Result Report

Basic Information Laboratory

<u>**Subject**</u>: Basic Information Laboratory

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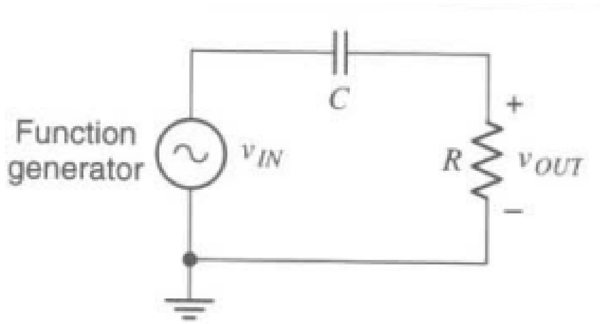
<u>**Submission Date**</u>: 2024. 10. 23.

Result

I completed the planned experiments for the sixth lecture. I will include the results related to our learning below this line.

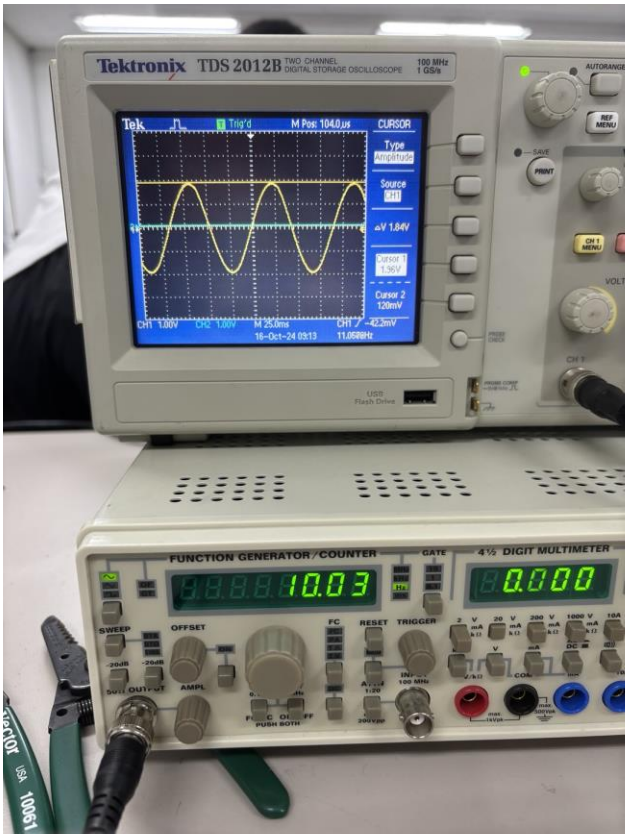
Task 2: Designing a high-pass filter



(I forgot to take a picture of the circuit we designed..)

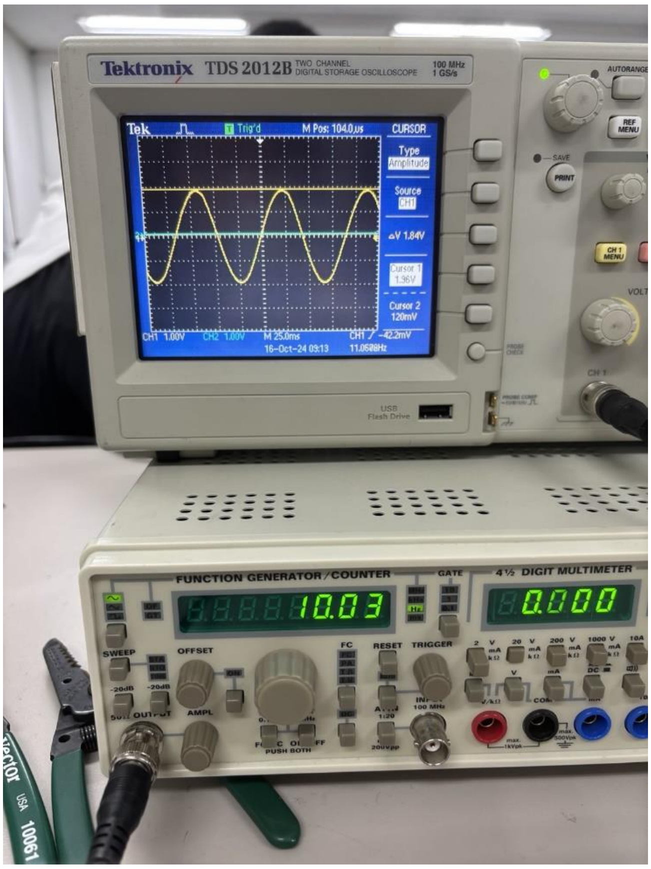
Before determining the planned values in the preliminary report, we first checked the waveform of the signal we gave to the circuit through the oscilloscope. (with 10 Hz and the peak value at 2V)

