

Syllabus Phys 220: Advanced Physics Lab

Time: Tuesday 1:25-4:15pm, and Thursday 1:25:10-4:15pm.

This is a 3cr. laboratory class and hence you are expected to devote about 9-12hrs per week to this class.

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Contents:

In this class, we will cover the basics and some advanced concepts of experimental physics with a focus on electronics, computer programming, and computerized measurements. We will cover basics electronics such as transistors, OpAmp, A/D converters,...

You will learn in a practical hand-on fashion

- how to program an Arduino board to control stepping motors and to read out various sensors,
- how to program on a higher level in Labview,
- how to evaluate experimental data and compare them to models using Python.
- how to write a scientific paper or report using LaTeX
- how to communicate between different hardware components
- how to use basic instrumentation such as photodiodes, photomultipliers, temperature sensors, digital oscilloscopes, and lock-In multipliers, stepping motors,....
- how to use a 3D Printer
- how to operate a lathe and drill in the machine shop

The class will be supplemented with in-lab lectures covering basic concepts of electronics, measurements, and data analysis.

The class will be capped with a project in which you will apply all those concepts to design an instrument that tracks the position of the sun and optimize the performance of a solar panel. The course is structured in such a way that you will learn the basic elements first and apply them as you may see fit for your final project.

Required Competencies: Basic Lab Skills as obtained in Phys 12 and 22. Basic Concepts of programming. Computer proficiency.

Final Competencies:

- Able to write programs in Labview, Python, and for the Arduino
- Demonstrate how these programming environments can interact.
- Understand the function of an AD converter
- Ability to design and build an automated experiment.
- Ability to handle large data sets.
- Ability to come up with model and fit experimental data to this model.
- Ability to find creative solution with available resources
- Write coherent informative reports that can be understood by physics majors that have not taken the course yet.
- Keep a lab note book

Structure of the Course:

The structure of the course is best described by the goals that we want to achieve. Elements of that will be guided but most of them you will do at your own pace. Guidance will be provided through expected accomplishment for each posted on CourseSite

- (1) Measure the characteristics of an LED. For that we start out doing this essentially by hand step by step but will ultimately do that measurements completely automatically using the Arduino board as a DAQ which is connected to your computer. With the computer we will collect, display, save, and evaluate the data using a higher programming language. We will do this both with Labview and Python. One the way, we need to address the following issues:
 - Measure voltages using the Arduino
 - How to switch on/off external voltages (transistor)
 - How to create a DC voltage using the Arduino (RC circuitry)
 - How to isolate the experiment from the Arduino (Operational Amplifier)
 - How to write a driver for the Arduino that allows to control it from a computer
 - Write programs in Python and Labview that allow to control the experiment, collect data, display data, save data, and fit data to a model.
 - Write a paper about the experiment (Latex)
- (2) Control of a stepping and servo motor to enable motion control
- (3) Final project in which you define your own measurement task, design the experiment, and develop a model that describes the observed behavior.

Degree Requirements: This course is a required course for all Physics majors for students that started AY2016/17 or later. For student before, the course replaces the Phys 190 requirements. It does not replace the Phys 262 requirement. The course fulfills writing intensive requirement.

LabManual:

No formal lab manual exists yet. Since this is a writing intensive class, it is one of your tasks to collect some of the information needed from the Internet and collect them for future use. We will have some handouts but none of them will be to on the level “Do this, do this,…”

You will need to keep a lab-book to document what you are doing throughout the labs. The outcomes of the experiments are summarized in reports. These reports should be written on a level such that somebody could just use the report and do the respective activity. *In a sense, you are writing a lab manual*

Grades:

The basis for your grades will be your work in the lab as demonstrated in weekly reports and the Final Paper about your projects. The basis for your grade is the demonstration of the final competencies outlined above.

5 Reports

50pts

Since this is a writing intensive course, your reports will be returned for revision. For the grades, the revised version will be most relevant but is expected that you don't repeat errors that had been pointed

out before. Late reports will not be excepted. Reports are due Tuesdays. You will receive revisions by Friday. Final Report will be due the following Tuesday, The reports are submitted using course site. The reports are written in the form of a scientific paper.

See for example <https://www.nature.com/scitable/ebooks/english-communication-for-scientists-14053993/118519636#bookContentViewAreaDivID>

to learn about what the expectations are

Labnote Book

25pts

A lab note book that describes your activities throughout the course must be kept. Have it signed by instructor once per week. (see document about note books)

Paper about final project:

25pts

In this paper , you will be evaluated on creativity of your approach, success in executing your approach, defining model for the collected data, discussion of results, quality of paper in terms of structure, referencing, and clarity.

Total:

100pts

COVID-19 Adjustment to the Course: Due to COVID-19 pandemic, this course will be held online only using Zoom during the regular class times. You are expected to attend at least part of the time. Preferentially the beginning. Mini lectures on some topics, will be given at 3pm. Some offline work is acceptable. Help with the experiments will be provided through Zoom breakout rooms. There may be some in-person interactions needed and possible. They will be arranged by appointment and will take place outside of the regular class time.

Rules for Online Session: To meet the challenge of teaching and learning during the COVID-19 pandemic, We will be adopting new forms of instruction and interaction; following new guidelines around classroom behaviors; enhancing communications; and doing our best to be patient, flexible, and accommodating with each other. In remote synchronous meetings, students are expected to attend just as they would any other Lehigh class. Zoom classes work best when all students come to class ready to participate and therefore you are asked to turn your camera on during active learning sessions in Zoom. If you have a strong preference not to do so, please contact me. Students should respect the in-classroom privacy of their instructors and fellow students by not taking screenshots or recording class sessions. I may record Zoom sessions; however, any recorded live sessions will be shared only with students in the class and will be deleted at the end of the semester. In our physical classrooms, Lehigh has established a policy requiring everyone to wear face coverings when in public spaces inside buildings on our campus and to maintain social distance. This policy applies to our physical classroom. Thank you in advance for following this rule.

Accommodations for Students with Disabilities

Lehigh University is committed to maintaining an equitable and inclusive community and welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact Disability Support Services (DSS), provide documentation, and participate in an interactive

review process. If the documentation supports a request for reasonable accommodations, DSS will provide students with a Letter of Accommodations. Students who are approved for accommodations at Lehigh should share this letter and discuss their accommodations and learning needs with instructors as early in the semester as possible. For more information or to request services, please contact Disability Support Services in person in Williams Hall, Suite 301, via phone at 610-758-4152, via email at indss@lehigh.edu, or online at <https://studentaffairs.lehigh.edu/disabilities>.

The Principles of Our Equitable Community:

Lehigh University endorses The Principles of Our Equitable Community [http://www.lehigh.edu/~inprv/initiatives/PrinciplesEquity_Sheet_v2_032212.pdf]. We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom..