Riverside Community College

Physics 4C

LABORATORY REPORT 1

OscilLABion

Author: Marlon Lopez

Lab Partner: Christopher Stark

Professor

Dr. Russel

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1 Introduction

In this lab we delve into simple harmonic motion and investigate the dependencies of the period of oscillation using a spring as well as a pendulum. With this we will also develop our spring constant for 164.7 gram spring.

2 Methodology

The lab is divided into two main sections. Part 1 investigates the spring's dependencies, and Part 2 examines the dependencies of the pendulum. [1]

1. For the initial experiment, you will require a vertically set pole, approximately one meter in length, with a hook attached to its top. Additionally, a spring weighing 164.7 grams should be connected to the hook.
   (a) To investigate amplitude dependency, attach a mass to the spring and measure the time it takes to complete one oscillation for six distinct amplitudes. [2]
   (b) Now to check whether if mass is a dependency, attach six different masses to the spring.For each mass stretch the current mass an additional 5 cm to where ever it lays at rest and record the oscillation time..
2. For the second experiment, retain the pole and hook setup. Replace the spring with a string attached to the hook. Prepare six strings of varying lengths for use in this part of the experiment.
   (a) First, assess whether amplitude affects the pendulum's oscillation period. With a mass attached to the string of the pendulum system, document the time it takes to complete one oscillation for six distinct amplitudes.
   (b) Next to determine whether the change of mass will be a dependency of the oscillation period, record the period of oscillation for six different masses.
   (c) Finally, evaluate the impact of string length on the oscillation period by recording the time for one oscillation using six different lengths of string.

[1] To determine the time for one oscillation, measure the duration for the mass to complete 10 oscillations from the release point and divide this time by 10.

[2] If you see that three measurements yield the same result then you can assume that measurement is not a dependency

3 Data

3.1 Dependencies of a Spring

3.1.1 Change of Amplitude

- Using a mass of 100 grams and changing the amplitude by 5 cm the time of oscillation was observed to be around 0.8 seconds for 3 data points. [3]

Amplitude (cm)	Time (s)	Frequency (s/10)
36	8.1	0.81
41	8.18	0.818
46	8.2	0.82

Table 1: Spring experiment change of Amplitude

3.1.2 Change of Mass

- Altering the mass of the spring-mass system and graphing mass against the square of the period resulted in a linear change of the period.

Mass (g)	Time (s)	Period (s)	Period squared (s^2)
92.35	5.78	0.578	0.33408
102.35	5.85	0.585	0.34223
132.35	6.7	0.67	0.4489
182.35	7.76	0.776	0.60218
282.35	10.2	1.02	1.0404
582.35	14.92	1.492	2.22606

Table 2: Variation of Oscillation Period with Mass

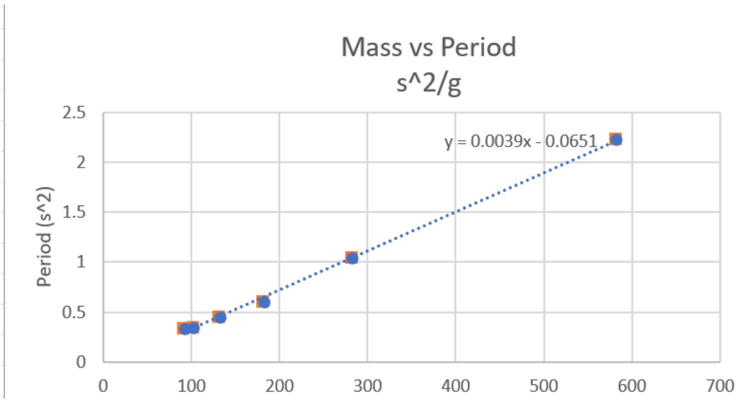

Figure 1: mass vs $period^2$

[3]To get the total mass of the spring mass object get half the mass of the spring and add the mass of the object being attached.

3.2 Dependencies of Pendulum

3.2.1 Change of Amplitude

- For the amplitude experiment, a 100-gram mass was used, and the amplitude was varied by 5 cm. The oscillation period remained consistent at 1.6 seconds across three measurements.

