

# PHYS 461 Modern Physics Lab, Spring 2024

University of Tennessee, Knoxville



**Meeting Time and Place:** Nielsen 217 MW 9:00 – 12:00 (6 contact hours)

Course Credit Hours: 3

## Contact Information

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**Course Description/Information:** Introduction to fundamental and modern techniques in experimental physics and to the theory and practice of measurement and data analysis. Selected experiments in nuclear, atomic, molecular and solid-state physics, and modern optics. Prerequisites: PHYS 250 or 252 or PHYS 411.

**Value Proposition:** This course is essentially the capstone experimental experience for physics majors. The laboratory includes specialized equipment for performing experiments to investigate

diverse physical phenomena. The experiments rely on knowledge garnered from across the undergraduate curriculum. This course is a research experience, going beyond simply following detailed step-by-step instructions. Together, we consider different approaches and improvements to the experiments, as well as sources of uncertainty. We take responsibility for ourselves, others, and the equipment when trouble shooting, or considering improvements. There is also a focus on scientific communication through short reports, leading into a longer written report and oral presentation at the end of the semester.

**Student Learning Outcomes/Objectives:** After successful completion of this course, you will be able to:

- 1) Make measurements with complex equipment, including making and applying calibrations. You will be able to use your own judgment in making observations and reading results, for example, from oscilloscopes.
- 2) Analyze data, including making error estimates and propagating these to the final results.
- 3) Communicate the physics motivation, experimental methods including descriptions of equipment used, and results, in writing and through oral presentations.
- 4) Illustrate results using graphs with error bars, and in clear tables.
- 5) Extract information from graphs using fits.
- 6) Keep a laboratory journal that includes notes about the physical concepts being studied and progress in taking data.

**Learning Environment:** The laboratory is a collaborative environment. It is important that everyone respects each other, as well as the health and safety rules in place to protect all of us. Students typically work in pairs. You are expected to collaborate with your lab partner in almost all aspects of the course except writing individual reports. Being able to collaborate with others effectively is an important skill.

**Course Communications:** Communication will be in-person in the laboratories, through e-mail, through Canvas, and via Zoom. Grading will be communicated through rubrics and comments on laboratory reports. Read these carefully and contact us with any questions. Please monitor your e-mail and Canvas regularly. For technical issues, contact the OIT HelpDesk via phone (865) 974-9900 or online at <http://help.utk.edu/>.

**How to Be Successful in This Course:** This course requires the completion of seven experiments. These are typically the seven experiments listed below.

Students are expected to attend class at least 6 hours per week, summed over the scheduled class times and outside of these times. Students should arrive promptly for scheduled sessions. The laboratory time can be used for background reading, as well as taking data and graphing results.

However, this semester we request that students prioritize working on lab-based tasks in the lab, work on reading and writing tasks outside of the laboratory, where possible. While collecting data, it is reasonable that students work on **writing reports, although generally these should be worked on outside of lab time.**

The best way to be successful in the course is to perform the experiments carefully, taking time with calibrations where needed, or for the temperature to equilibrate where needed. Most of the experiments will give poor results if rushed. Therefore, in order to complete all the experiments before the end of semester, when final exams become a priority, it is important to spend sufficient time in the laboratory and/or analyzing the data throughout the semester. The class is allocated six hours a week. Especially this semester, those six hours may not be during the normal class time, but you should endeavor to spend at least six hours a week working toward completing experiments and analyzing data. As we will be scheduling meetings with pairs of students, it is important that you come to those sessions prepared. This means that you should have read the handout for the experiment that you are starting, and you should have looked through all of the material in the module on Canvas relating to that experiment. All the handouts can be found on Canvas under each module.

Handing reports in on time is essential to get early feedback on your work. These reports take significant time to grade. We, the instructors, usually grade and return reports within a week of receiving them, especially for the first reports, but this may sometimes be closer to two weeks. We use a rubric for grading, so students know where they lost points, and we also write comments on the report. Not all the comments will result in lost points, some are grammatical corrections, or suggestions of a stylistic nature. **Reports that are turned in more than 1 week late will not be accepted.**

There is a possibility to resubmit your report. The resubmitted report should address the comments and corrections that you received and needs to be submitted within a week from the date when you received the graded report. Discuss with us (the instructors) the comments and have our consent for resubmission. For your first report in class, consent is always granted. To resubmit the revised report, upload it the same way as your original report, and in the "Comments for this Attempt" text box, detail briefly the changes you made in the revised report. **Submit the revised report within 1 week of receiving your comments and grade on the original submission.**

**Safety first:** We have tried to minimize electrical and radiation hazards, but there are always possibilities for injury. Follow all safety procedures for handling lasers, the x-ray machine, radioactive materials, and high voltage sources. **Be careful with the equipment.** Don't make connections unless you understand what you're doing. **Don't play with the equipment with "Idle Hands."** Read the equipment manuals.

