Rotating Lab 5
Wave Interference

Prof. Olness

PHYS 1320
Fall 2019

1 Introduction

1.1 Free-Form Lab Investigation

The last five labs of the semester are "free-form" rather than "cook-book" style. I provide you the equipment to investigate different phenomena, and you decide how you are going to explore the questions. Many of these labs are new, so I am looking for you to be creative and come up with interesting methods.

Since the equipment for these five labs is specialized and expensive. *Please take good care of the equipment.* I only have one set-up for each lab. This means that for week #1, five teams will be working on five different labs, ant then we will rotate. There will be a sign-up sheet to determine the rotation.

1.2 *Equipment Warnings*

As mentioned above, some of this equipment is hi-tech, and very expensive. Please be very careful; pay attention to all equipment warnings. *If you have a question, please ask.* Anyone who is electrocuted or explodes will receive a failing grade for that lab segment.

- **This lab makes use of a Fourier Transform board, oscilloscope, and home-made laser Lissajous device, all of which are expensive and delicate. If you have questions, please ask.**
- **The third part of this lab is optional and uses a laser. Please use this with caution: do not look at the laser beam, and do not point the laser beam at any person—this can result in permanent eye damage.**

1.3 Required Reading

The following passages from your textbook explain the material for this lab and prelab.

- Waves p.35-42
- Properties of waves p.45-49

2 Experiment

This lab is divided into three parts:

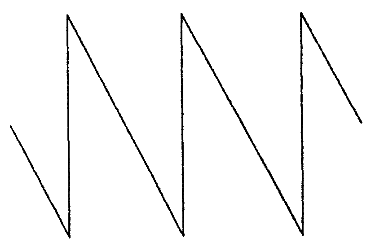
- Fourier Transforms (Frequency Domain Plots)

- Lissajous Figures (superposition of two different frequencies)
- Optional: Laser Lissajous figures

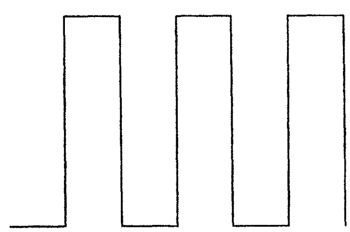
2.1 Fourier Transforms (Frequency Domain Plots)

Using the Fourier Transform box and an oscilloscope, generate a

- Saw-tooth wave



- Step-wave



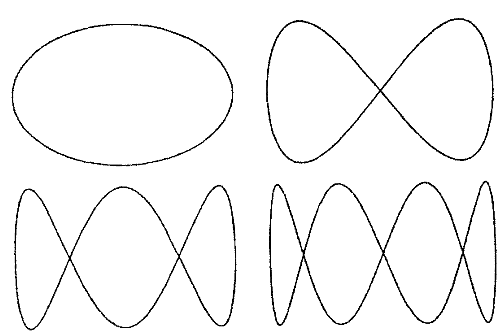
- Another wave of your choice.

Slowly vary the phase of the different partials.

- Does the phase affect the waveform you see on the oscilloscope?
- Does the phase affect what you here?

2.2 Lissajous Figures (superposition of two different frequencies)

Using the oscilloscope in "xy" mode, we will input one frequency on the x-axis, and vary the frequency on the y-axis to produce Lissajous figures. The figure below shows Lissajous figures for frequency ratios of 1:1, 1:2, 1:3, and 1:4. Identify each figure with the corresponding ratio. Now you try it with some different frequency ratios. Also, try adjusting the phase. Sketch your results for three cases.



2.3 Optional: Laser Lissajous Figures

This part is optional as the equipment is home-made, and may not work. If the equipment is working, you should attempt this section of the lab. We will repeat the above exercise, but use two mirrors instead of an oscilloscope to generate the Lissajous figures. I suggest that you set up the laser so that it shines on the ceiling (away from anyone's eyes), and I recommend you start with frequencies around 100Hz. If the frequency is too high, you will exceed the mechanical tolerances of the device. You will know the frequency is too high when you see "noise" in the signal. That is, the curve drawn on the ceiling by the laser will no longer be smooth but will instead vary wildly and unpredictably. If this is the case, lower the frequencies of the oscillators and try again until you produce the smoothly curving Lissajous figures you saw on the oscilloscope in the previous section.

Generate as many Lissajous figures as you can and see if the ratio of frequencies for each figure matches your expectation. What happens to the figure when the ratio of frequencies is slightly off the exact ratio (e.g. 1:3, 2:5) for that figure? What happens to the figure when the ratio is very far off of the exact ratio? Are there any other things you notice about the Lissajous figures you have drawn?