

PHY 451: Advanced Laboratory

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

COURSE SYLLABUS

Instructor:	Pawel Danielewicz (he/him)	Tyler Cocker (he/him)	Term:	Spring 2024
Office:	2101 FRIB	4252 BPS	Class Days:	Tues. (Sec. 1 Lab), Thurs. (Sec. 2 Lab), Wed. Lecture (all)
Phone:	(517) 908-7330	(517) 884-5682	Class Hours:	9:10-12:00, 6:00-8:50 (Lab) 5:20-6:10 pm (Lecture)
E-Mail:	danielew@msu.edu	cockerty@msu.edu	Class Location:	1245 BPS (Lab) 1300 BPS (Lecture)
Office Hours:	by appointment	by appointment		

Teaching Assistant: Kai Klink (they/them), Email: klinkkai@msu.edu

Course website: Please check it out on D2L: <https://d2l.msu.edu/d2l/home/2117685>

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. As oral conference presentations and written scientific reports are the primary means of communicating new findings, students will develop skills in scientific communication. This course fulfills the Tier II writing requirement (assuming completion of PHY 431 or PHY 440).

II. Course Credits: 3 credits

III. Course Prerequisites

The listed prerequisites are PHY 440 or PHY 431 and completion of Tier I writing requirement. However, you should also be familiar with electricity magnetism and quantum mechanics.

IV. Course Objectives

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

V. Class Operation and Requirements

Students will work in pairs and perform **two** sets of experiments (4 weeks each) during the semester. The experiments include: 1. Diode laser spectroscopy, 2. Nuclear magnetic resonance, 3. Optical pumping in atomic vapors, 4. Gamma ray spectroscopy, 5. Muon lifetime, 6. Sonoluminescence, and 7. Superconductivity and tunneling. 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 through discussions. Lab handouts and supplementary information for each experiment are available on D2L. No textbook is required.

Preparation: Following MSU’s general regulations, as a three-credit course, PHY 451 requires a *minimum* of 9 hours

of work per week in and out of the laboratory. As the laboratory time is limited, you must read the experimental handouts before the laboratory session. Your instructors will ask you questions at the beginning of your laboratory sessions, especially before starting new experiments. These questions will focus on understanding what you will measure and how you will perform such measurements before you begin your experiments.

Class Time and Attendance: This is a laboratory course, including laboratory experiments and a limited number of lectures. Both the laboratory and lecture classes will be delivered in person. We will discuss the students' physics and laboratory problems in the lecture class and their possible solutions. Attendance at these lectures is mandatory. Attendance of each laboratory session is also mandatory unless your instructor has excused you; in this case, you will make up the missed laboratory time as soon as possible. Please be on time for class.

Laboratory Notebooks: Each student will keep **TWO** bound laboratory notebooks in which all their ideas, designs, data analysis, graphs, and mistakes will be recorded. (See [the handout on lab notebooks](#) for more details.) While you collaborate in the laboratory, each student will keep their own notebook with their analysis. After the second week of the first experiment, the instructors, the teaching assistant, and/or student peers will comment on your lab notebook. After each experiment is completed, the instructor will grade your lab notebook. You will need **TWO** paper logbooks to use one while the other is being graded.

Written Scientific Report: By the end of the last week of classes, each student will turn in a term paper on one of her/his/their experiments. The paper will be presented in the paper style of a scientific journal such as *Physical Review Letters*. The paper's content should be based on your work in the lab, as reflected in your notebook, but with a broader perspective. It should also 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 should be 3,000 \pm 500 words long, double-spaced, with one-inch margins. A draft of the paper should be submitted by Monday, March 29, and will be reviewed by two classmates and your instructors, similar to the refereeing process for papers submitted to scientific journals. The paper will then be revised with this feedback in mind.

In-Class Presentation: Each group will deliver an in-class PowerPoint presentation on one of your completed experiments (together). The presentation should be 12-15 minutes long, including time for questions.

Quizzes: There will be **in-class quizzes** during the lecture.

