Intermediate Physics Lab—PHYS 390—Winter 2004

Information for 2nd year students (typically simultaneously enrolled in PHYS 351/2/3)

Instructors— Dr. Dean Livelybrooks
Rm. 225, Willamette Hall
346-5855
d livelyb@hendrix2.uoregon.edu (preferred)
Office hours: U:14:00, W:10:00, (F:10:00)

Prof. Eric Torrence
Rm. 418, Willamette Hall
346-4618
torrence@physics.uoregon.edu (preferred)
Office hours: TBA

TAs— Ian Sullivan
TBA
TBA
isulliva@gladstone.uoregon.edu
Office hours: TBA

Rahmat Rahmat
314 Willamette Hall
346-4847
rrahmat@darkwing.uoregon.edu
Office hours: TBA

Stephanie Vitus
svitus@gladstone.uoregon.edu


Class— Class meeting, every other Monday at 4:00 pm in Room 17 Willamette.

Labs— One of the following 2-hour slots:
   Wednesday: 12:00-14:00 (SV)
   Thursday: 13:00-15:00, (SV) 17:00-1900 (RR/IS)
   Friday: 13:00-15:00 (IS), 15:00-17:00 (RR)

—Lab attendance is mandatory. If you must miss a lab, please arrange with the instructor to make it up as soon as possible. —

—Please take this course for 1 credit-hour.

The Intermediate Physics Lab is taught along with the Foundations in Physics II (PHYS 351-3) sequence, which covers the topics of vibrations, waves, and statistical physics. During the fall term we will be concentrating on enhancing your understanding of oscillators, vibration and waves, Fourier analysis, and the photoelectric effect by undertaking laboratory experiments each week. Understanding the role that error analysis plays in experimentation will also be emphasized, and how computers can be interfaced to sensors to automate data acquisition.

Course learning goals:
• Understanding the physical phenomenon at play during oscillations in various systems.
• Mathematical descriptions (models) of oscillatory motion and initial conditions using differential equations.
• Resonance, damped motion and forced oscillations.
• Coupled oscillators and normal modes
• The sampling theorem and Fourier analysis.
**Experimental skills goals:**
- The scientific process and experiment design.
- Error analysis skills, propagation of errors, and estimation.
- Interfacing probes to computers to facilitate data acquisition.

**Grading:**
Course grades will be based on homework problem solutions from the textbook (25%) and laboratory reports and lab notebooks (75%). Lab reports handed in after the due date will suffer a 15% grade deduction.

**Syllabus:**
Class will meet on Mondays at 3:00 pm and lab teams will undertake labs thereafter, according to the schedule above (under Labs). **Please note what parts of lab reports are due when, below.**

<table>
<thead>
<tr>
<th>Week</th>
<th>Lab</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 1; 1/5/04 | **Lab meeting.** Monday at 4pm. 
Assignment/selection of lab times. 
**Lab 1: Diffraction and Optical Spectroscopy** | **HW assignment 1:** Problems 7.4, 7.5, 7.7 from Taylor due on Tuesday, 13-January by 5pm. |
| 2; 1/12/04 | **No lab meeting.** 
Continue with **Lab 1.** | |
| 3; 1/19/04 | **Lab meeting.** 
Continue with **Lab 1.** | **Lab 1 report** (detailed outline with complete Introduction & Abstract) & lab notebook due by 10:00 am on Tuesday, 27-January. |
| 4; 1/26/04 | **No lab meeting.** 
**Lab 2: The Photoelectric Effect** | **HW assignment 2:** Problems 8.5, 8.9, 8.16, 8.25 from Taylor due on 5pm Tuesday, 10-February. 
**Lab 2 report** (detailed outline, Abstract, & complete Analysis) & lab notebook due the following Tuesday, 17-February by 10:00 am. |
| 5; 2/2/04 | **Lab meeting.** 
Continue with **Lab 2.** | **Lab 3 report** (complete) & lab notebook due the following Tuesday, 9-March by 5:00 pm. |
| 6; 2/9/04 | **Continue with Lab 2.** | |
| 7; 2/16/04 | **Lab meeting.** 
**Lab 3: Measurement of Absolute Zero** | |
| 8; 2/23/04 | **Continue with Lab 3** | |
| 9; 3/1/04 | **Lab meeting.** 
Continue with **Lab 3** | |
Guidelines for lab notebooks:

Lab notebooks constitute an honest record of:
- the purpose of an experiment (question addressed, physics "law" tested)
- what the experiment looked like and how it was done
  - diagram of setup
  - notes about how to do experiment
- any data taken
  - raw
  - analyzed/refined
- estimation of errors involved in experiment
- conclusions and speculations (if things didn't work as planned)
Copies are available of logbook from a working high energy physicist if needed.

Guidelines for lab reports:

There is an art to communicating scientific findings—besides being prepared in a concise, neat, grammatically correct and organized manner, a report must contain certain specific information. The goal is to communicate what you set out to do, how you did it, what you found out and what conclusions you reached. Your report should include enough information so that a person with your level of knowledge of physics can understand what you did and duplicate the experiment.

Do not assume that the reader of your report has undertaken the experiment and knows of what you write!

Try to keep complete lab reports to a maximum of 3 pages (both sides) plus figure and tables. As we grade the lab reports, we will suggest improvements in organization and grammar so that you can better learn to communicate technical information in an effective manner.

Reports can be neatly written by hand. If typed or written on a computer, you need not typeset equations and the like. Diagrams of experimental apparatus can also be hand-drawn, but you should print out graphs of important data. The IBM-type PCs in 17, Willamette (the lab room) are available for you to use.

Your Lab Reports should include four parts. Here is some advice about each element.

1) Abstract: A clear and concise abstract or summary of your lab, not to exceed two short or one long paragraph(s). The abstract, which succinctly describes the experiment(s) and your findings, is to help the reader decide whether to read the report. Typically this is the last part of the report you should write.

2) Introduction & Description: This section should include:
- a paragraph (or two) discussing the science under consideration that motivates what is to follow (think big picture!).
- a statement (in words as well as equations) of the theory and critical physics parameters under consideration (e.g., relationships governing motion of pendulum, words about the mass of the pendulum and whether it is important).
- figures depicting how those parameters act on the body/bodies under study (e.g., force diagrams)
- a brief introduction to the experiment
- labeled drawings of the experimental apparatus.
The idea is to provide enough information so that another physics undergraduate could replicate the experiment. It is important to label all elements of figures and drawings.

3) Analysis: This section should be organized around each of the experimental goals. For each goal, then:
• start with any predictions you make as part of the lab.
• exposit, with writing and equations, how your experiment relates to each experiment goal.
• include and refer to graphs giving experimental data and their errors.
• include a brief explanations about how error was estimated/calculated for each experiment goal.
• analysis of results should speak clearly to whether the stated hypotheses were, indeed, confirmed.

Analysis sections without cogent explanations involving words will result in the deduction of points. In other words, don't just hand in a massive sprawl of equations.

4) **Summary:** a summary section listing the physics principles addressed by your investigation(s), the results of your investigation(s), any procedural problems you encountered and how you solved them, and a short statement giving your impression of the lab.

Each report will be graded according to the clarity and conciseness of the writing, the organization and thought put into describing the experiment and assumptions made, the quality and pertinence of diagrams, and the appropriateness and correctness of the interpretation and analysis as presented in the last two sections.

**A final word.** The challenge of experimentation is to remain both organized and on task on one hand, and to be creatively playing with science on the other. The Intermediate Physics Labs are intended to be both challenging and fun, and have been designed to provide you with further insight into the material you will be/have been studying in the Foundations of Physics II course. As budding experimentalists, you are now are colleagues. Please let us know what you think!