Amplitude (cm)	Time (s)	Period (s)
5	16.68	1.668
10	16.88	1.688
15	16.6	1.66

Table 3: Observations of pendulum oscillation period with varying amplitudes.

3.2.2 Change of mass

- Altering the mass of the pendulum had no observable effect on the period of oscillation.

Mass (g)	Time (s)	Period (s)
10	16.4	1.64
20	16.42	1.642
50	16.52	1.652

Table 4: Observations of pendulum oscillation time with varying masses.

3.2.3 Change of Length

- Varying the length of the string and using log, made a linear change of the period of oscillation for the pendulum.

Length (cm)	Time (s)	Period (s)	log(T)	log(L)
27	11.26	1.126	0.05154	1.43136
32	12.13	1.213	0.08386	1.50515
36	12.78	1.278	0.10653	1.5563
55	15.03	1.503	0.17696	1.74036
68	16.93	1.693	0.22866	1.83251
85	18.73	1.873	0.27254	1.92942

Table 5: Observations of pendulum oscillation period with varying string lengths.

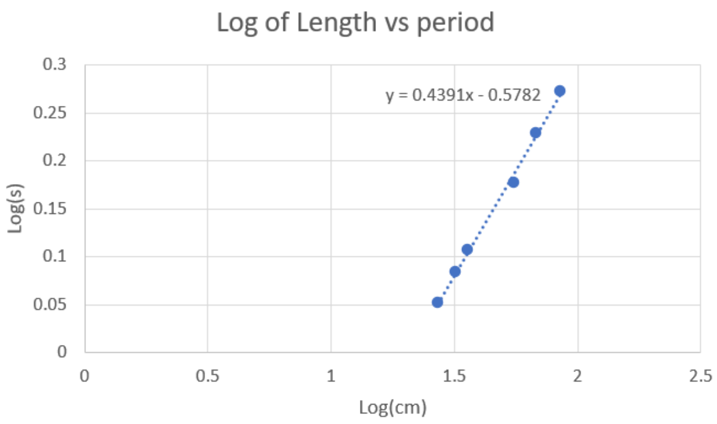

Figure 2: log(cm) vs log(period)

4 Analysis

4.1 Frequency Response Measurement

4.1.1 Part 1

1. An experiment was designed to study the amplitude and frequency response of the circuit shown in Figure ??.

2. Data collected was recorded in an appropriate format. The results were analysed and interpreted.

4.1.2 Part 2

1. A 100 Hz square wave was applied to the input and the effect on the output waveform V_2 was observed.

2. Repeated with 1kHz follow by 10 kHz square wave.

3. The observations were analysed and interpreted.

4.1.3 Part 3

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4.2 Fading due to Multipath Propagation

5 Result

5.1 Frequency Response Measurement for RC circuit(Low pass filter)

5.1.1 Experimental Result

Table 6: Experimental result for Second order low pass filter

$V_{in}(mV)$	f	$V_2(mV)$	**(I.L)dB**	**Phase (ϕ)**
5760	100 Hz	1190	-13.70	$-5°$
5730	200 Hz	1160	-13.87	$-11°$
5630	500 Hz	1070	-14.42	$-21°$
5320	1 kHz	849	-15.94	$-38°$
4930	2 kHz	560	-18.89	$-65°$
4830	5 kHz	265.1	-25.21	$-74°$
4780	10 kHz	123.86	-31.73	$-77°$
4700	20 kHz	32.55	-43.19	$-79°$
4700	50 kHz	7.7	-55.7	$-83°$
4700	100 kHz	2.29	-63.26	$-85°$