* With $R = 15k\Omega, C = 10nF$



2-1. The result of varying the frequency over a wide range while the amplitude was kept.

0.01 kHz (10 Hz)

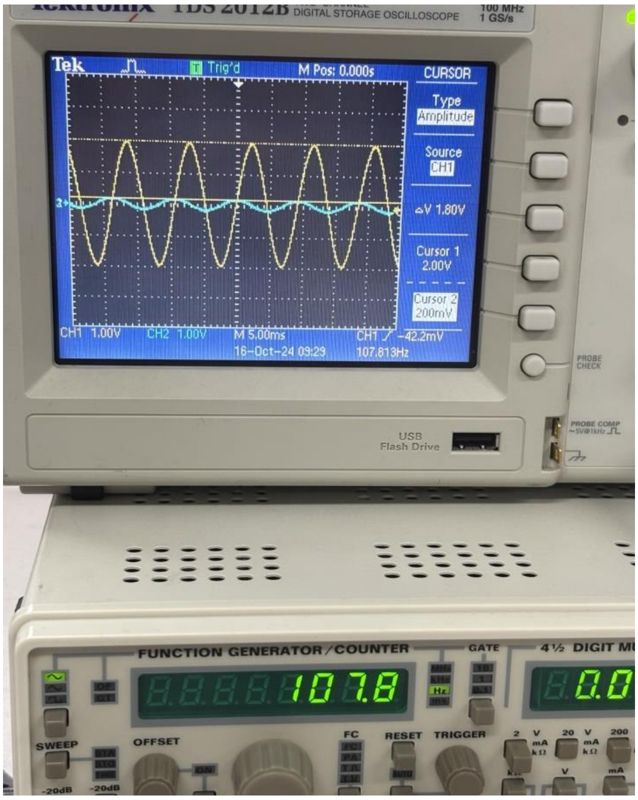


V_{in} = 2 V

V_{out} = 120 mV

G = 0.06

0.1 kHz (100 Hz)

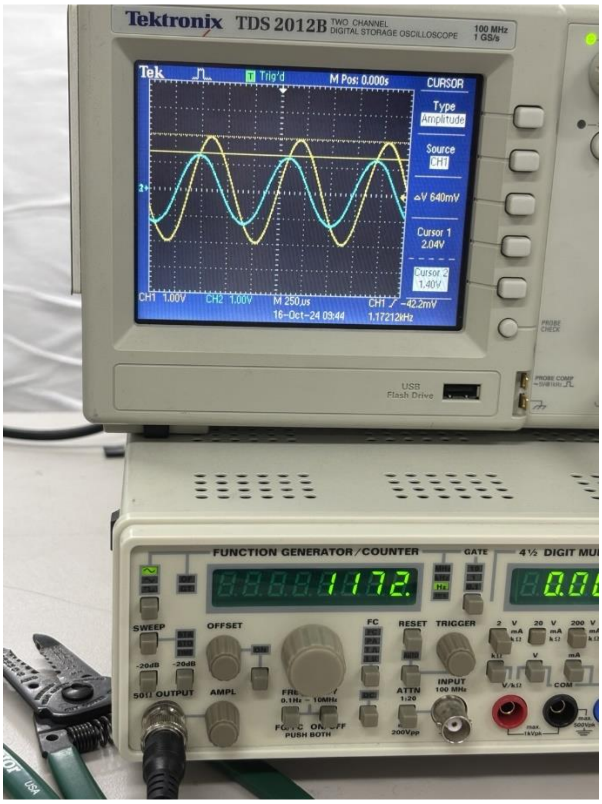


V_{in} = 2V

V_{out} = 200 mV

G = 0.1

1 kHz (1000Hz) -> We noticed that the amplitude of channel 2 increased significantly.

