Jan. 2015

PHYSICS 442/842 EXPERIMENTAL PHYSICS II (3 Cr)

Instructor: Sy-Hwang Liou, 085 Jorgensen Hall, 472 2405 (office), sliou@unl.edu
Lecture: Monday 11:30 am -12:20 pm, 247 Jorgensen Hall
Lab: 233 Jorgensen Hall
Co-instructor: Xiaolu Yin, 084 Jorgensen, (402)472-5431, yinxiaolu@huskers.unl.edu
Office Hours: Mon 1:00 pm-3:00 pm or by appointment

Lab. TA: Alex Hotchkiss, 051 Jorgensen Hall, 402-210-5985, alhotchki@gmail.com

OBJECTIVES OF THE COURSE:

To develop skills required for research in physics.
Specifically- to develop your ability to maintain an effective research notebook, take and analyze data, deal with errors, draw warranted conclusions, enter and work effectively in a new laboratory situation, write informative reports and present your results.

FORMAT OF THE COURSE:

There will be one lecture each week to discuss experimental techniques, background information, and the procedures to be used in laboratory work. The laboratory period is 3 hours each week. (Some flexibility is possible for the scheduling of lab time. See the instructor.) At the end of the term, you will give a ten-minute oral presentation on an experiment of your choosing from the course. We will attempt to schedule all of these presentations for the final week of classes, at April 27, 2015.

The class size may permit some experiments to be carried out individually. Although most labs are expected to be done in partnership, **each student must have his own lab notebook and data entry. The lab reports must be individually written.**

COURSE GRADE:

Your final grade will be based on your laboratory reports, your lab notebook, and your laboratory work, that is, your participation, the amount of preparation you carry out before the experiment, your approach to the experiment, the quality of the data taken and handling of the apparatus.
Lab reports, lab notebooks (75%), presentation and attendance (includes to schedule at least 3 times with the instructor to discuss your experimental issues.) (25%)
A grade and comments will be put on each report. The usual grading system will be employed, that is, A+, A, A-, B+, B, B-, C+, etc

LABORATORY NOTEBOOKS:

Each student must maintain a laboratory notebook. The type with vertical as well as horizontal rulings is preferred since it makes it easier to tabulate your data and to draw preliminary graphs. All data is to be taken directly in the notebooks, not on loose paper to be recopied into the notebook.

The following information should be recorded:

1. The title of the experiment and the date you performed it.
2. Your name and the name of your partner, if any.
3. A brief description of the apparatus - a diagram is usually helpful.
4. The data, usually in tabular form, with columns carefully labeled and units given.
5. Explanatory notes and experimental conditions.
6. Data analysis - calculations are best done directly in the notebook. Graphs can be drawn right on the notebook page.

LABORATORY REPORTS:

Unless otherwise agreed upon with the instructor, formal reports are required for all experiments. They are to be **individually written**, even if the lab work was done in partnership.

The reports should tell clearly what was done, what was observed, how data were analyzed, and what conclusions were reached. Where appropriate, there should be a discussion of any interesting points that come up, and perhaps a critique of the experiment.

The reports should be written as if intended for a reader who has studied physics but is **less** familiar with the material than the author is.

On the cover of the report, give:
Your name
Name of lab partner
Title of experiment
Date(s) when work was done
Date of submission of report.

Lab reports will be due on the assigned date posted by the instructor. If there are any issues that need to change the due date please arranged with the instructor. Reports submitted after the assigned time will be subject to a progressively harsh reduction in grade. (5% perday)

THE FORM OF LAB REPORTS:

I. Introduction

Pertinent background information and motivation for doing the experiment. (1-2 pages)

II. Theory

Describe the theory behind the experiment that you are going to discuss. Make the physical principles clear, and if possible derive useful results. (1-2 pages)

III. Description of Apparatus and Experimental Procedures

Describe the apparatus used and outline how the taking of data was accomplished. Someone reading your report should be able to set up the experiment (perhaps after consulting references) and duplicate your results. (1-2 pages)

IV. Results

Indicate clearly how calculations using the original data were made. Make it clear which numbers were used, but do not include the details of the arithmetic. Where appropriate, indicate the precision of the measurements and results.