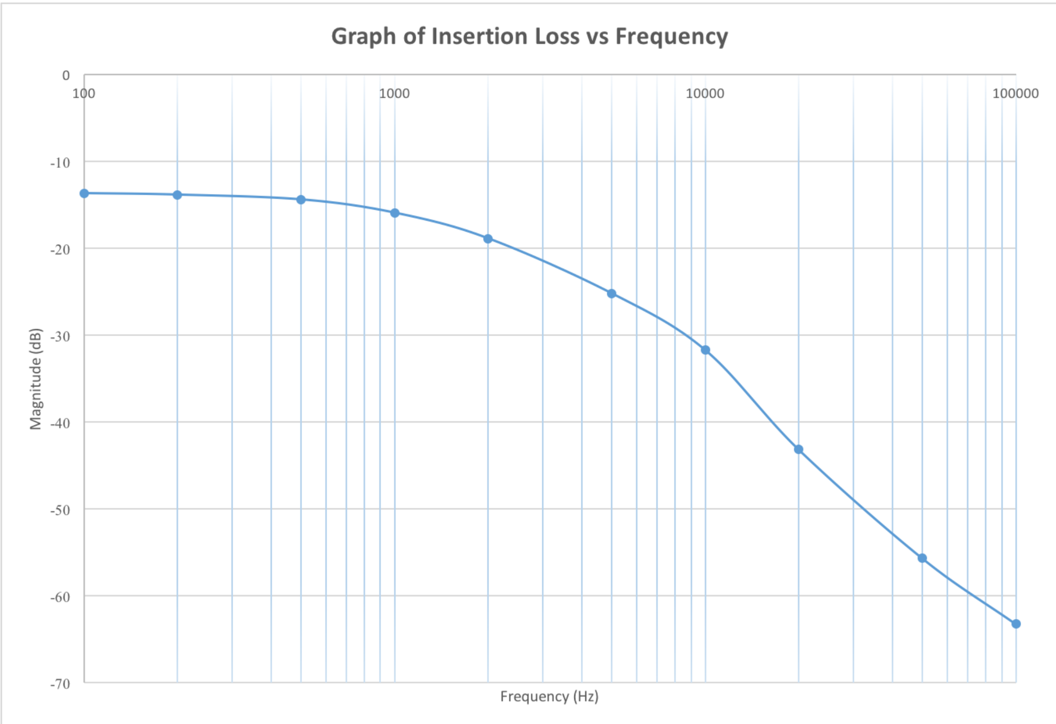


Figure 3: Graph of insertion loss versus frequencies (Low pass filter)

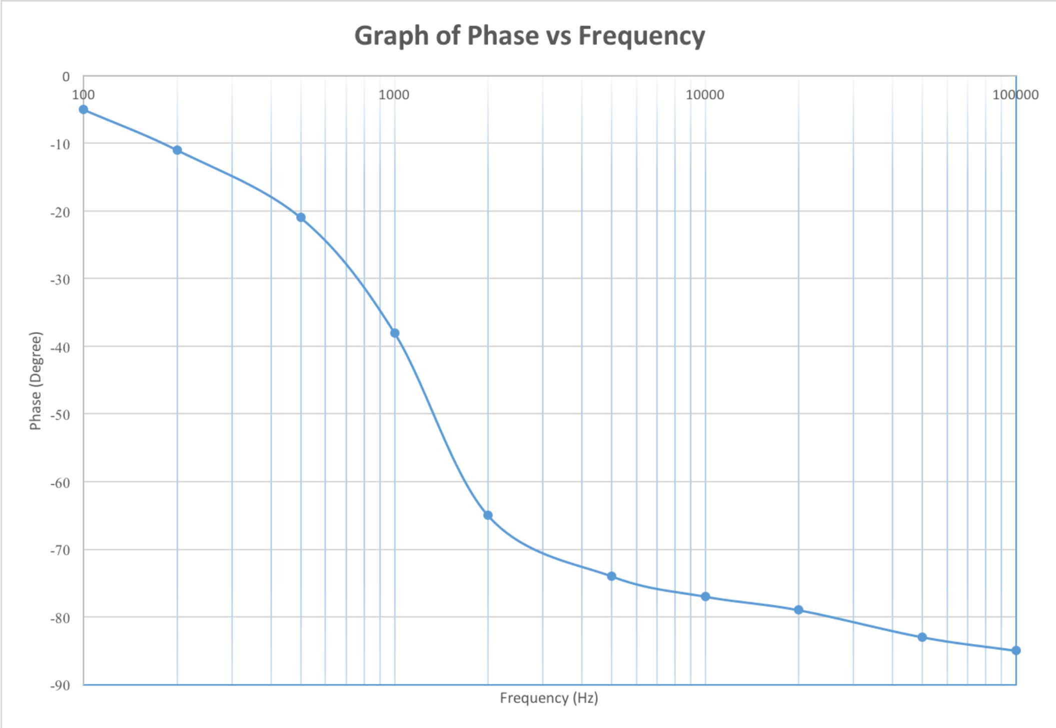
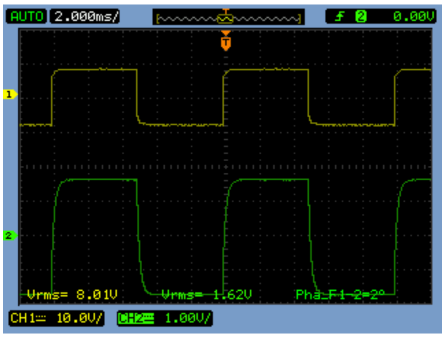
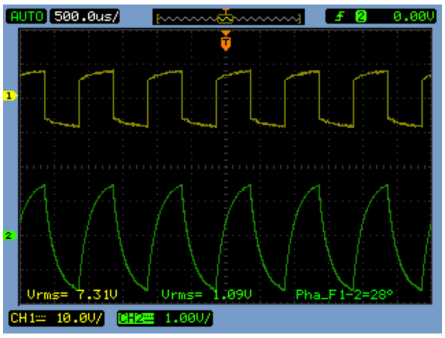


