PHYS 2300L: Vibrations, Waves, and Optics Laboratory (fall)

Contents

Overview

The instructors of the laboratory portion of PHYS 2300 enjoy some autonomy in how the lab is conducted, but it is the instructor of the lecture portion of the course, hereafter the "lecturer", who is responsible for the overall course, assigns final grades to the students, and is judged by student evaluations. Therefore, the lab instructor(s) need to consult with the lecturer in how the lab is conducted, and where there is disagreement, the view of the lecturer shall prevail.

The primary aim of the laboratories is to develop the skills and tools necessary for experimental physics. Secondary aims include reinforcing physical concepts introduced in the lectures, and learning how to communicate results in a scientifically meaningful and useful fashion.

As much as is practical, labs are designed and sequenced so that the physical concepts are reviewed in the lectures before they are used in the lab.

From time to time, instructors may wish to develop new experiments to enhance the students' education, skill sets, lab experience, etc. Any new experiments should be reviewed and approved by the Curriculum Committee, in consultation with the lecturer, the physics technician, and the instructors assigned to other lab sections before being implemented.

Prerequisites

Students must be enrolled in PHYS 2300 (Vibrations, Waves, and Optics). Thus, see the prerequisistes sections for this course.

Dependent courses

PHYS 2400L Electricity and Magnetism laboratory

Even though the lecture portion PHYS 2400 does not depend upon the lecture portion of PHYS 2300, the lab portion does. Indeed, the lab portion of PHYS 2400 is treated as a direct follow-on to the lab portion of PHYS 2300, and is often taught by the same instructor. Obviously, the subject material of the lab changes in PHYS 2400L, but the lab techniques, use of computer analysis, error propagation, and the style of formal reports and presentations should be consistent in both second year lab courses. Therefore, if two different instructors are assigned to the lab components of PHYS 2300 and 2400, they should discuss before the fall term begins a common grading scheme, lab protocol, and skills to be stressed in the second year laboratory.

Student Outcomes

Students completing the second year lab should begin to master the following skills:

1. a methodical, systematic approach to gathering data
2. familiarity with data analysis tools:
   - choosing variable quantities reasonably
   - interpretation of straight lines ("convert the theory to your slope")
   - propagation of uncertainties (using partial-differential method)
   - elementary statistics (averages)
   - use of computer software to facilitate analysis
3. safe and effective use of basic experimental equipment
   - circuit building
   - multimeter and oscilloscope proficiency
   - lens/optical-component handling
   - vernier proficiency
   - user's manuals
4. communicate scientific results, including:
   - search for and use results from the literature
   - succinct, clear prose (impersonal) in written reports
   - analytical expression
   - experimental methodology
   - representing data using tables and graphs

- uncertainties: systematic *vs.* random, and sources
- qualitative and quantitative discussion of results,
- proper use of citations
- preparing an oral presentation

Curriculum

These experiments will be reviewed, re-sequenced and/or replaced in due course to ensure that labs:

- reflect the curriculum of the lecture segment of the course;
- are consistent with the development of outlined skills for this course;
- require an effort (*e.g.*, six labs and write-ups per term) commensurate with the portion of the grade assigned to lab work (*e.g.*, 20% to 30%).

Following is a list of the experiments currently in use.

1. Forced, damped oscillator
2. Coupled oscillators (*e.g.*, Wilberforce pendulum)
3. Refraction, reflection and dispersion
4. Geometric optics, thin lenses
5. Polarisation and polarimetry
6. Interferometry
7. Bragg spectrometer, microwave crystallography
8. Faraday effect
9. Interference of light and Newton's rings
10. Frauenhofer diffraction

Suggested texts

There is just one: *PHYS 2300/2400 Laboratory Manual*, edition 2007–08, produced and sold by the Department of Astronomy and Physics, SMU.

Notes to the instructor

1. The instructor should meet with the lecturer of PHYS 2300 before classes begin to reach an understanding of the goals of the course and how the labs and lectures will couple. Frequent meetings throughout the term to retain cohesion is strongly encouraged.

2. If different from him/herself, the instructor should also meet with the instructor of PHYS 2400L (the lab portion of PHYS 2400, Electricity and Magnetism) before the fall term begins to align the two second year labs so that a common lab protocol, grading scheme, and expectations can be reached before the labs begin.

3. The lab instructor should meet frequently (*e.g.*, weekly) with the physics technician, who will be an important resource for the lab, not only in setting up the equipment and keeping it in good repair, but also on designing the labs, what physics can be gleaned from the labs, and effective and safe use of the lab and its components.

4. This is the first real physics lab students will encounter. The first year lab, dominated by engineers and other non-physics majors, did not attempt to convey most of the skills required in a dedicated physics lab. This course is where that education begins, and it is important to emphasise lab skills, lab safety, "common sense physics", computer methodology, scientific presentation, *etc.*