Syllabus Phys 221: Advanced Physics Lab II

Time: Wednesday and Friday 1:35pm-4:15pm.

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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COVID-19 related safety measures:
1. **Students with COVID-19 symptoms are not allowed in the lab.**
2. **Students must complete and obtain clearance from the COVID-19 Self-Assessment each day.**
3. We will work in groups of two but until further notice only one of the lab partners will be in the lab while the other one is connected via ZOOM.
4. A maximum of 4 students are allowed in the lab. Students are required to wear face masks and stay in their lab station which are spaced far apart from each other.
5. Students wipe down the equipment before and after use with the provided disinfectant.
6. No food or drink allowed in the lab. Should you need a break step out of the lab.
7. Wear gloves and dispose of them after use.

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 the 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 using Labview or Python,
- how to evaluate experimental data and compare them to models using Python.
- how to write a description of an experiment using LaTeX
- how to design an experiments including hardware, software control, and development of models to evaluate experiments.
- how to use basic instrumentation such 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

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.
- Effectively present experiments and results in an oral presentation

Degree Requirements: This course is a required course for all Physics majors.

LabManual:
There is no formal lab manual for this course. An outdated lab manual will be posted on course site for reference. This manual is meant to give some background and basic ideas.
You will need to keep a lab-book to document what you are doing throughout the labs. The outcomes of them are summarized in instruction manuals, reports and oral presentations.

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.

Demonstration of Proficiency in the Lab (throughout):	**30%**
Phase 1: Written Experiment description for Peers:	**20%**
Phase 2: Lab Reports:	**20%**
Phase 3: Final Project Presentation	**30%**
Total:	**100pts**

Accommodations for Students with Disabilities:

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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..

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

<u>Course Schedule (preliminary)</u>

Week	Activities	Expected Outcome
2-3	Programming Instruments with Labiview • Use a Lock-In amplifier to study the characteristics of a long=pass filter • Install Labview on a computer or use existing computer • Use a GBIB interface to program a Lock-In amplifier or a Powermeter • Use Arduino with controller to control a Stepping motor • Create a sine wave using the NI-6008 card • Detect a sine wave using the NI 6008 card • Save data and display using Python.	Running Labview demonstrated by each student individually.
4-8	In four teams, we will build up four core experiments from scratch. Including machine shop work, Labview programming, Arduino Programming, execution of experiments and evaluation of data. The experiments are: • Polarization and the determination of the state of polarization of an unknown light source • Interferometry including the determination of the coherence length of e.g.:, the refractive index of air, and of an unknown glass plate • Spectroscopy including the spectral characterization of a semiconductor laser. • Spectroscopy including the characterization of atomic spectra. Determination of the Rydberg Constant	• Fully functioning experiment. • Labview Program that controls the experiment including two commercial instrument and one homebuilt control of rotation. • 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) Due before Wednesday of week 9
9	Perform experiment from other group	LabReport with Data Analysis due Wednesday of week 10
10-14	Final Project. In this phase, you will combine the knowledge acquired previously to build a more challenging experiment or instrument. Examples that come to mind are • Homebuilt Raman Spectrometer • Automated Wavemeter to measure the wavelength of a laser • Homebuilt Optical Tweezer • Tunable diode laser • Automated Polarimeter	Final Presentations 25min. each on last Friday