Figure 4: Graph of phase versus frequencies (Low pass filter)

5.1.2 Transmission distortion over a RC channel



(a) frequency = 100Hz



(b) frequency = 1kHz

LPF10k.png

(c) frequency = 10kHz

Figure 5: Signal Transmission Distortion for LPF

5.2 Frequency Response Measurement for the CR circuit(High pass filter)

5.2.1 Experimental Result

Table 7: Experimental result for Second order low pass filter

$V_{in}(mV)$	f	$V_2(mV)$	**(I.L)dB**	**Phase (ϕ)**
7310	100 Hz	14.19	-54.24	173°
7040	200 Hz	40.0	-44.91	164°
6720	500 Hz	170.0	-31.94	151°
6430	1 kHz	492.85	-22.31	131°
5370	2 kHz	1050	-14.18	108°
3920	5 kHz	1840	-6.57	72°
3180	10 kHz	2040	-3.86	45°
2840	20 kHz	2170	-2.34	25°
2530	50 kHz	2200	-1.21	12°
2580	100 kHz	2230	-1.27	7°

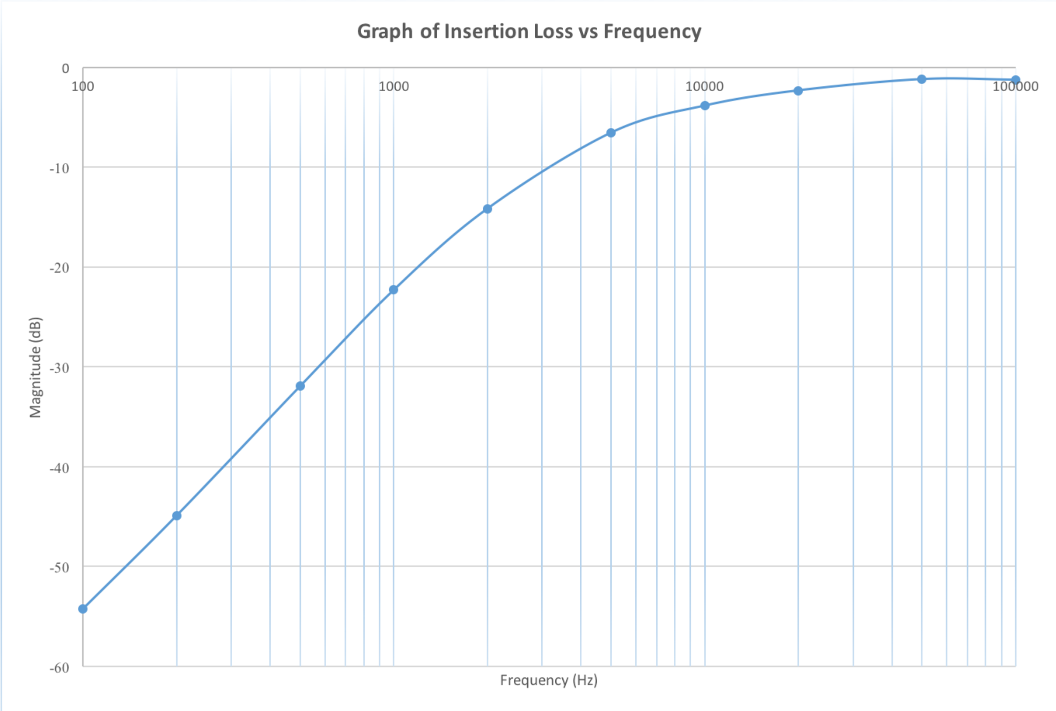


Figure 6: Graph of insertion loss versus frequencies (High pass filter)

