Student Name

Professor's Name

Course

Date

Lab Report

1. Aim of the experiment

The experiment sought to study the difference between low and high-pass filters. It also examined the response of the gain voltage to the frequency for RC circuits.

2. Theory

Passive filters emerge as an essential component of electrical circuits. As indicated in the laboratory manual, these components allow a specific band of frequencies to pass while attenuating all the signals outside the band. Circuit designers use resistors, R, inductors, L, and capacitors, C to eliminate frequency components outside the range of interest. For instance, low-pass filters allow frequencies below the cutoff to pass through while attenuating higher frequencies. On the other hand, high-pass filters allow frequencies above the cutoff to pass while attenuating lower frequencies. Other types of filters include band-pass and band-stop, which allow a specified range to pass through while rejecting other frequencies and rejecting a range of frequencies while allowing others to pass, respectively. One of the most essential characteristics of a filter is the gain. It refers to the ratio of the magnitude of the output voltage to the input voltage. For R-R filter circuits, the gain remains constant and does not depend on the frequency of the input voltage. The input and output voltage also remain in phase. In contrast, the gain of RC circuits depends on the frequency of the input voltage. The input and output voltages have a phase difference of 90°.

3. Equipment

The equipment used included:

1. Oscilloscope
2. Function generator
3. Resistors
4. Capacitors
5. Coil
6. BNC connectors

4. Procedure

The first part of the experiment investigated R-R circuits. To do so, the students connected the circuit shown in the laboratory manual with R = R1 = 10 Ω (see Figure 1). Next, the students connected channel 1 of the oscilloscope to display V_{in} (across the function generator) and channel 2 to show V_{out} across R. On the functional generator, the procedure selected the sinusoidal signal input and varied the frequency from 100 Hz to 10,000 Hz. Lastly, the students measured the quantities displayed on the oscilloscope including the period T of the signal.

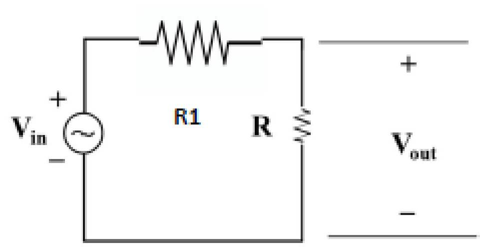

Figure 1. R-R circuit investigated in the laboratory

For the second part of the experiment, the students connected the RC circuit as shown in the laboratory manual before choosing R = 10 Ω and C = 4 μF. Next, the students connected channel 1 of the oscilloscope to display V_{in} (across the function generator) and channel 2 to show the voltage across the capacitor, C. For the functional generator, the procedure selected the sinusoidal signal input and varied the frequency from 100 Hz to 5,000 Hz. Lastly, the students measured the quantities displayed on the oscilloscope and estimated measurement errors.

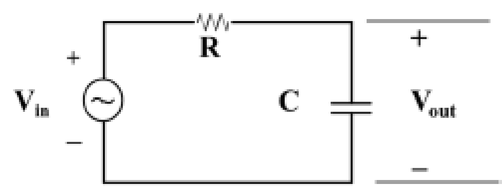

Figure 2. R-C circuit investigated in the laboratory

5. Results

5.1. R-C circuit

f (HZ)	u(f) (Hz)	V_{in} (V)	$u(V_{in})$ (V)	V_{out} (V)	$u(V_{out})$ (V)	G	u(G)	Δt (s)	Δφ (rad)	υ(Δφ) (rad)
102.13	0.01	2.3	0.1	1.1	0.1	2.1	0.1	0.0022	1.41	0.01
505.6	0.1	1.8	0.1	2.6	0.1	0.7	0.1	0.0002	0.64	0.01
803.9	0.1	1.7	0.1	2.8	0.1	0.6	0.1	0.0001	0.51	0.01
1204.1	0.1	1.6	0.1	2.9	0.1	0.6	0.1	0.00004	0.30	0.01
2003.2	0.1	1.6	0.1	3	1	0.5	0.1	0.00002	0.25	0.01
5093.5	0.1	1.5	0.1	3	1	0.5	0.1	0.000002	0.06	0.01

5.2. Uncertainties on V_{in} and $u(V_{out})$

The uncertainties in the measurement are equal to:

$$u(V_{in}) = \text{smallest increment}$$

$$u(V_{out}) = \text{smallest increment}$$

Therefore, for V_{in} = 2.3 V, the smallest increment equals 0.1 V. Similarly, for V_{out} = 1.1, the smallest increment equals 0.1.