VI. MSU COVID-19 Policy:

The in-person laboratory class abides by all the [MSU COVID Guidance](#) principles, guidelines, and requirements. Specifically, all participants in the class will adhere to the following:

- **If you have symptoms of COVID-19 or have a positive COVID-19 test result**, please isolate and do not go to class or any social event for 5 days from the onset of the symptoms or from the positive test result or while you are experiencing the symptoms. This applies regardless of your vaccination status. You must contact and work with your instructors to ensure all coursework is completed on time. Get a test for COVID-19 if you did not take it yet. Students experiencing significant symptoms can request a medical appointment at Olin Health Center. Please contact your primary care physician or the Olin Health Center if your symptoms worsen. Seek emergency medical attention if you are experiencing warning signs as outlined by the CDC. Return to normal activities after 5 days only if you have no symptoms, your symptoms resolve, and you do not have a fever. During isolation and the first 5 days after returning to normal activities, wearing a mask around others is recommended.
- **Please note** that these protocols have changed over the past few months and likely will continue to change based on federal, state, and local public health guidance. Please check the [MSU COVID Guidance](#) regularly for the latest guidance.

VII. Course Grading

No Final exam for this course

Course Item	Points
Laboratory Performance (independence, quality and quantity of work, experimental skills, preparation, attendance, etc.)	30%
Laboratory Notebook (quality of: (1) the record of your work and (2) your data analysis)	30%
Term Paper	22%
First draft	10%
Referee Report on Classmates' Papers	5%
Final draft	7%
Presentation	10%
Quizzes	8%

Student Perceptions of Learning Survey:

The Student Perceptions of Learning Survey (SPLS) is an instrument to support course improvement in MSU's teaching and learning environments. Towards the end of the semester, you will receive an email with a link to the survey for our course. The student responses, including comments, are solely reported as an aggregated summary that cannot be linked to any particular student's online form. The SPLS feedback should provide ideas to improve the course and stimulate instructors' professional development. There is an option on the SPLS form to decline to participate in the survey. However, we hope students are willing to provide frank and constructive feedback so the information can be used to enhance the quality of teaching in the future.

VIII. Course Policies

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

Spartan Code of Honor and Academic Pledge: *As a Spartan, I will strive to uphold values of the highest ethical standard. I will practice honesty in my work, foster honesty in my peers, and take pride in knowing that honor is worth more than grades. I will carry these values beyond my time as a student at Michigan State University, continuing the endeavor to build personal integrity in all that I do.*

If you are uncertain about what constitutes academic dishonesty, please consult the General Student Regulations (<http://splife.studentlife.msu.edu/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. You may also receive a failing grade for the course at the instructor's discretion.

IX. Course Schedule and Important Dates

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

On the week of Jan. 8 (Sec. 1: Jan. 9; Sec. 2: Jan 11), the labs will be introduced in the morning session. Students will then select lab partners and experiment preferences. Lectures will begin Jan. 10.

Experiment 1

Section	Laboratory Dates	Notebooks Due
1	Jan. 16, 23, 30, Feb. 6	Feb. 20
2	Jan. 18, 25, Feb. 1, 8	Feb. 22

Experiment 2

Section	Laboratory Dates	Notebooks Due
1	Feb. 20, Mar. 5, 12, 19	Mar. 25
2	Feb. 22, Mar. 7, 14, 21	Mar. 27

Written Reports

Draft	Referee Reports	Final Report
Mar. 29	Apr. 5	Apr. 19

Jan. 8 – 12: Introduction to labs (morning session only)

Feb. 12 – 16: Only Wednesday lecture, no lab days

Feb. 26 – March 1: Spring Break

April 8 – 12: Lab open for make-ups (at your usual lab time)

Mar. 20, 27, Apr. 3, 10: Student in-class presentations during Wednesday lecture time

Note: The curriculum and grading system may be altered in response to any changes in MSU COVID-19 policies.

X. Safety in the Laboratory

Safety is very important to everyone involved in the Advanced Physics Laboratory. General safety directives are provided in the document titled “Safety in the Advanced Laboratory” on D2L:

<https://d2l.msu.edu/d2l/le/content/2117685/viewContent/15192945/View>

Safety courses must be taken before handling cryogenics or compressed gas cylinders. Additional directives may pertain to your specific experiments and should be discussed with the instructors ahead of your experiment. Emergency and medical procedures are posted on the class wall.