PHYS 4600: Experimental Physics II (fall and winter)

Calendar description: This course is designed primarily for honours physics students to study advanced topics in (astro)physics in the laboratory. Students are responsible for setting up and performing the experiments, writing computer programs to aid the analysis, and preparing and presenting their results in a professional manner. The majority of work will be project-based, each project conceived and built by the students from equipment available in the lab.

Note: While this is a 3 hour course, it will be taught over two semesters.

Lab 3 hrs. per week; 2 semesters.

Contents

Overview

This is a project-based lab course. Students typically do three or four major labs throughout the year, and are expected to design, construct, and run these labs semi-independently. Only students in their fourth year of an honours physics programme are enrolled in this course, and typically this means two or three students.

This course is often taught by the same instructor as PHYS 3600 (Experimental Physics I) and in the same time slot. Fourth year students may participate in some of the lectures, may help mentor some of the third year students, but are otherwise largely independent, consulting with the instructor and/or physics technician only when needed.

Prerequisites

PHYS 3600 Experimental Physics I

This course is a follow-on to PHYS 3600. Skills students acquire in designing, building, and executing their project including its write-up and presentation are directly germane to PHYS 4600.

Dependent courses

none

Student Outcomes

Students completing the fourth year lab should have mastered the following skills:

1. a methodical, systematic approach to gathering data
2. experimental design
3. familiarity with data analysis tools:
    - choosing variable quantities reasonably
    - propagation of uncertainties (using partial-differential method)
    - advanced statistical analysis, function fitting with uncertainties
    - use of computer software to facilitate analysis
4. use of advanced experimental equipment
    - program computer interface for digital data acquisition
    - advanced use of oscilloscopes
    - basic digital electronic devices (lock-in amplifier)
5. communicate scientific results, including:
    - search for and use results from the literature
    - succinct, clear prose (impersonal) in written reports
    - analytical expression
    - experimental methodology
    - representing data using tables and graphs
    - uncertainties: systematic *vs.* random, and sources
    - qualitative and quantitative discussion of results,
    - proper use of citations
    - preparing an oral presentation

Curriculum

There are no fixed labs for this course. The course consists of independent "projects" in experimental physics of sufficient complexity that students can complete one or two different projects per semester; three or four throughout the year.

Suggested texts

While there is no set lab manual or even written directions for the labs, the following texts on fundamental techniques for the physics lab have been found to be useful. These are the same texts listed for PHYS 3600.

Data Reduction and Error Analysis for the Physical Sciences, by P. R. Bevington and D. K. Robinson (ISBN 0 071 19926 8)

The Art of Experimental Physics, by D. W. Preston and E. R. Dietz (ISBN 0-471-84748-8)

Practical Physics, by G. L. Squires (ISBN: 0 521 27095 2)

Notes to the instructor

1. The departmental memory and experience of this course is retained by the physics technician, the lab coordinator, and any previous instructors of this course still on faculty. Despite the few number of students, this can be a demanding course to teach because of the need to get students "up and running" in a relatively short period of time with equipment that may or may not be well-designed for the task required. Thus, the instructor is strongly urged to consult frequently (*e.g.*, weekly) with the physics technician and the lab coordinator to ensure students get the maximum experience out of this lab.

2. Because labs at this level involve complex and often expensive equipment and lab components, the physics technician retains a somewhat limited list of what labs can be and have been done on site, and it is from these that students normally choose their projects. If the expertise of the lab instructor permits them to help students design and assemble other labs from existing equipment or if a new lab can be designed with a modest capital outlay, the instructor is encouraged to discuss this with the physics technician and lab coordinator. Particularly if there is a student keen on doing a particular lab not currently in the Department's repertoire, such designs and/or purchases can often be made quickly.