5.3.Gain and phase difference

For part 2, the gain at 102.13 Hz equals,

$$G = \frac{Vin}{Vout} = \frac{2.3\,V}{1.1\,V} = 2.1$$

The phase difference at the same frequency equals,

$$\Delta\phi = \frac{2\Pi}{T}\,\Delta t$$

Replacing the known values,

$$= \frac{2\Pi}{1/f}\,\Delta t = \frac{2\Pi}{1/102.13}\,0.0022 = 1.41$$

5.4. Uncertainties on gain and on phase difference

The uncertainties in the measurement at 102.13 Hz equal to:

$$u(G) = smallest\ increment = 0.1$$

$$u(\phi) = smallest\ increment = 0.01$$

5.5. Graph of Δφ vs. f

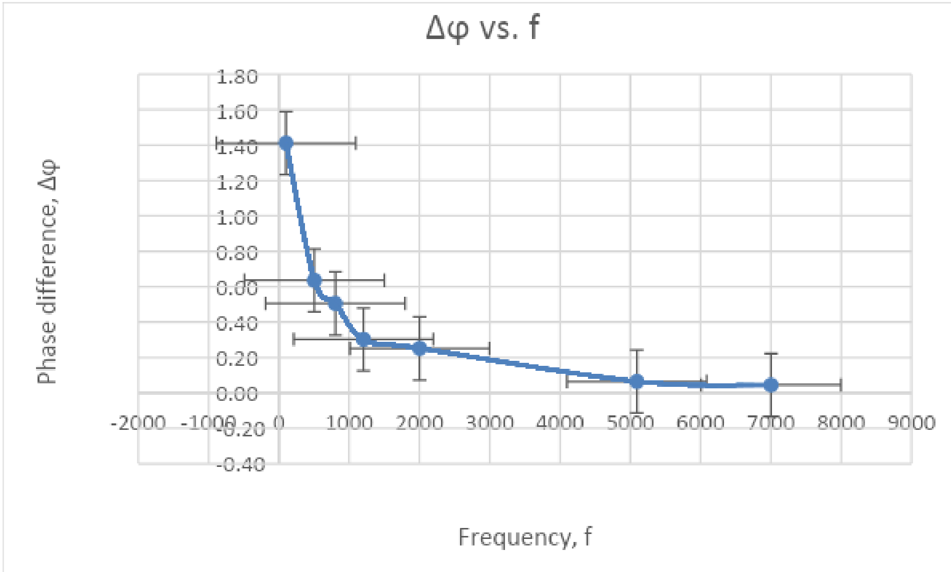

Chart 1. Plot of Δφ vs. f including error bars

5.6.Graph of G vs. f

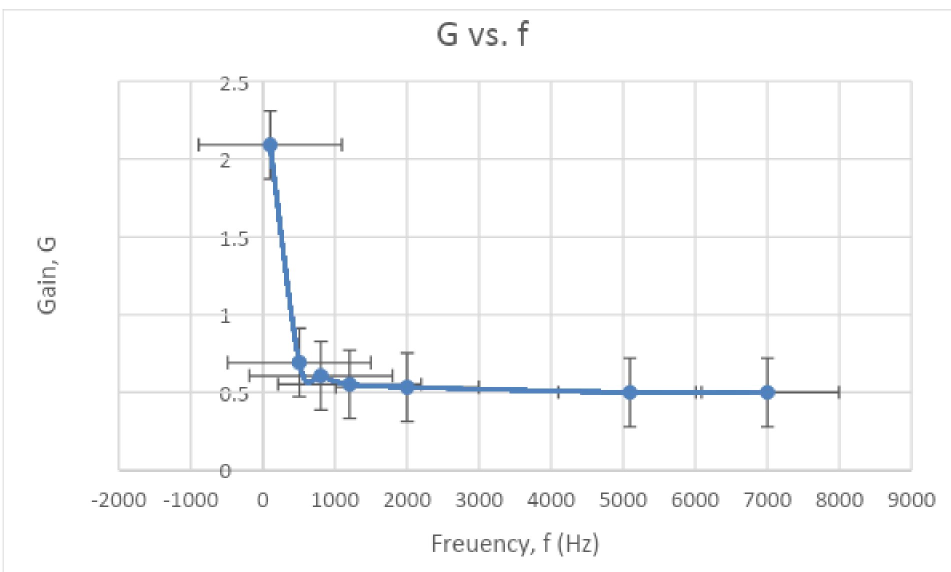

Chart 2. Plot of G vs. f including error bars

6. Discussion of the results

As indicated in the introduction section, the gain of RC circuits depends on the frequency of the input voltage. The experimental findings support this assertion, since based on chart 2, the gain varies with the frequency of the input signal. Moreover, the input and output voltages have a phase difference that also varies with frequency. The data plotted in chart 2 confirmed this assertion. Therefore, the experimental data confirmed the theoretical expectations associated with the characteristics of RC circuits.