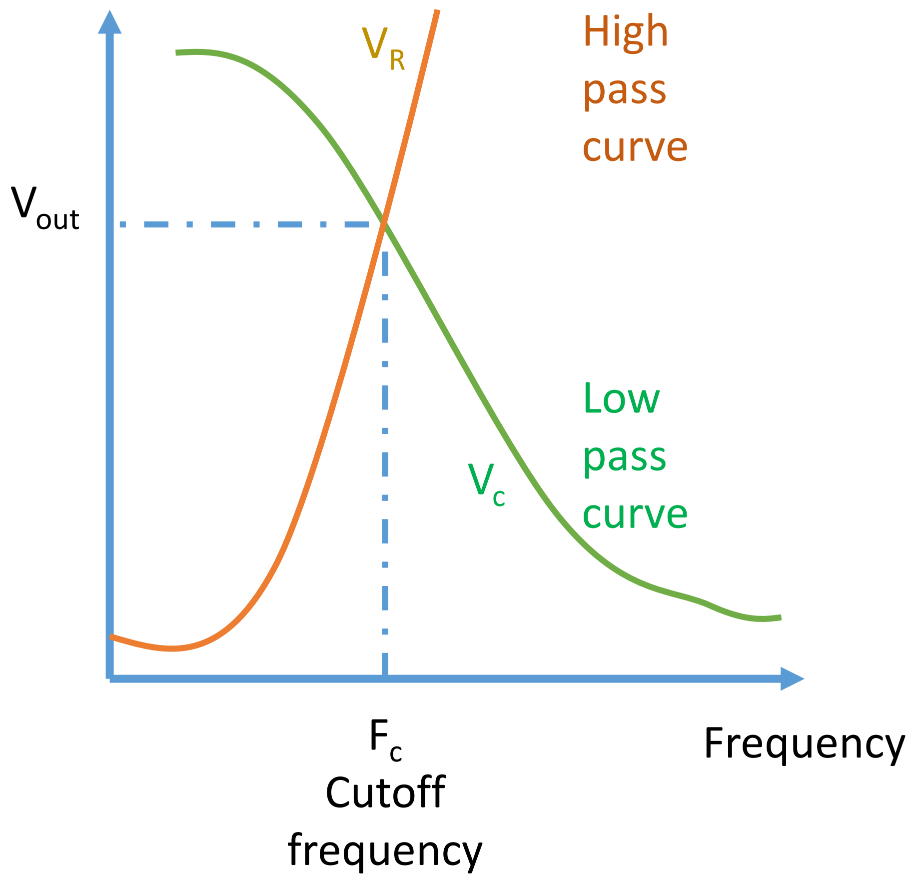
$$R = \frac{1}{\omega_0 C} = \frac{1}{2\pi f c C}$$

$$F_c = \frac{1}{2\pi R C}$$

Attenuation Factor: α

$\alpha = 1 - G$

$$= 1 - \frac{V_{out}}{V_{in}}$$



Procedures

1. Connect the circuit as shown in Figure.
2. Vary the value of frequency f and determines V_{out} on the oscilloscope.
3. Connect the circuit as shown in Figure.
4. Vary the value of frequency f and determines V_{out} on the oscilloscope.

