Experiment 10

Filters

ابو ريدة

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Data:

$c = 0.1\ \mu F$

$V_{in} = 4\ volt$

$R = 1\ K\Omega$

		Low-pasa		High-pass	
f (KHz)	ω (rad/sec)	V_{out} (volt)	A	V_{out} (volt)	A
0.2	1256	3.96	0.99	0.53	0.1325
0.3	1884	3.92	0.98	0.75	0.1875
0.5	3140	3.78	0.945	1.16	0.29
0.6	3768	3.7	0.925	1.45	0.3625
0.8	5024	3.5	0.875	1.78	0.445
1	6280	3.26	0.815	2.1	0.525
1.2	7536	3.15	0.7875	2.44	0.61
1.5	9420	2.84	0.71	2.72	0.68
1.8	11304	2.56	0.64	2.91	0.7275
2	12560	2.4	0.6	3.02	0.755
3	18840	1.85	0.4625	3.45	0.8625
5	31400	1.2	0.3	3.66	0.915
8	50240	0.8	0.2	3.875	0.96875
10	62800	0.63	0.1575	3.96	0.99

Note: The original datasheet signed by Dr.Khalid
is attached to the end of report

Abstract:

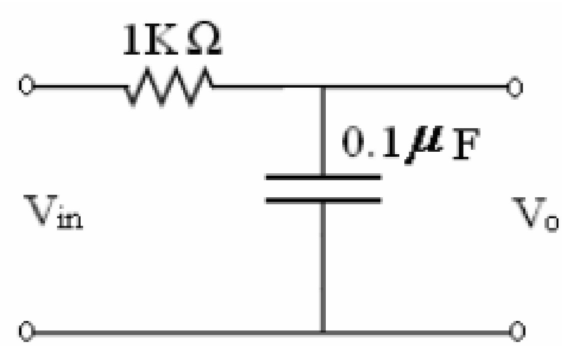
The purpose of the experiment is to examine filters and their operation, and to determine the frequency of the band pass filters. This is achieved by connecting filter circuits, reading data from a DSO screen and plotting graphs to identify the frequency. The angular frequency (ω -3dB) is then calculated, serving as the dividing line between high and low filter attenuation.

Introduction:

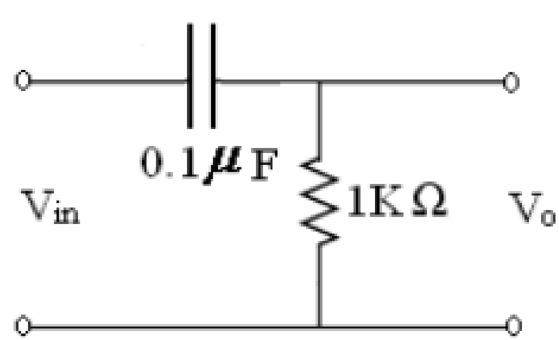
Apparatus:

1kΩ resistor, 1μF capacitor, a circuit board, a signal generator and an oscilloscope.

In this experiment will build this two filters :



a) Low-pass filter.



b) High-pass filter.

In electronic circuits, filters are devices used to pass certain frequencies while blocking others. Unwanted frequencies are reduced in amplitude, a process known as attenuation. The attenuation factor (A) of a filter at a specific frequency.

For Low-pass Filter:

⇨ The *attenuation factor*, A, is defined as follows:

$$A = \frac{V_{C0}}{V_{in0}} = \frac{V_{in0}}{\sqrt{1+\omega^2 C^2 R^2}}.$$

⇨ For reasons to be explained later. let us define

$$\omega_{-3dB} = \frac{1}{RC},$$

⇨ then, the attenuation factor takes the following form:

$$A = \frac{1}{\sqrt{1+(\frac{\omega}{\omega_{-3dB}})^2}}.$$

We have three cases:

1- When ω is much greater than ω-3dB, A is close to zero and the output signal is highly suppressed.
2- When ω is much less than ω-3dB, A is close to 1 and the output signal's amplitude is equal to the input's.
3- When ω is equal to ω-3dB, A is equal to 0.707, resulting in the output signal's amplitude being 0.707 times the input's amplitude. This value distinguishes between passed signals and those with significant attenuation.

