This course is offered through the
SCHOOL OF ARTS AND SCIENCES
SYLLABUS

Course Number: PHY 307	**Course Name: Modern Physics Laboratory**
Semester: Spring 2024	**CRN: 3385**
Schedule: T: 1:00-3:40 pm (SAMC 358)	**Mode: Traditional Lab**
Instructor: Ram Rai, PhD	**Email: rairc@buffalostate.edu**
Office Hours: M & W: 1-2 pm or by appointment	**Office Location: SAMC 280**
Phone: 878-3767	

Course Description:
Selected modern physics experiments in optics, atomic physics, electricity and magnetism, and nuclear physics. Students will acquire, analyze, and interpret experimental data and write lab reports in a scientific format. (Required for physics majors)
Prerequisite: PHY 305 (or corequisite) or instructor permission.

Required Materials: Recommended
The Art of Experimental Physics (1991), by Daryl W. Preston
or 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 systematically collect data for the dependent physical parameters.
2. analyze the acquired data using graphical analysis techniques and theoretical models.
3. interpret the analyzed data to measure physical constants.
4. evaluate the experimental results based on the expected values and the possible sources of error.
5. write comprehensive lab reports in a scientific format.
6. defend the experimental findings with peers.

COURSE DESCRIPTION:
This junior-level lab aims to help students improve their laboratory skills and deepen their understanding of physical theories by conducting experiments in modern physics. Students will acquire, analyze, and interpret the experimental data and prepare journal-style lab reports. For each experiment, the lab manual or a short description of theory and experimental procedures will be provided. It should be noted that the lab manual gives general guidance but not explicit step-by-step instructions. Students are urged to look for more relevant elements in the physics textbook. "The Art of Experimental Physics (1991)" is a particularly useful book.

This is a writing-intensive course, and written lab reports count heavily toward the final grade. Lab reports should be written in a standard scientific format and must adhere to basic proficiency requirements. To create graphs and fit curves, we will use OriginLab, a computer software that is installed on five computers in room 358.

You are expected to complete **eight to ten labs** from the list below:

1. Electronic Charge/Mass Ratio
2. Franck-Hertz Experiment
3. Michelson Interferometer
4. Gamma Ray Spectroscopy using NaI or Ge detectors and Pu(Be) neutron source
5. Magnetism Experiment with the Levitating Cue Ball
6. Muon Particle Detection and Its Half-Life
7. Torsional Oscillator
8. Two-slit interference with single photon source
9. Planck's Constant Experiment
10. The Hall Effect in a n-Type Semiconductor
11. Scanning Tunneling Microscopy (Graphene, TaS_2, Gold film)

GENERAL COURSE REQUIREMENTS:

ATTENDANCE

Attendance is REQUIRED and will be taken during the lab. Any labs missed due to unexplained absences must be made up by you. If you have an excused absence, I can assist you with the lab, but it must be completed after regular class hours.

PRE-LAB AND READING ASSIGNMENT

Prior to coming to the lab, you are expected to read the theoretical portion of each experiment from the supplied lab manual and a modern physics text. Every lab has a pre-lab component. At the start of every lab, a pre-lab consisting of a few questions will be collected and graded. It is worth 5%. You should know the basics of conducting the measurements and be familiar with the theory when you enter the lab. You and your group members should always talk about the experiment's plan.

LAB NOTEBOOKS

Learning to maintain a good notebook is one of the important things you should learn in this course. Having a clean, well-maintained lab notebook is crucial when it comes time to write your report or create a presentation. I recommend the quadrille-ruled laboratory notebook, but a regular notebook is also fine. Be sure to bring your lab notebook to all classes. Your lab notebook will be collected twice for evaluation: at the midterm and at the end of the semester. The following are some guidelines for maintaining your notebook.

- Create a descriptive table of contents and add to it every time you make an entry:
  Date ----------Contents----------Page no.
- Don't erase or tear out pages. Indicate mistakes by simply crossing them out.
- Take notes on typical readings or instrument settings so that you can reproduce results or repeat the experiment later if necessary.
- If you have computer generated graphs or data tables, cut them out and paste them into your lab notebook.
- Make drawings or diagrams of all relevant designs, circuits, or set-ups. Record data in tabular form with units clearly indicated.
- Writing "Learning Commentaries" in your notebook is highly advised: Don't be shy about jotting down thoughts and words in your notebook. Take note of any data analysis or uncertainty analysis findings, as well as any conclusions.
- Record any notes from discussions.

LABORATORY REPORTS:

For each lab completed, you MUST write a final lab report as a separate document. Lab reports should be computer-typed. Each student must write an independent lab report. All graphs must have their axes labeled with the appropriate parameters and units. You can use the sample lab report available on Brightspace as a template when writing your own. As mentioned above, your lab report constitutes a significant portion of this writing-infused course. In general, your lab report should contain the following sections:

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

All lab reports should be submitted in hard copies **no later than one week after the experiment is completed. Late lab reports will be subject to penalties.**

Each lab report must be self-contained. The writing style ought to be understandable to a physics major in their junior or senior year of college. Your lab report should include a well-defined concept (theory), a discussion of the experiment, sufficient justification for the main idea (i.e., experimental data), an explanation and analysis of the data along with any associated uncertainties, and conclusions. Grammar, punctuation, and spelling conventions must be followed. Any lab report that does not meet the expected standard or is not written in accordance with the above guidelines will be sent back to be revised. Rewriting the lab report is not penalized. For assistance with manuscript writing, visit the American Institute of Physics website at this link: https://publishing.aip.org/authors

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	15 %
Lab notebook	10 %
Lab reports	60 %
Oral Presentation	15 %

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 a very low activity, you should still take precautions to keep them as far away from your body as is practical while using them and to put them away when you are done with them.

Coronavirus Information

Check the website (https://coronavirus.buffalostate.edu/) for current guidance.

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 requirement. "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 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