**Be courteous:** Return tools, equipment, etc. to their proper place. Don't remove equipment from someone else's experiment for use on your own (without asking first).

### **Texts/Resources/Materials:**

Students are required to purchase a laboratory notebook. A hardbacked version is recommended as there are few open hard surfaces that students can use for writing. If you prefer to keep a digital laboratory notebook, that will also be acceptable. You may want to make sketches, so think about using software that allows text and drawings.

### **The Experiments:**

1. Zeeman Effect
2. Compton Scattering
3. X-Ray Bragg Diffraction
4. Temperature Dependent Lifetimes of Fluorescence from a Phosphor
5. Nuclear magnetic resonance
6. Hall Effect
7. The Speed of Light--Rotating Mirror Version

### **Other Experiments that may be available**

1. Cavendish Experiment--Determination of Gravitational Constant

### **Assignments**

The assignments for this course are **1) notes for each lab, 2) reports, 3) one final report, and 4) final presentation.** Please see the individual pdfs regarding each of these assignments.

### **Due dates for the reports**

Laboratory reports are due on the day shown in the table below and must be handed in promptly to progress through the experiments. Any student who is delinquent by two reports cannot move on to their next experiment. For example, you need to hand in your first short lab report before you can start your third experiment. **Reports that are turned in more than 1 week late will not be accepted.**

| <b>Day</b> | <b>Date</b> | <b>Note</b>        |
|------------|-------------|--------------------|
| Monday     | 01/22/24    | First Day of Class |
| Wednesday  | 01/24/24    |                    |
| Monday     | 01/29/24    |                    |
| Wednesday  | 01/31/24    |                    |
| Monday     | 02/05/24    | First Report Due   |
| Wednesday  | 02/07/24    |                    |
| Monday     | 02/12/24    |                    |
| Wednesday  | 02/14/24    |                    |
| Monday     | 02/19/24    | Second Report Due  |
| Wednesday  | 02/21/24    |                    |
| Monday     | 02/26/24    |                    |
| Wednesday  | 02/28/24    |                    |
| Monday     | 03/04/24    | Third Report Due   |
| Wednesday  | 03/06/24    |                    |
| Monday     | 03/11/24    | Spring Break       |
| Wednesday  | 03/13/24    | Spring Break       |
| Monday     | 03/18/24    |                    |
| Wednesday  | 03/20/24    | Fourth Report Due  |
| Monday     | 03/25/24    |                    |
| Wednesday  | 03/27/24    |                    |
| Monday     | 04/01/24    |                    |
| Wednesday  | 04/03/24    | Fifth Report Due   |
| Monday     | 04/08/24    |                    |
| Wednesday  | 04/10/24    |                    |
| Monday     | 04/15/24    |                    |
| Wednesday  | 04/17/24    | Sixth Report Due   |
| Monday     | 04/22/24    |                    |
| Wednesday  | 04/24/24    |                    |
| Monday     | 04/29/24    |                    |

|           |                   |   |
|-----------|-------------------|---|
| Wednesday | 05/01/24          | Final Report Due  |
| Monday    | 05/06/24          | Last Scheduled Class Session  |
| Exam      | <b><i>TBD</i></b> | <b><i>Presentations will be during the exam time slots for our class.</i></b> |

## Grades

Final grades will be calculated as follows:

| <b>Component of Grade</b> | <b>Weight</b> |
|---------------------------|---------------|
| Reports                   | 60%           |
| Notes                     | 15%           |
| Final Report              | 15%           |
| Presentation              | 10%           |
| <b>Total</b>              | <b>100%</b>   |

|    |              |
|----|--------------|
| A  | 90 and above |
| A- | 87 and above |
| B+ | 83 and above |
| B  | 80 and above |
| B- | 77 and above |
| C+ | 73 and above |
| C  | 70 and above |
| C- | 67 and above |
| D+ | 63 and above |
| D  | 60 and above |
| D- | 57 and above |
| F  | below 57     |

## UNIVERSITY POLICIES:

### ACADEMIC INTEGRITY

Each student is responsible for their personal integrity in academic life and for adhering to UT's Honor Statement. The Honor Statement reads: "An essential feature of the University of Tennessee, Knoxville is a commitment to maintaining an atmosphere of intellectual integrity and academic honesty. As a student of the university, I pledge that I will neither knowingly give nor

receive any inappropriate assistance in academic work, thus affirming my own personal commitment to honor and integrity.”