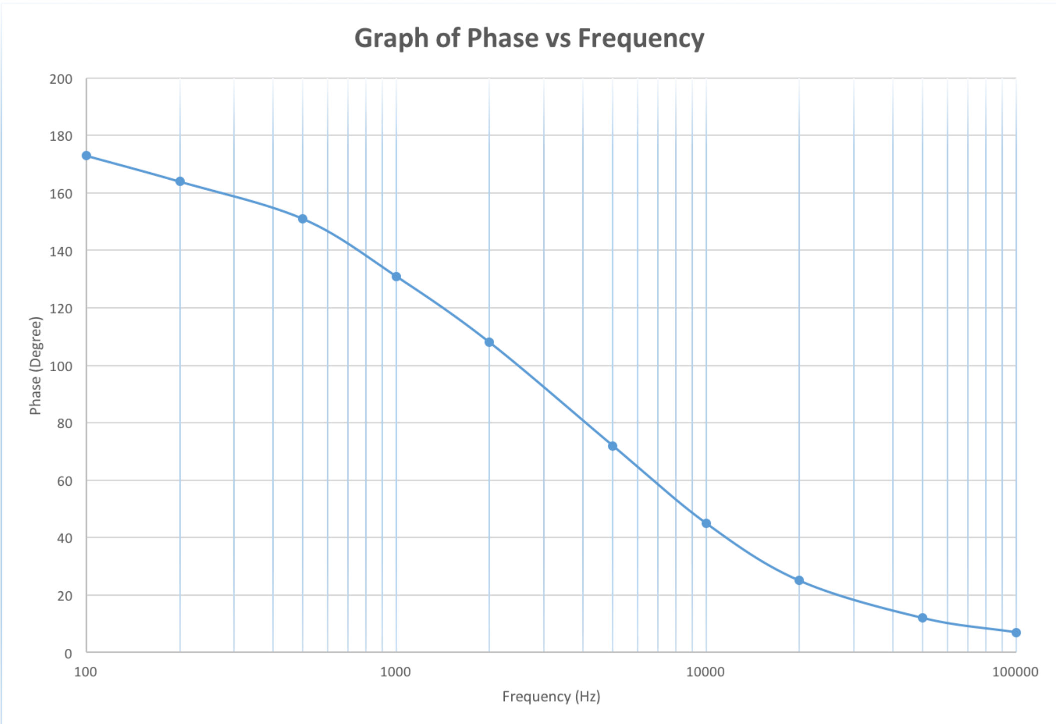
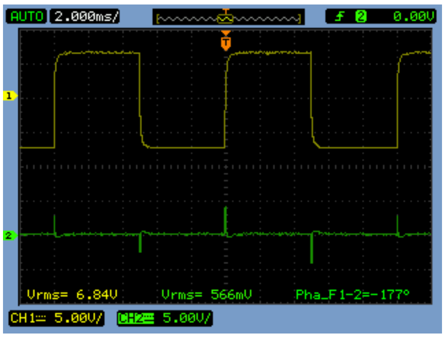
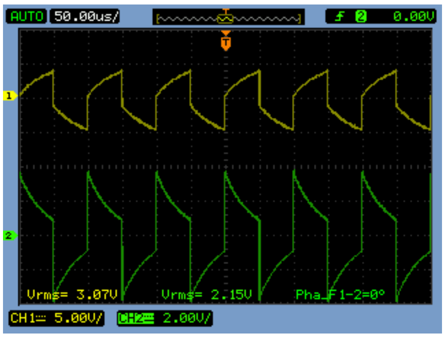


Figure 7: Graph of phase versus frequencies (High pass filter)



