



Course Number: PHY 410
Semester: Spring 2025
Schedule: TR: 9:25-12:05 pm (SAMC 358)
Instructor: Ram Rai, PhD
Office Hours: TR: 1-2 pm or by appointment
Phone: 878-3767

Course Name: Advanced Physics Lab
CRN: 3427
Mode: Traditional Lab
Email: rairc@buffalostate.edu
Office Location: SAMC 280

Course Description:

Selected advanced experiments chosen from the areas of solid-state physics, modern physics, electricity and magnetism, and optics. (Required for physics majors)

Prerequisite: PHY 305 or equivalent

Required Materials: Recommended

1. The Art of Experimental Physics (1991), by Daryl W. Preston or
2. Experiments in Modern Physics (2nd Edition), by A. Melissinos and J. Napolitano, Academic Press, 2003.

Student Learning Outcomes

On completion of this course, students will be able to:

1. Design experiments to test theories and to measure physical quantities.
2. Utilize the equipment to acquire data systematically.
3. Analyze the acquired data employing graphical analysis and the underlying physical theory.
4. Measure physical constants by modeling and interpreting the studied data.
5. Evaluate the experimental results based on the expected values and the possible sources of error.
6. Compose comprehensive lab reports in a scientific format.
7. Defend the experimental findings.

COURSE OVERVIEW:

The course aims to improve students' laboratory skills and physics knowledge through more advanced and less structured experiments than those in introductory or modern physics labs. Students are required to analyze experimental data and present the results in a standard scientific format. For each experiment, a lab manual containing the theory and experimental procedures will be provided. Please note that the lab manual provides general guidance rather than explicit step-by-step instructions. While some reading materials will be provided for each lab, students are encouraged to seek additional reference materials that are relevant to the lab. "The Art of Experimental Physics" (1991) is particularly helpful.

This course requires extensive writing, with lab reports being a key component of the evaluation process. Lab reports should follow a standard format for scientific reports and must meet basic proficiency requirements. Each lab report, for instance, should have a clearly defined purpose or major concept, enough justification for the main idea (i.e., experimental data), explanation, and analysis of the data together with any associated uncertainties, discussion, and conclusions regarding the experiment. Grammar, punctuation, and spelling conventions should be followed carefully.

We will use OriginLab software for graphical and statistical analyses. This software is installed on five of the lab's PCs. Additionally, you can download and install OriginPro Learning Edition for free on your PC. The link is as follows:

<https://www.originlab.com/originprolearning.aspx>

You are expected to complete approximately **six labs** from the list below:

- 1) Torsional oscillator
- 2) Magnetic Susceptibility
- 3) Optical properties of thin films (fiber optic spectrometer)
- 4) Pulsed NMR or Earth's Field NMR
- 5) Superconductivity with Mr. SQUID and a YBCO pellet sample
- 6) X-ray diffraction of powder samples
- 7) Atomic force microscopy
- 8) Noise Fundamentals
- 9) Mossbauer spectroscopy

GENERAL COURSE REQUIREMENTS:

ATTENDANCE

Attendance is **required** and will be taken during the lab. You are responsible for making up any labs you missed due to unexcused absences from class. I can assist you with the lab if you have an excused absence, but the lab needs to be finished after regular class hours.

PRE-LAB AND READING ASSIGNMENT

A short lecture on the theory for each experiment will be given before starting the lab. Usually, one lecture (1 hour) will cover the theoretical discussions for two labs. There is a pre-lab component in each lab. The pre-lab, which contains a few questions, will be collected at the beginning of each lab, and will be graded; it is worth 5%. Before coming to the lab, you must read the manual or any other pertinent documents for the experiment. When you enter the lab, it is anticipated that you are familiar with the lab's theory and have a basic understanding of how to carry out the measurements. You should always discuss the plan for the experiment with your group members.