For High-pass Filter:

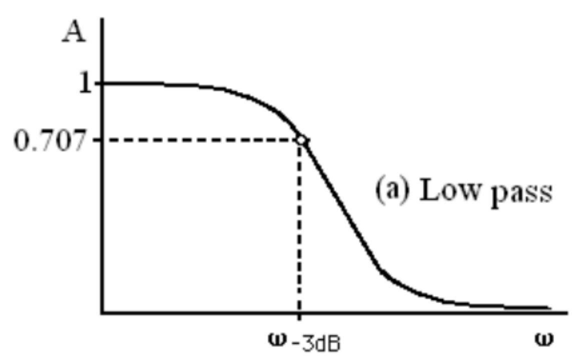
The attenuation factor, A can be deduced using exactly the same procedure used in the case of the low pass filter as:

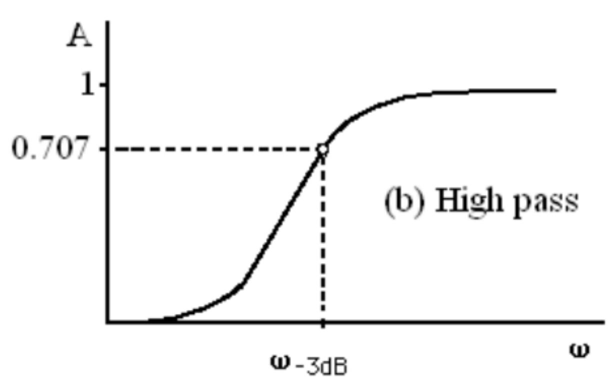
$$A = \frac{1}{\sqrt{1+(\frac{\omega_{-3dB}}{\omega})^2}}$$

We have three cases:

1- When ω is much less than ω-3dB, A is close to zero and the output signal is highly suppressed.
2- When ω is much greater than ω-3dB, A is close to 1, resulting in the signal passing without suppression.
3- When ω is equal to ω-3dB, A is equal to 0.707, marking the boundary between passed and suppressed signals.

When you represent the graph of A vs ω:





Data & Analysis:

Theoretically:

$$\omega_{-3dB} = \frac{1}{RC}$$

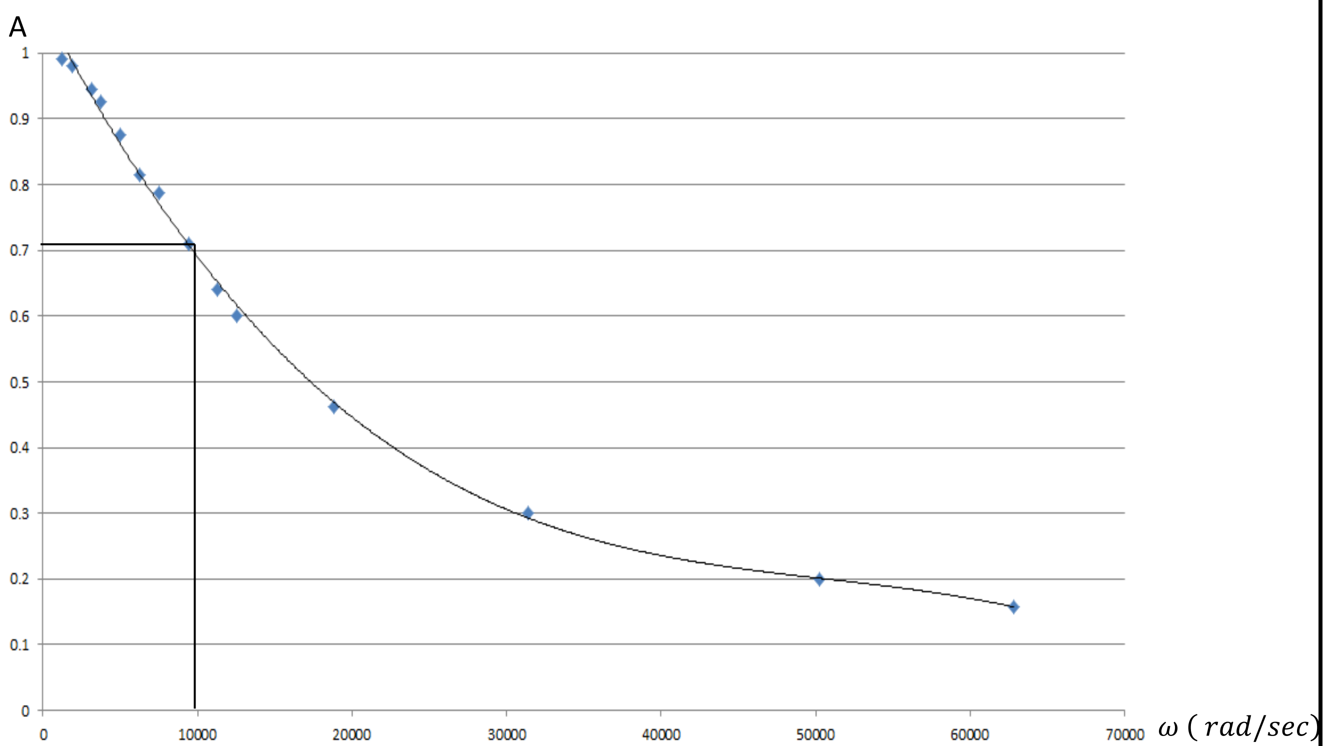
$$\omega_{-3dB} = \frac{1}{10^{-4}}$$

$$\omega_{-3dB} = 1.0 * 10^4$$

Experimentally:

⇨ For Low-pass Filter:

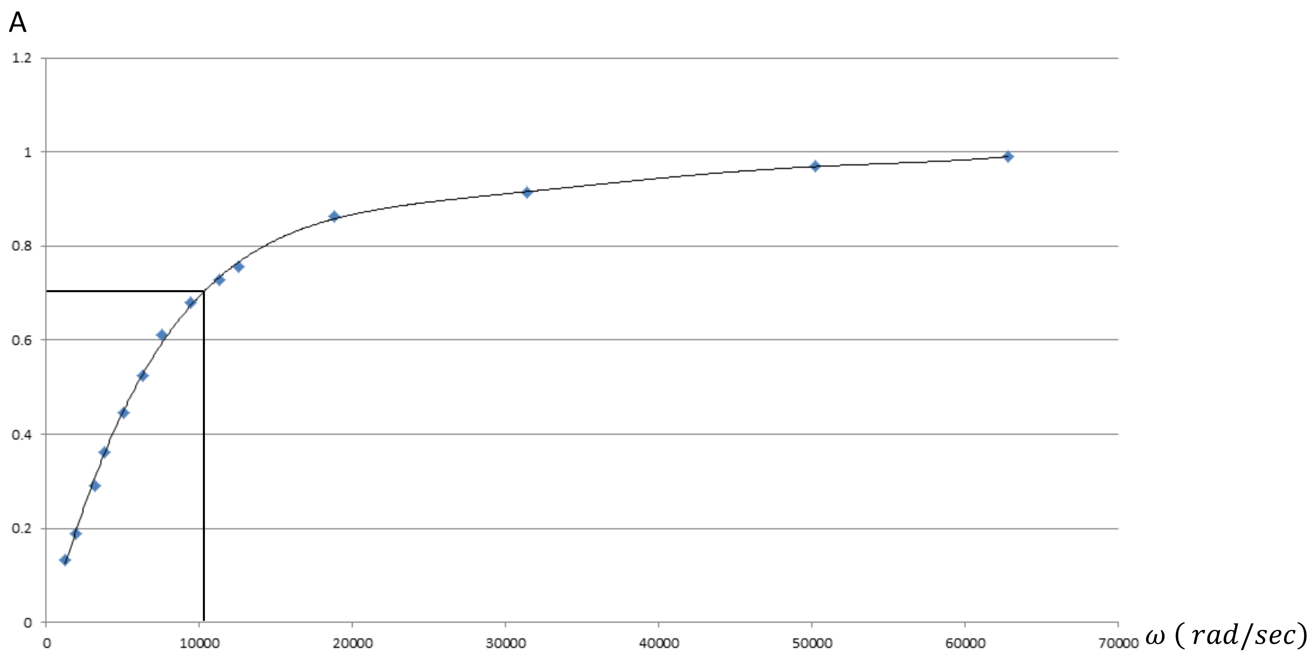
$$A \ VS \ \omega \ (rad/sec)$$



$$\omega_{-3dB} = 0.99 * 10^4$$

⇨ For Low-pass Filter:

$$A\ VS\ \omega\ (rad/sec)$$



$$\omega_{-3dB} = 1.01 * 10^4$$

The Theoretically result equal $\omega_{-3dB} = 1.0 * 10^4$ and the experimentally result from Low-pass Filter equal $\omega_{-3dB} = 0.99 * 10^4$ and experimentally result from Low-pass Filter equal $\omega_{-3dB} = 1.01 * 10^4$, The results are very similar and the difference is due to the inaccuracy of the measurement.

Conclusion:

Circuits with a response that depends upon the frequency of the input voltage are known as filters. Filter circuits can be used to perform a number of important functions in a system. Although filters can be made from resistors and capacitors, And ω_{-3dB} marks the threshold between frequencies that experience high attenuation and those that pass without it. By attenuation, we mean a decrease in amplitude such that the signals passing without it retain a large amplitude, similar to the source, whereas those with attenuation have a small amplitude.