(a) frequency = 100Hz

(b) frequency = 1kHz



(c) frequency = 10kHz

Figure 8: Signal Transmission Distortion for HPF

5.2.2 Transmission distortion over a CR channel

5.3 Frequency Response Measurement for Fading due to Multipath Propagation (Band pass filter)

5.3.1 Experimental Result

Table 8: Experimental result for Multipath Propagation (Band pass filter)

f	$V_2(mV)$	**(I.L)dB**
500 Hz	1520	-13.27
1000 Hz	1320	-14.49
1200 Hz	1260	-14.89
1400 Hz	1120	-15.92
1600 Hz	1280	-14.76
1800 Hz	1310	-14.56
2000 Hz	1450	-13.67
2500 Hz	1490	-13.44
3000 Hz	1510	-13.32
5000 Hz	1650	-12.55

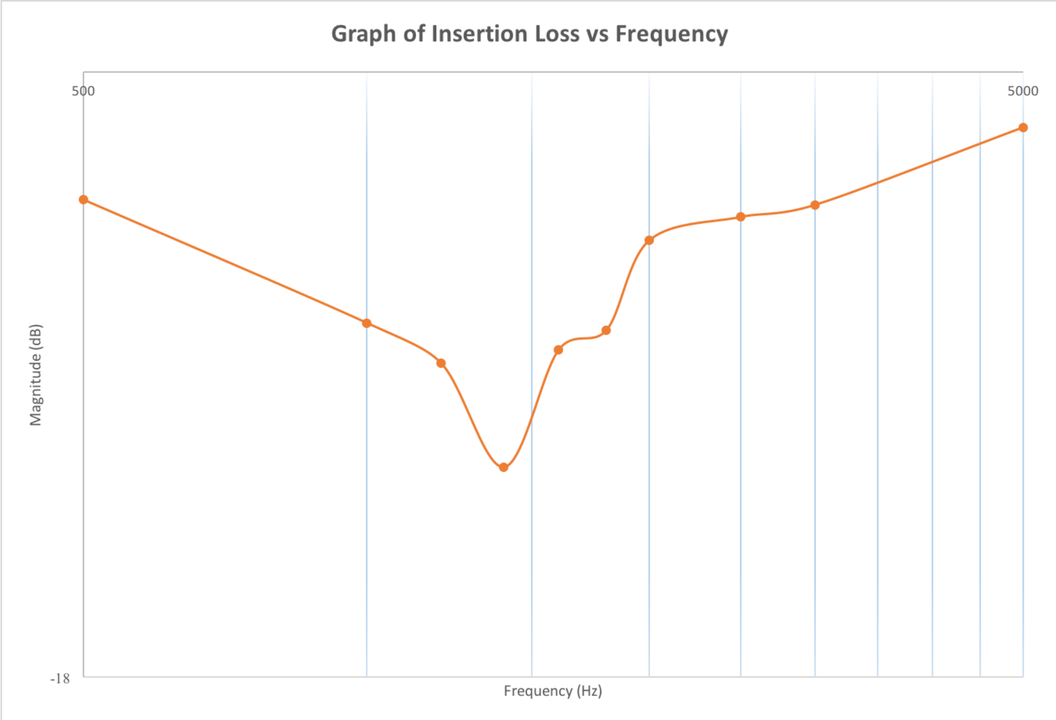


Figure 9: Graph of insertion loss versus frequencies (Band pass filter)

6 Conclusion

There are many factors may cause distortion in signal transmission. After completion of the experiment, we understand some factors from experiment, which are channel with insufficient bandwidth, multipath propagation channel and fading channel. In the last part of this experiment, the frequency that caused fading due to multipath propagation is 1.4kHz.

7 References

[1] Electronics Tutorials Low Pass Filter http://www.electronics-tutorials.ws/filter/filter_2.html.

[2] Electronics Tutorials High Pass Filter http://www.electronics-tutorials.ws/filter/filter_3.html.

[3] Multipath Wave Propagation and Fading http://www.iitg.ernet.in/scifac/qip/public_html/cd_cell/chapters/a_mitra_mobile_communication/chapter5.pdf.

[4] Frequency response of RC and LR circuits http://www.ece.sunysb.edu/~oe/Leon/ESE211/Lab05