Fall 9-1-2016

PHSX 444.01: Advanced Physics Laboratory

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PHSX 444 Advanced Physics Laboratory Autumn 2016

Instructor: Paul Janzen
Office: CHCB 128
Office hours: MT 11:00 - 12:00, W 2:00 - 5:00, and by appointment
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Text: *Data Reduction and Error Analysis for the Physical Sciences* by Philip R. Bevington & D. Keith Robinson.
Lecture: Mondays 3:10-5:00 PM in CHCB 012
Lab: Tues 1:10-4:30 PM **or** Thurs 1:10-4:30 PM

Description:

Advanced experiments in classical and modern physics, including optics; spectroscopy; laser science; atomic, nuclear, and particle physics; and data collection and reduction techniques for experimental scientists. This course is recommended for students entering graduate school in any experimental science.

Prerequisites:

PHSX 343 (Modern Physics) or equivalent, PHSX 327 (Optics) or equivalent; PHSX 323 (Intermediate Physics Lab) strongly suggested but not quite required. Students may not audit this class.

Lecture:

Each week, Monday will be dedicated to a lecture on one or more laboratory experiments you will be asked to perform. Methods of data reduction and error analysis will also be covered.

Laboratory Experiments:

Weekly labs will be performed on Tuesdays or Thursdays, with students working in groups. Labs will be carried out in rotations of two or three. Over the course of the semester, students will perform seven labs for which formal reports will be required. Six lab sessions, such as those involving programming, will be evaluated based on answers to questions included in the lab hand-out. Students are expected to maintain a clear, dated record of all experiment notes and hand-recorded data; a quadrille-ruled

notebook is traditional. A USB memory stick will often be useful for maintaining an accessible copy of computer-recorded data.

It is expected that students will arrive to the lab sessions prepared to begin work, having read the outlines and started any necessary research ahead of time. Students should be prepared to answer ``what are you about to measure" and ``how will you measure it" prior to the start of lab.

Data analysis will be performed in Python.

Laboratory Reports:

A formal typeset report is required for seven labs. Each report must include an abstract, theoretical background, any necessary diagrams of the apparatus, a description of the experimental procedure, data tables, data analysis and discussion, and conclusions. Computer analysis of data is generally required; many labs will require detailed error analysis. Although students will work in groups to set up the experiments and to collect data, the analysis and the text of each report is to be done individually.

For the seven labs requiring formal reports, the reports are due ONE week after the conclusion of the lab. A brief analysis of the data is due sooner (the Friday following a Tuesday lab, or the Monday following a Thursday lab) and will be graded and returned prior to the due date of the formal report. Requests for extensions on time should be made as soon as it is clear more time is needed (I expect to grant most students a one-week extension at some point).

Programming lab work should be finished during the lab session, or at most within one day. ``Q & A" labs are due one week after the lab session and do not require a prior brief analysis.

Any homework assigned in a Monday lecture will be due by 5:00 pm that Friday. A 5% per day fee will be assessed for late work. Homework will generally be statistics problems or short reviews of papers.

Grading:

Formal Lab Reports: 45%
Preliminary Data Analysis: 15%
``Q&A" Labs: 30%
Homework: 10%

Tentative Course Outline

Week	Week of	Laboratory Topic
1 - 2	Aug 29 - Sep 8	Laser modes (full) / Thermal laser
3	Sep 12 - 15	Python programming 1
4	Sep 19 - 22	Grab bag: Poisson stats, Helmholtz coils, e/m
5	Sep 26 - Sep 29	Python and curve fitting
6 - 8	Oct 3 - 20	Compton scattering (full) / Fresnel / Spectrosocopy 1 (Balmer, isotope) (full)
9 - 13	Oct 24 - Nov 15	Spectroscopy 2 (Zeeman) (full) / SQUID (full) / Rb hyperfine (full)
13 - 14	Nov 17 - Dec 1	Labview and PID control / TBD (full)

Learning Outcomes:

In completing this course, it is expected that the student:

- will gain basic familiarity with a variety of standard experimental techniques in classical and modern physics.
- will be able to set up, configure, and use a variety of laboratory equipment, including oscilloscopes, lock-in amplifiers, low-power lasers, spectrometers, scintillators, and photomultipliers.
- will be able to collect and study experimental data using Labview and Python.
- will be proficient in experimental data analysis, including propagation of error, curve fitting, and plotting.
- will be able to present the results of experiments to peers.
- will be prepared to pursue further experimental physics work at a graduate student level.

Notes:

All students must practise academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or disciplinary sanction by the University. All students need to be familiar with the Student Conduct Code. The Code is available for review online at http://www.umt.edu/vpsa/policies/student_conduct.php

Students with disabilities may request reasonable modifications by contacting me. The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students. ``Reasonable'' means the University permits no fundamental alterations of academic standards or retroactive modifications.