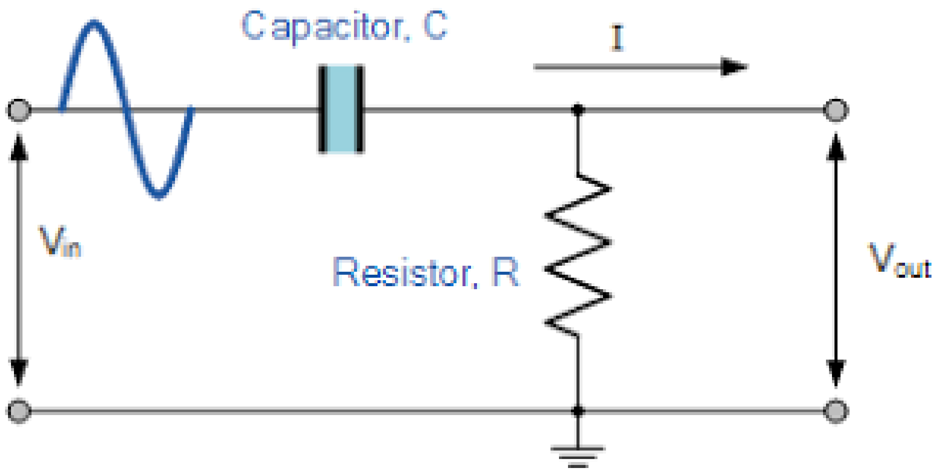


Fig. 1

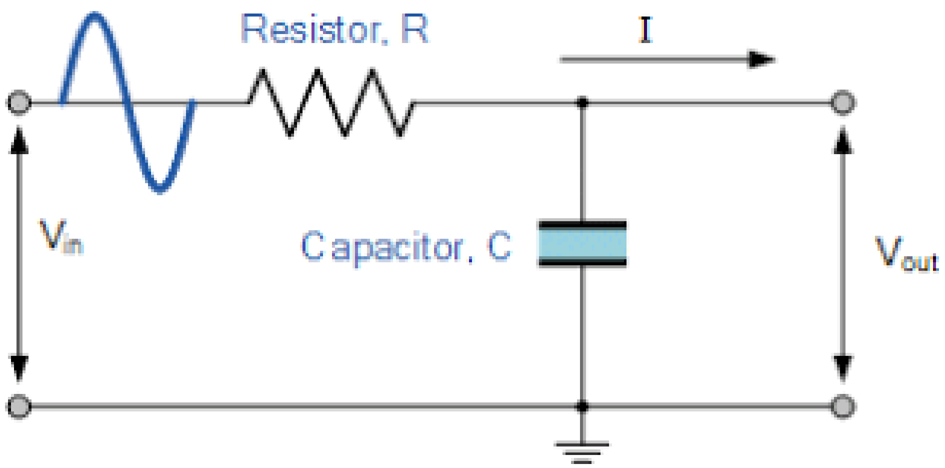


Fig. 2

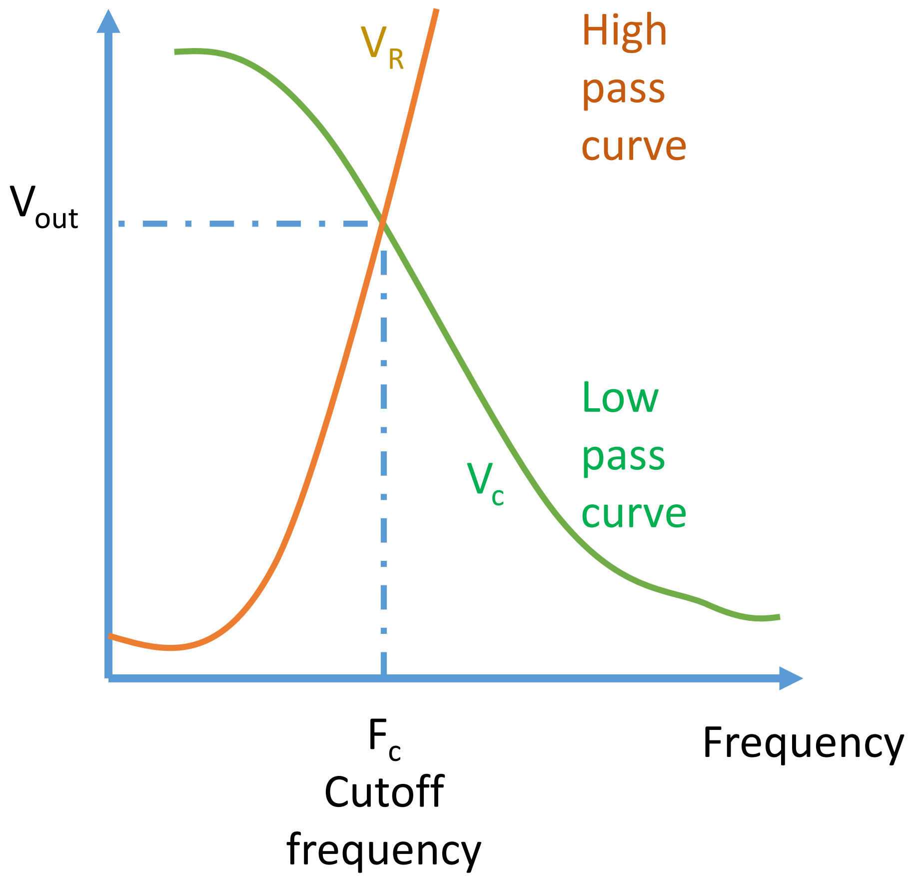
Results:

High pass curve

F (Hz)						
V_{out}						

Low pass curve

F (Hz)						
V_{out}						



F_c =...........

α = ...

THANK YOU