V. Discussion

Compare your results with what is expected theoretically or with results obtained by other workers. Do they agree as well as could be expected, worse, or too well? Why? Discuss anything unusual or unexpected about the experiment or the results. Discuss, if appropriate, the precision. Discuss, if appropriate, how the experiment could be improved.

EXPERIMENTS

Experiments for Physics 442 (assigned three)

Note: If you would like to have different set of experimental arrangement please discuss with Professor Liou.

Assigned Three:

1. X-ray diffraction (alloy, single crystal etc.) (Shah Valloppilly)
2. Nanofabrication, patterning (Jiong Hua) and magnetoresistance measurement, resistance versus temperature. (Liou)
3. Interferometer (fiber optics) (Liou)

Other Experiments for Physics 441/442 include:

(See instructor to discuss the details)

1. Thin film deposition, and MOKE (Liou)
2. Exploring Photonic Crystals--An Analysis of the Resonant Cavity as a Quantum Mechanical Analogue (Liou)
3. Using a Camera to Film Ions in a Quadrupole Trap and Quadrupole Trapped Ions Trajectories (Maria Becker)
4. SPM, MFM, STM (Lanping Yue)
5. Residual Gas Analysis
6. Faraday Effect
7. Speed of light

New experiments (for extra credits or replace the current assignments)

(See instructor to discuss the details)

We will devote some class time focused on the design of an experiment. Emphasis will be placed on the connection between formulating the questions to be investigated and the experimental design. Another important criterion of the design will be incorporating critical tests of hypotheses that are made.

REFERENCES:

A number of books and manuals are kept in the laboratory. Consult them as you see fit, but **do not remove them from the laboratory**.

- A useful consultation book: "Experimental Physics" by R. A. Dunlap (1988). It gives discussions of many relevant devices, techniques and concepts.
- "A practical guide to dada analysis for physical science students", by Louis Lyons (1991)
- "A student's guide to Fourier transforms", by J. F. James (2002)

Academic Integrity
Refer to the Student Code of Conduct and Academic Integrity, which can be found at http://stuafs.unl.edu/ja/code/. The first violation of the code will result in at least a failing grade for the assignment and notification of university officials. Further action may be taken. Subsequent violations will result in failure for the course, along with notification of university officials. To avoid situations of cheating, plagiarism or academic dishonesty, contact the instructor in advance if a course-related issue is unclear.

Students with Disabilities
Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 132 Canfield Administration, 472-3787 voice or TTY.

ACE Certification
This course satisfies ACE 10; on the next page is the boilerplate information required in the syllabus, but note that the actual course grade fractions are not as given there.

ACE Certification for PHYS 441 and 442

(i) the ACE Outcome(s) for which the course is certified

Student Learning Objective 10: Generate a creative or scholarly product that requires broad knowledge, appropriate technical proficiency, information collection, synthesis, interpretation, presentation, and reflection.

(ii) the opportunities the course will give students to acquire the knowledge or skills necessary to achieve the Learning Outcome(s)

The students are required to plan, execute, analyze, and report on a series of laboratory experiments that illustrate both key principles of physics and the practice of laboratory research. The creative scholarly product is the complete process from planning through reporting and is evaluated as such by the instructor(s). This process teaches the following skills. 1) Develop skills and practices needed for work in experimental physics. 2) Gain some understanding of what is involved in making measurements. 3) Develop written and oral communication skills for the presentation of scientific work. 4) Provide hands-on experience with phenomena and principles of physics through laboratory work. The process requires the development and application of broad knowledge and information collection in both the planning and reporting activities, development and demonstration of appropriate technical proficiency in the execution, and finally, interpretation, synthesis, and reflection in the analysis and reporting of their results.

(iii) the graded assignments which the instructor(s) will use to assess the student' achievement of the Outcome(s).

Student achievement will be assessed from the quality of the student's preparation for and conduct of the laboratory work (10%), weekly laboratory notebook records (15%), four

written experiment reports (60%) and an oral presentation on one of the experiments (15%). The students will receive timely written and or oral feedback on each graded component.