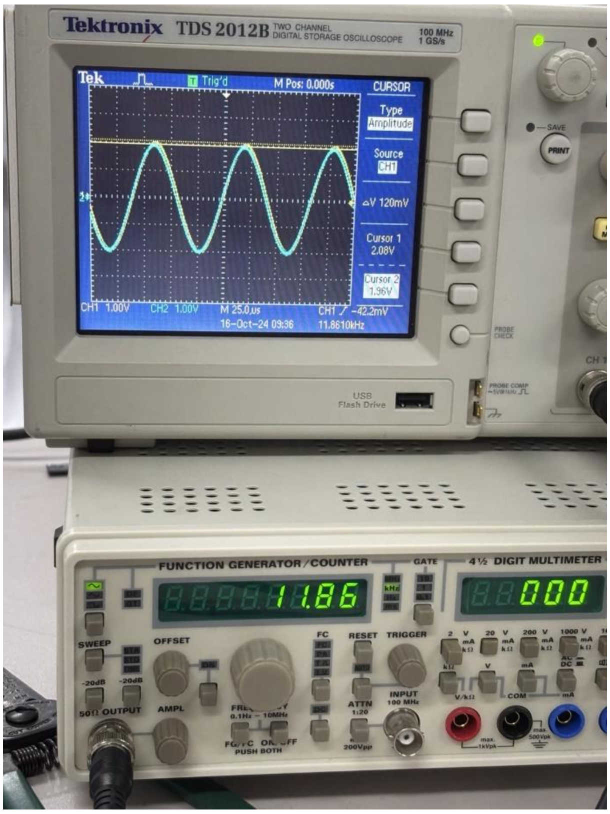


$V_{in} = 2\text{V}$

$V_{out} = 1.4\text{V}$

G = 0.7

10 kHz

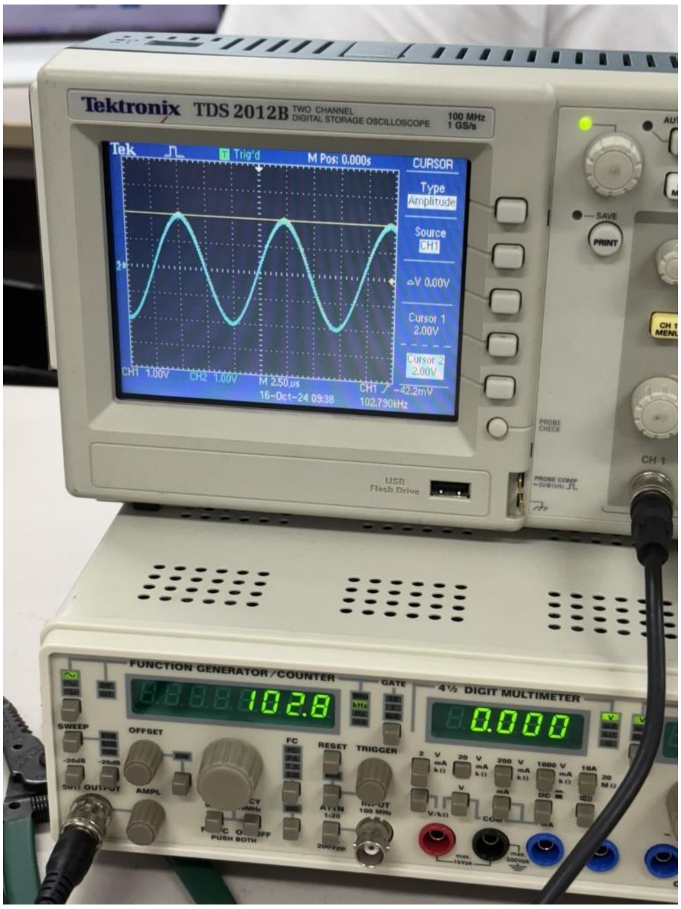


$V_{in} = 2\text{V}$

$V_{out} = 1.96\ \text{V}$

G = 0.96

100 kHz -> Now the output became nearly the same as an input signal.



