PHY 451: Advanced Laboratory

Department of Physics and Astronomy, College of Natural Science, Michigan State University

COURSE SYLLABUS

Instructor:	Dr. Jaideep Singh Dr. Chong-Yu Ruan	**Term:**	**Fall 2015**
Office:	2061 NSCL (Singh) 4222 BPS (Ruan)	**Class Days:**	Tues. (Sec. 1 Lab), Thurs. (Sec. 2 Lab), Wed. Lecture (all)
Phone:	(517) 908-7176 (Singh) (517) 884-5655 (Ruan)	**Class Hours:**	9:10-12:00, 6:00-8:50 (Lab) 4:10-5:00 pm (Lecture)
E-Mail:	jsingh.msu@gmail.com (Singh) ruan@pa.msu.edu (Ruan)		
Office Hours:	by appointment	**Class Location:**	1245 BPS (Lab) 1420 BPS (Lecture)

Teaching Assistant: Ben Loseth. Office: 2171 BPS. Email: losethbe@msu.edu

I. Course Description

As described in the MSU Description of Courses catalog, the focus of PHY 451 is "general research techniques, design of experiments and the analysis of results based on historical experiments in modern physics." Our approach is to study a small number of experimental systems and techniques in depth, so that you learn how experimental physics is done. Students work in pairs, and perform **three** sets of experiments (4 weeks each) in the course of the semester. We expect the third experiment, which can be related to the first two experiments but must include **innovative components**, will form the foundation of a term paper that each student is required to write. We encourage you to think about and discuss the experiments with the instructors throughout the course, so that you not only learn basic techniques of experimental physics, but also hone your ability to learn independently through discussions.

II. Course Credits: 3 credits

III. Course Prerequisites

The listed prerequisites are PHY 440 and completion of Tier I writing requirement. However, you should be familiar with electricity and magnetism and quantum mechanics as well.

IV. Course Objectives

- Learn to design, assemble, and perform experiments.
- Learn how to connect textbook physics to the world of experiment.
- Develop good laboratory record-keeping practices.
- Develop your skills in data analysis.
- Hone your written and spoken presentation skills.
- Learn to prepare a paper in the style of a scientific journal report.

V. Class Operation and Requirements

Students work in pairs, and perform **three** sets of experiments (4 weeks each) in the course of the semester. We expect the third experiment, which can be related to the first two experiments but must include **innovative components,** will form the foundation of a term paper that each student is required to write. We encourage you to think about and discuss the experiments with the instructors throughout the course, so that you not only learn basic techniques of experimental physics, but also hone your ability to learn independently through discussions.

Class Time and Attendance: This is a laboratory course with only a limited number of lectures. The class meets one hour each week for lectures or to discuss laboratory problems students are having and their possible solutions. The lectures will cover such topics as vacuum and cryogenics, optics, nuclear magnetic resonance, data acquisition and measurement methods, noise, and scientific presentations. Attendance at these lectures is mandatory. Attendance of each laboratory session is also mandatory unless you have been excused by your instructor, in which case you will make-up the missed laboratory time. Please be on time to class.

Preparation: As laboratory time is limited, you must read the experimental handouts before class. You will be asked questions by your instructors at the beginning of your laboratory sessions, especially before starting new experiments. These questions will focus on your understanding of what you will measure and how you will do so before you begin your experiments.

Laboratory Notebooks: Each student will keep a bound laboratory notebook in which all of your ideas, designs, data analysis, graphs and mistakes will be recorded. (See the handout on lab notebooks for more details.) While you will collaborate in the laboratory, each student will keep his/her own notebook with his/her own analysis. After each required portion of the experiment is completed, we will inspect your lab notebook and enter a current grade. In the notebook, you should propose improvements to your experiments, or even better come up with new ideas for experiments to further advance your research on the subject based on the results you obtained and physics to be understood. In the third period, you are encouraged to come up with your innovative ideas either to initiate a new experiment or improve key prior measurements. You shall present such ideas in the notebook and test them out in the first week of the third period. After receiving feedback from us, you should use the remaining weeks to implement these ideas, and at the end of experiment period submit a paper on the subject.

Term Paper: Each student will turn in a term paper in the style of a report in a scientific journal (see Schedule section). The content of the paper should be based on the notebook, but broader. It should include a literature survey with proper citations, in-depth analysis, and conclusions, in addition to reporting the main techniques and experimental results obtained. The paper will be 13 ± 2 pages, double spaced, with one-inch margins.

In-Class Presentation: Together, you and your partner will deliver a PowerPoint presentation on your first experiment after its completion. The presentation should be 15-17 minutes including time for questions. The presentation should not be as technical as the report but rather should place most emphasis on the scientific issues and how the experiment addresses those.

Quizzes: There will be a pair of in-class quizzes based on what is covered in lectures and your classmates' presentations.

VI. Course Grading Course Item	Points
Laboratory Performance (independence, quality and quantity of work, experimental skills, preparation, attendance, etc.)	35%
Laboratory Notebook [quality of: (1) the record of your work and (2) your data analysis]	35%
Term Paper	20%
Presentation	5%
Quizzes	5%

VII. Course Policies: (see online version for more details)

Late Assignment Policy: If an emergency arises and you cannot submit your notebook or paper on or before the scheduled due data, you MUST inform your instructor and obtain approval NO LESS than 24 HOURS BEFORE the scheduled date/time.

Academic Conduct Policy: Academic dishonesty in any form will not be tolerated. Academic dishonesty at Michigan State University is defined by the General Student Regulations (http://splife.studentlife.msu.edu/regulations) as conduct that violates the fundamental principles of truth and honesty.
If you are uncertain as to what constitutes academic dishonesty, please consult the General Student Regulations for further details. Violations of these rules will result in a record of the infraction being placed in your file and receiving a zero on the work in question AT A MINIMUM. At the instructor's discretion, you may also receive a failing grade for the course.

VIII. Course Schedule
All assignments are due at 5:00 PM on the specified dates.

Experiment 1

Section	Laboratory Dates	Notebook Due
1	Sep. 15, 22, 29, and Oct. 6	Oct. 9 Prof. Singh's Office
2	Sep. 10, 17, 24, and Oct. 1	Oct. 5 Prof. Ruan's Office

Experiment 2

Section	Laboratory Dates	Notebook Due
1	Oct. 13, 20, 27, and Nov. 3	Nov. 6 Prof. Singh's Office
2	Oct. 8, 15, 22, and 29	Nov. 2 Prof. Ruan's Office

Experiment 3

Section	Laboratory Dates	Rough Draft of Term Paper Due	Notebook & Term Paper Due
1	Nov. 10, 17, 24, and Dec. 1	Dec. 4 Email to Prof. Singh	Dec. 9 Prof. Singh's Office
2	Nov. 5, 12, 19, and Dec. 3	Dec. 7 Email to Prof. Ruan	Dec. 11 Prof. Ruan's Office

- The week of December 7th is the make-up week.