

## Syllabus Phys 221: Advanced Physics Lab II

**Time:** Wednesday and Friday 1:10-4pm.

This is a 2cr. laboratory class and hence you are expected to devote about 6-9hrs per week to this class. You are expected to spend at least 6 hours in the lab working on the lab experiments. Some work outside of the lab such as writing reports is required. During the core times short lectures may be given.

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### Contents:

In this class, we will cover the basics and some advanced concepts of experimental physics with a focus on experimental methods and instrumentation and the way they can be implemented in an automated way.

You will learn in a practical hand-on fashion

- how to program an Arduino board to control stepping motors
- how to control commercial instruments 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 design an experiment including hardware, software control, and development of models to evaluate experiments.
- how to use basic instrumentation such as Lock-In amplifiers, Motion Controllers, CCD Cameras, Temperature Controllers, Laser Diode Controllers,
- how to use a 3D Printer
- how to operate a lathe and drill in the machine shop

The experiments are out of the areas of Optics and include:

- Interferometry
- Confocal Microscopy
- Polarization
- Spectroscopy
- Laser Diodes
- Optical Amplifiers and Fibers
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**Required Competencies:** Basic Lab Skills as obtained in Phys 12, 22, and Phys 220. Use of oscilloscope, power supplies, electric circuits (transistors, Op.amp), use of Arduino, Basic Python programming, basic Labview programming.

### Final Competencies:

- Able to write programs in Labview to control a variety of instruments.
- Build instruments that can be controlled by Labview.
- Design of experiments from scratch
- Demonstrate how these programming environments can interact.
- Ability to handle large data sets.

- Understand the optical concept that are covered in Phys 21 on a level that allows the design of advanced instrumentation.
- 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.

**Degree Requirements:** This course is a required course for all Physics majors for students that started AY2016/17 or later. For student before it replaces the Phys 262 requirement.

**LabManual:**

There is no formal lab manual for this course. An outdated lab manual will be posted on course site for reference. We will have some handouts but none of them will be to on the level “Do this, do this,...”. For each experiment you will receive a handout that describes the task.

You will need to keep a lab-book to document what you are doing throughout the labs. The outcomes of the 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 reports, experiment descriptions and a final project paper, and the demonstration of the proficiencies in class. We will also have an informal peer evaluation (see below). The basis for your grade is the demonstration of the final competencies outlined above.

<b>Demonstration of Proficiency in the Lab:</b>	<b>30%</b>
<b>Written Experiment description for Peers:</b>	<b>20%</b>
<b>Lab Reports:</b>	<b>20%</b>
<b>Final Project Report:</b>	<b>30%</b>
<b>Total:</b>	<b>100pts</b>

You will able to earn extra points in activities that will be labelled as challenge. Each challenge is worth 10 its but must be completed at the time stated in the challenge. Since these challenges may only by challenges at the time, no late credit will be given.

**Accommodations for Students with Disabilities:**

If you have a disability for which you are or may be requesting accommodations, please contact both your instructor and the Office of Academic Support Services, Williams Hall, Suite 301 (610-758-4152) as early as possible in the semester. You must have documentation from the Academic Support Services office before accommodations can be granted.

**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](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.

**Since we are working as teams and teams are relying on other teams these principles are very important for the success of the class.**

## Course Schedule

Week	Activities	Expected Outcome
1-5	<p>In three teams, we will build up three core experiments from scratch. Including machine shop work, Labview programming, Arduino Programming, execution of experiments and evaluation of data. The experiments are:</p> <ul style="list-style-type: none"> <li>• Polarization and the determination of the state of polarization of an unknown light source</li> <li>• Confocal Microscopy including basic imaging and the determination of the spatial resolution of the instrument</li> <li>• Interferometry including the determination of the coherence length of an LED, the refractive index of air, and of an unknown glass plate</li> </ul>	<ul style="list-style-type: none"> <li>• Fully functioning experiment.</li> <li>• Labview Program that controls the experiment including two commercial instrument and one homebuilt control of rotation.</li> <li>• Written description of the experiments that allows another team to perform the experiment. The other teams will comment both on the quality of implement of the experiments (does it work) and of the description (can the experiment be done following the description)</li> </ul> <p>Due before Wednesday of week 6.</p>
6	Perform experiment from other group I	LabReport with Data Analysis due Wednesday of week 7
7	Perform experiment from other group II	LabReport with Data Analysis Due Wednesday of week 8
8	<p>Advanced Experiments I. These experiments are chosen from</p> <ul style="list-style-type: none"> <li>• Optical Amplifier</li> <li>• Laser Diodes</li> <li>• Optical Spectroscopy (Raman)</li> <li>• Optical Tweezer</li> </ul>	LabReport with Data Analysis due Wednesday of week 9
9	Advanced Experiments II	LabReport with Data Analysis due Wednesday of week 10
10-14	<p>Final Project. In this phase, you will combine the knowledge acquired previously to build a more challenging experiment. Examples that come to mind are</p> <ul style="list-style-type: none"> <li>• Homebuilt Raman Spectrometer</li> <li>• Automated Wavemeter to measure the wavelength of a laser</li> <li>• Homebuilt Optical Tweezer</li> <li>•</li> </ul>	<p>Final Report Due last day of Finals</p>