LAB NOTEBOOKS

Learning how to maintain a proper notebook is essential in this course. A well-organized laboratory notebook is crucial for writing reports or preparing presentations. I suggest using a quadrille-ruled laboratory notebook, although a regular notebook is also acceptable. Your lab notebook should be bound and should not contain loose-leaf or tear-out pages. It will be collected twice for evaluation: once at midterm and again at the end of the semester. Here are some guidelines for maintaining your notebook:

1. Create a descriptive *table of contents*.
2. Don't erase or tear out pages. Indicate mistakes by simply crossing them out.
3. Take notes on typical readings or instrument settings so that you can reproduce results or repeat the experiment later if necessary.
4. Make drawings or diagrams of all relevant designs, circuits, or set-ups. Record data in tabular form with units indicated.
5. Writing "Learning Commentaries" in your notebook is highly advised. Also, take notes on any discussions or lectures in your notebook.

LABORATORY REPORTS:

You must write a detailed lab report using a computer for every lab you complete. This is a requirement that cannot be overlooked. Although you work in a team of two students to complete the lab, each student must write an individual lab report. Refer to the sample lab report on Brightspace, which serves as a template for writing lab reports. In general, your lab report should include the following sections:

- 1) Title
- 2) Abstract
- 3) Introduction
- 4) Experimental technique
- 5) Results and Discussion
- 6) Conclusion
- 7) References

Each figure must have a detailed caption that describes the graph, including any equations used to fit the data. All graphs must have axes labeled with appropriate parameters and units. The "Results and Discussion" of your lab report carry about 60% of the total points. Each lab report must be self-contained. It should be written at a level comprehensible to a junior/senior undergraduate physics major. Any lab report that is not written according to the above guidelines or that does not meet the expected standard will be returned to be rewritten. There is no penalty for rewriting the lab report. Here is a link to the American Institute of Physics site for manuscript writing help: <https://publishing.aip.org/resources/researchers/author-instructions/#prep>

All lab reports should be submitted electronically through Brightspace no later than **one week** after each experiment is completed. **Late lab reports will be subject to penalties.**

Turnitin: *I strongly encourage you to write the lab report in your own words. Even when discussing scientific theories and facts, it's important to paraphrase and cite the sources in References. I will not accept any text that is copied or plagiarized from online sources, as Turnitin will check all lab reports for plagiarism.*

ORAL PRESENTATION

At the end of the semester, each student will give an oral presentation based on one lab report of his/her choice. The presentation will take place during the "Critique and Evaluation" week. The presentation should be limited to about 15 minutes, followed by a 5-minute question session. For this project, I would like to work individually with you as your mentor. I recommend breaking down the preparation into several steps, and I'll provide feedback at each stage: (1) Students will decide on the lab. (2) Students may repeat the lab for more data collection. (3) Students prepare Power-Point slides for the presentation. In the next step, each student will give a dress rehearsal in the class and get feedback from other students. The final presentation will be given before the faculty during the Critique and Evaluation Week.

Evaluation and Grading Scale:

Lab attendance and participation	10 %
Lab notebook	10 %
Lab reports	60 %
Oral Presentation	20 %

Table 1: Grades will be distributed as follows:

Overall Percentage	Grade
90.0 - 100	A
87.0 - 89.9	A-
83.0 - 86.9	B+
80.0 - 82.9	B
77.0 - 79.9	B-
73.0 - 76.9	C+
70.0 - 72.9	C
67.0 - 69.9	C-
63.0 - 66.9	D+
60.0 - 62.9	D
< 60	E

SAFETY:

Please use common sense to avoid injuring yourself or others when working in the lab. The most common hazards are from electrical shock, lasers, and radioactive sources.

- When using electrical devices, exercise caution, and if you are not sure how to hook something up, please ask me before you turn it on. Be particularly aware of bare wires and devices capable of providing sizeable currents.
- When using a laser, avoid looking directly into the beam or directing the beam at someone else. Also be aware that a laser beam can reflect off a shiny surface and may go somewhere that you are not expecting.
- Although the radioactive sources we use have very low activity, you should still take precautions to keep them as far away from your body as is practical while using them and putting them away when you are done with them.

