Physics Department

Physics 112

Experiment 10: Filters

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Abstract:

The aim of experiment is to study the effect of the two types of RC-Filters (high and low pass) on output voltage in terms of:

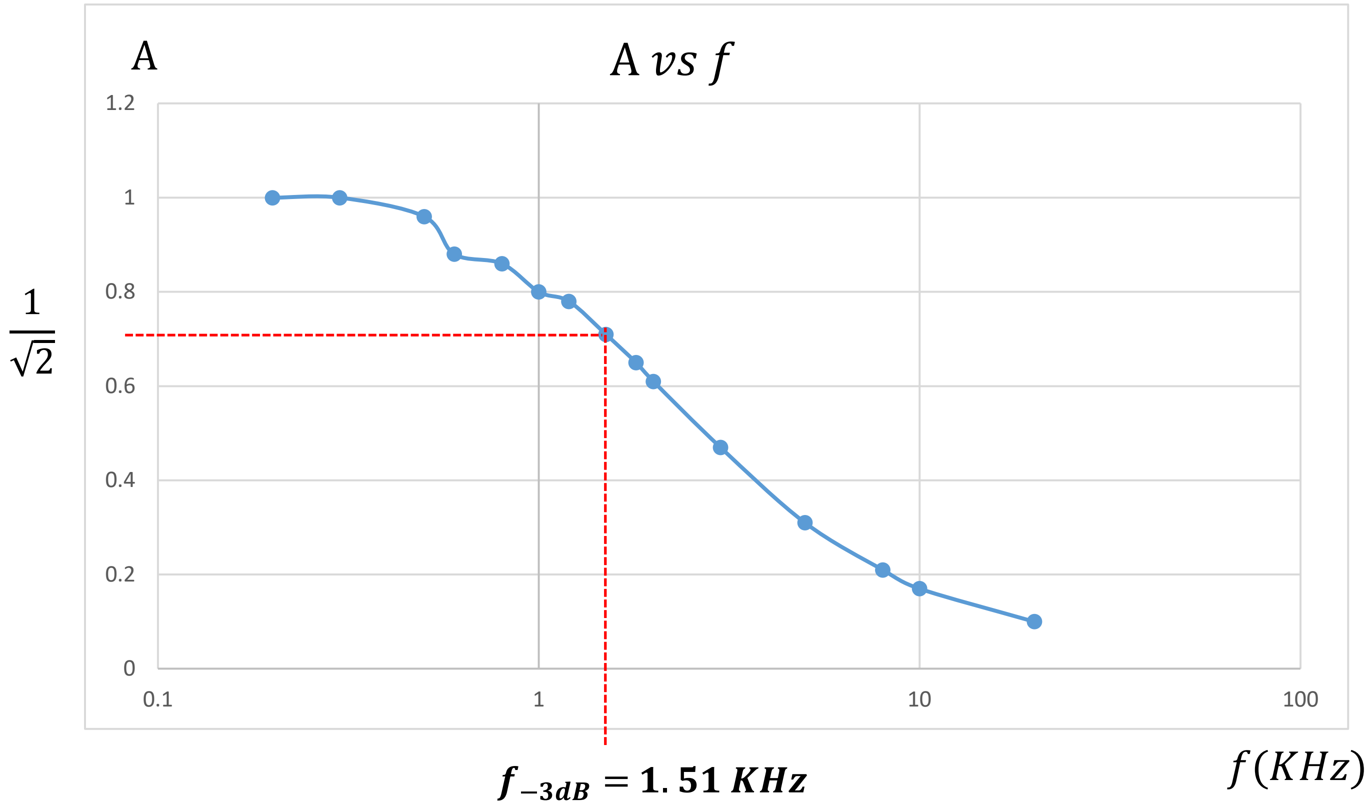
1- Attenuation (decreasing the amplitude of the input signal).

2- The shape and behavior of the output signal.

The main result is: $\boldsymbol{w_{-3dB} = 1.03 * 10^4 \frac{rad}{s}}$

Calculations:

GRAPH 1: Low-pass filter: –



From the graph:

The intersection point is $f_{-3dB} = 1.51\ KHz \gg\ w_{-3dB} = 2\pi f_{-3dB}$

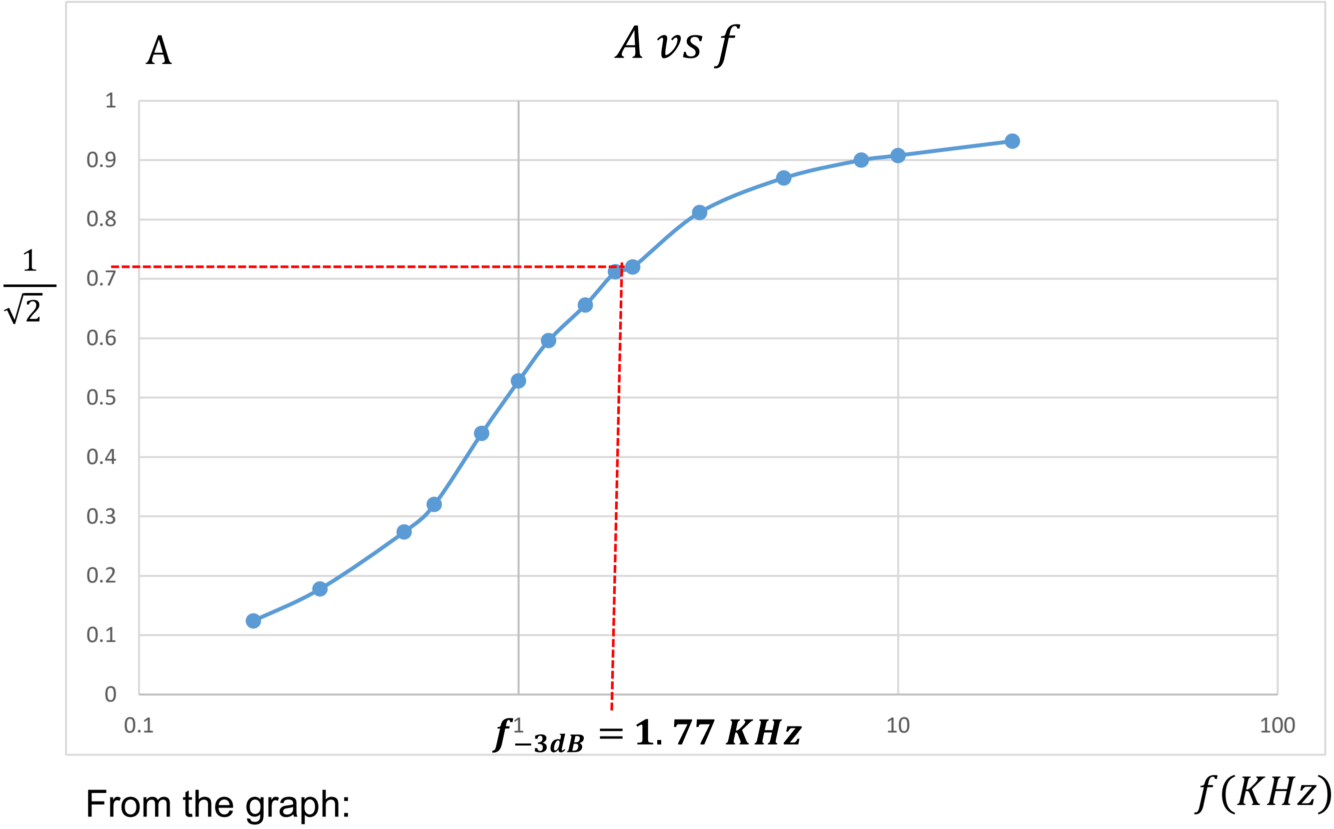
$= 2\pi \times 1.51 \times 10^3 = 9.48 * 10^3\ rad/s$

Note: (we use desmos to find the intersection point)

Theoretically:

$\omega_{-3dB} = \frac{1}{RC} = \frac{1}{1000*0.1*10^{-6}} = 1 * 10^4 \frac{rad}{s}$.

GRAPH 2: High-pass filter: -



From the graph:

The intersection point is $f_{-3dB} = 1.77\ KHz \gg \ w_{-3dB} = 2\pi f_{-3dB}$

$= \ 2\pi \times 1.77 \times 10^3 = 1.11 * 10^4\ rad/s$

Note: (we use desmos to find the intersection point)

Theoretically:

$$\omega_{-3dB} = \frac{1}{RC} = \frac{1}{1000*0.1*10^{-6}} = 1 * 10^4\ \frac{rad}{s}.$$

By taking the average value of f_{-3dB} from high and low pass filters:

$$f_{-3dB} = \frac{f1 + f2}{2} = \frac{1.51 + 1.77}{2} = 1.64\ KHz$$

$$and\ w_{-3dB} = \ 2\pi f_{-3dB} = 2\pi * 1.64 * 10^3 = 1.03 * 10^4\ \frac{rad}{s}$$

Results and conclusion:

This experiment discussed: 1) the difference between low-pass and high-pass filters, as well as 2) how to find the integration and differentiation using the filter circuits: Low and High pass filter. To begin, the theoretical value of omega was found to equal to 10000 rad/s which was relatively close to the experimental values found in the Attenuation vs frequency graphs for both circuits. The experimental value of omega from high and low pass filters is $\omega_{-3dB} = 1.03 * 10^4$.

In the low-pass filter if $\omega \gg \omega_{-3dB}$ then A is small and output signal is highly attenuated, and if $\omega \ll \omega_{-3dB}$ then A is almost 1 and $V_{out} \approx V_{in}$ and the signal passed without attenuation. Also if $\omega = \omega_{-3dB}$ then $A = \frac{1}{\sqrt{2}}$ and $V_{out} = 0.707\, V_{in}$.

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