$V_{in} = 2$ V

$V_{out} = 2$ V

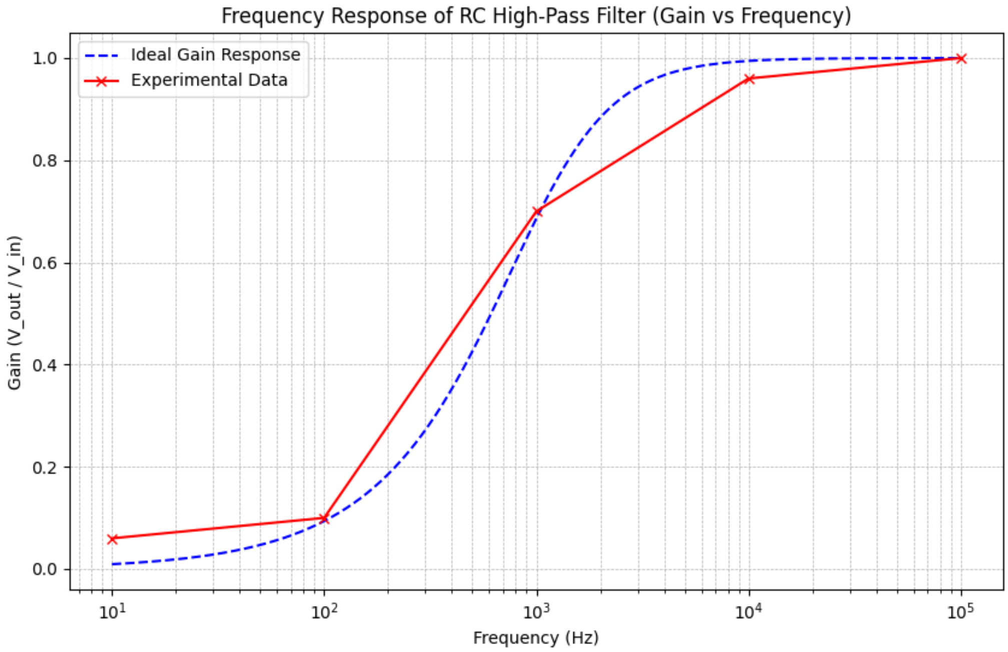
G = 1

2-2. Finding cutoff frequency.

$f(kHz)$	0.01	0.1	1	10	100
V_{in}	2V				
V_{out}	120mV	200mV	1.4V	1.96 V	2 V
G	0.06	0.1	0.7	0.96	1

-> We have determined that the cutoff frequency is approximately 1 kHz.

I plotted the graph in a logarithmic scale with Python.

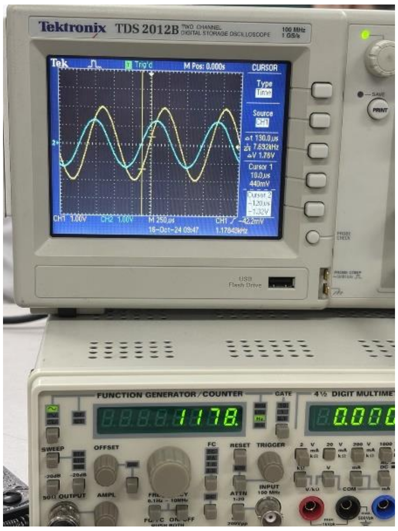


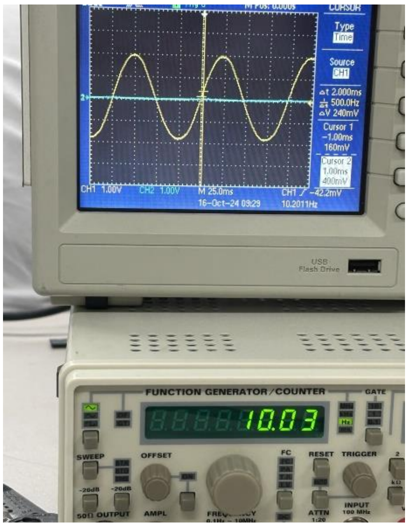
Due to various influencing factors, our plotted graph does not accurately adhere to the ideal graph. However, based on our analysis, we can infer that our data approximately aligns with the expected trend depicted by the ideal gain graph in the blue line.

We should identify the intersection point of the two lines close to the 1 kHz mark, where the recorded value is about 0.7($\approx \frac{1}{\sqrt{2}}$). Based on my calculation, the ideal cutoff frequency value is 1061 Hz. In our experiment, we found the value to be 1000 Hz, which is very close to the ideal value.

1-3. Finding phase shift between output and input.