Student Resources:

Title IX:

My priority as your professor is to ensure a safe, respectful education environment where all students can learn and thrive. The University does not tolerate any form of discrimination or harassment (including sexual assault, dating and domestic violence, stalking) based on protected characteristics (e.g., sex, gender identity, sexual orientation, religion, pregnancy, etc.) or related retaliation. All faculty and teaching assistants are considered mandated reporters by the University, which means that if they observe or learn of sex-based harassment/ discrimination or related retaliation, they are obligated to immediately share that information with the University's Title IX Coordinator. This obligation, grounded in law and policy, is designed to protect the safety of students and the broader Buffalo State community, as well as ensure that students receive information about available supportive measures and resolution options to enable them to make informed choices. Supportive measures include reasonable academic accommodation available with or without the filing of a formal complaint.

If you need academic accommodations due to sex discrimination, harassment, or related retaliation, you may:

On Campus Resources:

- Contact the TIX Coordinator directly (titleix@buffalostate.edu or 716-878-5212), without sharing any personal information with me.
- If you would like to speak with a **confidential** counselor about sexual misconduct, [The Counseling Center](#) provides 24/7 confidential support for students via the Bengal Support Line (833-823-0260), or by scheduling an appointment at 716-878-4436.
- If you are a student with a disability and require reasonable accommodations to meaningfully participate in this course, please contact the University's [Student Accessibility Services](#) at your earliest convenience (sas@buffalostate.edu or 716-878-4500), as SAS is responsible for processing and approving such requests.
- If you are pregnant, have recently experienced childbirth, and/or have medical needs related to childbirth, please contact our Title IX Coordinator for assistance.

- You can file an [anonymous report](#) with our University Police Department: 716-878-6333, police@buffalostate.edu

Off Campus Resources

- Crisis Services: 24/7 hotline, 716-834-3131
- National Suicide Prevention Lifeline: 1-800-273-8255
- Family Justice Center: 716-558-7233, safe@fjcsafe.org

Tutoring: Buffalo State offers a wide array of FREE tutoring services: Math Center, Writing Center, Other Subject Tutoring Center, STAR-NY online tutoring, and EOP/ACE. Most tutoring is face-to-face in the Academic Commons area of Butler Library. For details check out the tutoring website: <https://academicsuccess.buffalostate.edu/tutoring>.

Support: The Dean of Students Office helps students navigate the college experience, particularly during difficult situations such as personal, financial, medical, and/or family crises. If you or someone you know needs support, services are available. For a list of support services and information, please visit <http://deanofstudents.buffalostate.edu/>, 716-878-4618 or stop by 311 Campbell Student Union during business hours.

Policy on Cell Phone Use:

During the class, cell phones and other electronic devices must be turned off or set to SILENCE.

Academic Misconduct:

All students at Buffalo State College are expected to display honesty and integrity in completing course requirements. "Academic misconduct" refers to any form of plagiarism or cheating on examinations or assignments and is inconsistent with the aims and goals of Buffalo State College. The violation of "Academic Misconduct Policy" will lead to an "E" grade in this course. For details, visit the website at <https://academicstandards.buffalostate.edu/misconduct>.

Students with Disabilities:

Students who require accommodations to complete the requirements and expectations of this course because of a disability are invited to make their needs known to the Student Accessibility Services Office, Butler Library 160, (716) 878-4500, or email sas@buffalostate.edu.

Procedures Regarding Disruptive Individuals:

Disruptive behavior (cell phones, talking, noise, tardiness, etc.) by students in my class will not be tolerated. Whenever I deem a student to be acting in a disruptive or threatening manner, I will exercise my right to ask that individual to leave the classroom. If refused, I will exercise my right to notify the University Police. The responding officer will determine whether an arrest should be made or whether a referral to medical or counseling staff is appropriate. If a student is perceived as a danger to themselves or others, the Dean of Students may propose an interim suspension until a hearing is held. Any student removed from class will have the right to a hearing.

For details, see <https://facultyhandbook.buffalostate.edu/disruptive-students>