### **YOUR ROLE IN IMPROVING THE COURSE THROUGH ASSESSMENT**

At UT, it is our collective responsibility to improve the state of teaching and learning. During the semester you may be requested to assess aspects of this course, either during class or at the completion of the class, and through the TNVoice course evaluation. Please take the few moments needed to respond to these requests as they are used by instructors, department heads, deans and others to improve the quality of your UT learning experience.

### **STUDENTS WITH DISABILITIES** – <http://sds.utk.edu>

The University of Tennessee, Knoxville, is committed to providing an inclusive learning environment for all students. If you anticipate or experience a barrier in this course due to a chronic health condition, a learning, hearing, neurological, mental health, vision, physical, or other kind of disability, or a temporary injury, you are encouraged to contact [Student Disability Services](#) (SDS) at 865-974-6087 or [sds@utk.edu](mailto:sds@utk.edu). An SDS Coordinator will meet with you to develop a plan to ensure you have equitable access to this course. If you are already registered with SDS, please contact your instructor to discuss implementing accommodations included in your course access letter.

### **ACCESSIBILITY POLICY AND TRAINING** – <http://accessibility.utk.edu>

The University of Tennessee, Knoxville, provides reasonable accommodations for individual students with disabilities through its office of [Student Disability Services](#). The university is also committed to making information and materials accessible, when possible. Resources and assistance to support these efforts can be found at <http://accessibility.utk.edu/>.

### **WELLNESS** – <http://wellness.utk.edu/> and <http://counselingcenter.utk.edu/>

The [Center for Health Education and Wellness](#) empowers all Volunteers to thrive by cultivating personal and community well-being. The Center can answer questions about general wellness, substance use, sexual health, healthy relationships, and sexual assault prevention. The [Student Counseling Center](#) is the university’s primary facility for personal counseling, psychotherapy, and psychological outreach and consultation services.

Any student who has difficulty affording hygiene products, groceries, or accessing sufficient food to eat every day is urged to contact the [Big Orange Pantry](#) for support. The Big Orange Pantry, located in Greve Hall, is a free resource for all students, faculty, and staff, no matter how great or small their need is. Students who need emergency financial assistance can also request funding from the [Student Emergency Fund](#).

Students who are experiencing non-academic difficulty or distress and need assistance should call 974-HELP or [submit an online referral](#). The 974-HELP team specializes in aligning resources and support to students experiencing mental health distress.

## **EMERGENCY ALERT SYSTEM** – <http://safety.utk.edu/>

The University of Tennessee, Knoxville, is committed to providing a safe environment for learning and working. When you are alerted to an emergency, please take appropriate action. Learn more about what to do in an emergency and sign up for UT Alerts. Check the emergency posters near exits and elevators for building specific information. In the event of an emergency, course schedules and assignments may be subject to change. If changes to graded activities are required, reasonable adjustments will be made, and you will be responsible for meeting revised deadlines.

### **Key Campus Resources for Students:**

- [Center for Career Development and Academic Exploration](#) (Career counseling and resources; Handshake job search system)
- [Course Catalogs](#) (Listing of academic programs, courses, and policies)
- [Hilltopics](#) (Campus and academic policies, procedures and standards of conduct)
- [OIT HelpDesk](#) (865) 974-9900
- [Schedule of Classes/Timetable](#)
- [Student Health Center](#) (visit the site for a list of services)
- [Academic Success Center](#) (Academic support resources)
- [Undergraduate Academic Advising](#) (Advising resources, course requirements, and major guides)
- [University Libraries](#) (Access to library resources, databases, course reserves, and services)

*The instructor reserves the right to revise, alter or amend this Syllabus as necessary. Students will be notified in writing / e-mail of any such changes.*