$f(kHz)$	0.01	0.1	1	10	100
T	100ms	10ms	1ms	100μs	1000μs
Δt	Unable to measure	-2.4 ms	-130μs	-3μs	-4 ns
$\varphi(°)$	≈ 90	86.4	46.8	10.8	2.16

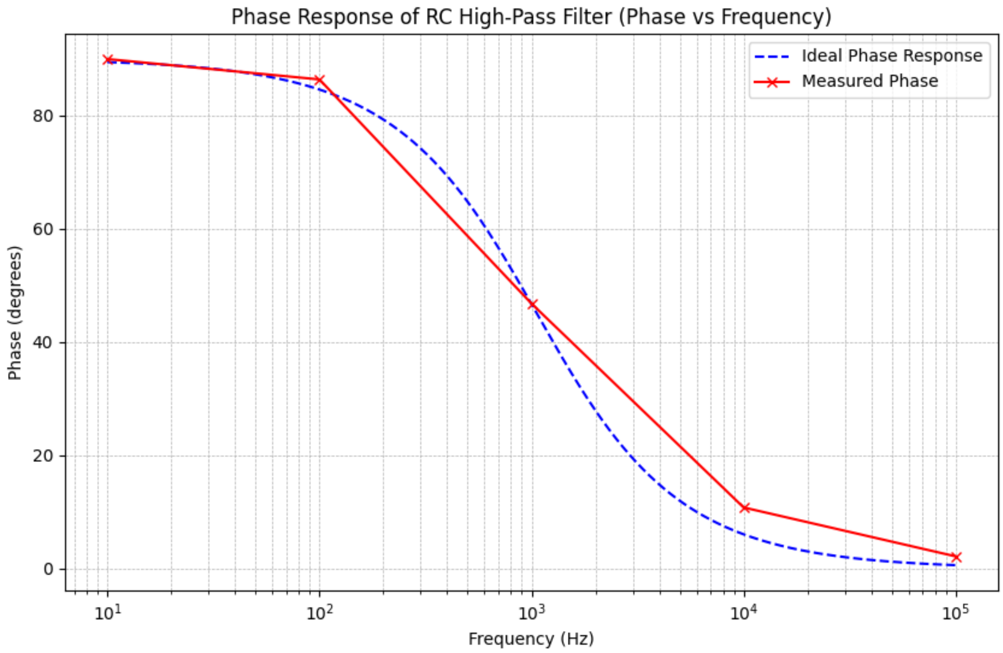




The first picture of a properly adjusted waveform of output and the input signal in cutoff frequency.

The second one shows graphs with low frequency, which cannot be measured.

I plotted the graph in a logarithmic scale with Python.



Due to various influencing factors, our plotted graph does not precisely adhere to the arctan graph. However, based on our analysis, we can infer that our data approximately aligns with the expected trend depicted by the ideal gain graph in the blue line.

Observing the values near 1000 Hz, the blue line marks 45° while the red line marks 46.8°.

Discussion

These are the group's discussions about the assigned tasks.

Task 2: Designing a high-pass filter.

- In a well-designed high-pass filter, a low-frequency input signal could not make any output signal but zero. On the other hand, when a high-frequency input signal is applied to the filter, the capacitor could be replaced with a wire.

- To find the voltage gain G, we need to measure the output signal's amplitude using an oscilloscope's cursor while keeping the input signal's amplitude constant.

* Check the output signal's amplitude increases and becomes the same as the input signal at the end.

- To find the cutoff frequency f_c, look at the point where the value G hits 0.707 in the logarithmic scale graph.

* Note that there will be ignorable differences with your calculations.

- To find phase shift φ, we need the equation given in our reference (equation (2)). Also, we need to measure the points with two oscilloscope cursors so that we can easily find delta t.

- When creating a logarithmic scale graph for phase shift, pay attention to the point where the cutoff frequency marks -45 °

- There could be slight differences in real-world tasks.

Conclusion

Through this lecture, I discovered several things about basic electrical knowledge.

1. The capacitor needs enough period to be charged and discharged.

2. Utilizing the characteristics of the capacitor, we can design a high-pass filter that rejects the low-frequency input signal.

3. To find out the cutoff frequency value, we should plot the logarithmic graph to record the large range of frequencies.

4. At cutoff frequency, the phase shift reaches -45 degrees.