Dalhousie University
Faculty of Science, Department of Physics and Atmospheric Science
PHYC 2150 / Physics Tools: Experiment
Fall 2026

Dalhousie University operates in the unceded territories of the Mi'kmaw, Wolastoqey, and Peskotomuhkati Peoples. These sovereign nations hold inherent rights as the original peoples of these lands, and we each carry collective obligations under the Peace and Friendship Treaties. Section 35 of the Constitution Act, 1982, recognizes and affirms Aboriginal and Treaty rights in Canada.

Dalhousie recognizes that African Nova Scotians are a distinct people whose histories, legacies, and contributions have enriched the part of Mi'kma'ki known as Nova Scotia for over 400 years.

Instructor Information

Instructor: Dr. Tim Bardouille
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Office Hours: Mondays @ 10:30 am - 12:00 pm
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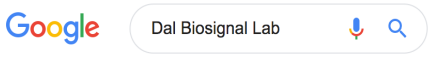
Course Description



In this class, you will learn to measure and address random and systematic error in scientific experiments, operate data acquisition and device control equipment, and complete and report on fundamental physics experiments. Instruction will follow principles of interactive learning and peer instruction. Conceptual understanding and problem solving will be the focus of this project-based course, with instructor-student and student-student engagement fostered through group work and discussion. You will also work in groups to conceptualize and complete experiments, report on your findings, and provide formative feedback to your peers.

The aim is to learn and apply techniques commonly used in physics research. You will be introduced to experimental tools and techniques to explore concepts including instrumentation, developing a testable hypothesis, planning and executing methods to test your hypotheses, interpreting results in the context of objectives and hypotheses, and reporting on your findings.

Teaching assistants will help you learn to use lab equipment appropriately, and share best practices for data acquisition, data analysis and reporting.

Course Learning Outcomes

On successful completion of this course, you will be able to:

- ✓ Use an Arduino board to perform data acquisition and device control
- ✓ Quantify random and systematic error in data using the appropriate statistical analyses for the problem

- ✓ Follow instructions to successfully complete physics experiments
- ✓ Develop a testable hypothesis and appropriate methods to test your hypothesis
- ✓ Present the comprehensive details of a physics experiment in written and oral form

Course Pre-requisites, Co-requisites and/or other Restrictions

Prerequisites:

- ✓ PHYC 1190/1290 and a 1000-level calculus course, or
- ✓ PHYC 1310/1320 and a 1000-level calculus course, or
- ✓ SCIE 1506/1507 and a 1000-level calculus course, or
- ✓ permission of instructor.

Course Structure

Class Time:		*Laboratory Time:*	
Tuesday	14:35 - 15:25 (Dunn 221C)	Tuesday	15:35 - 17:25 (Dunn 221E)
		Thursday	14:35 - 17:25 (Dunn 221E)

This course is 100% in-person. This laboratory course is composed of lab and class time. Class time will focus on learning about statistical analysis. Lab time will focus on completing physics experiments and research projects. The week-by-week schedule will be posted to Brightspace. Changes to the schedule may be required during the term based on our rate of progress.

It is important that you check your assigned Dalhousie e-mail account **daily**. Announcements pertaining to the course will be made via e-mail and Brightspace. These are two of the University's official channels of communication.

The Dal Brightspace page for this course is an **essential resource**. You can access this page at dal.brightspace.com. At that location, you will find class materials, assignment, instructions, announcements, as well as other information and media that are relevant for our course.

I am happy to discuss questions about course material, and physics in general, outside of class. My office hours are an excellent opportunity to supplement your learning with one-on-one (or some-on-one) mentoring. You can imagine that this type of learning is more effective in real time, rather than by e-mail. Office hours will occur in person. I am also available to meet by appointment.

For administrative requests regarding this course, please e-mail me. This will ensure that there is a "paper trail" for these requests, which can help avoid confusion.

Course Materials

An Introduction to Error Analysis, John R. Taylor, Publisher: University Science Books (2nd Edition or newer) 1997.

- Hard copy available online for approximately $70

Lab Notebook or Binder (Quad rule paper required)

Course Content

In class, we will cover the following topics:

- Quantifying Error and Uncertainty
- Error Propagation
- Estimating Error under the Gaussian Distribution
- Linear Regression
- Covariance and Correlation
- Estimating Error under the Binomial Distribution
- Estimating Error under the Poisson Distribution
- Model Fitting and Rejection

In lab, you will complete three projects. Project 1 focuses on developing the ability to acquire data and control devices using a user-friendly microprocessor. Project 2 focuses on answering a research question posed by the instructor by applying the scientific method to develop and implement an experiment. Project 3 builds on the second project – students applying the scientific method to develop and implement an experiment that answers a research question of their own choosing.

Course Assessments

Assessment	Value
Data Acquisition and Device Control Project	10
Guided Research Project	15
Independent Research Project	17
Weekly Assignments	18
Reading Quizzes	5
Midterm Quiz	15
Final Exam	20
Total	100

Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

Data Acquisition and Device Control Project
This major project will focus on learning to use an Arduino prototyping board as a data acquisition and device control platform. You will complete several learning modules with your Arduino kits. In-line with these modules, you will complete a hand-written assignment that will test your understanding of data acquisition and device control using Arduino technology. Following this, you will build your own Arduino project, develop a manual for this project, and present the project to your peers. Specifics of the mark breakdown of this major project will be provided.

Guided Research Project
You will complete an experimental physics project to measure fundamental physical constants using your Arduino as a data acquisition and device control platform. While you will receive some guidance, you will also have freedom to personalize the conceptualization and methodology of your approach. You will receive feedback and guidance from the instruction team and your peers along the way. Specifics of the mark breakdown of this major project will be provided.

Independent Research Project

You will complete an experimental physics project of your own design, which may (but is not required to) make use of your Arduino as a data acquisition and device control platform. While you will receive some guidance, you will have the freedom to personalize the conceptualization and methodology of your approach. You will receive feedback and guidance from the instruction team and your peers along the way. Specifics of the mark breakdown of this major project will be provided.

Weekly Problem Sets

These hand-written assignments will test your ability to quantify random and systematic error in data using the appropriate statistical analyses for the problem, and to visualize data. These assignments are based on the class content (i.e., error analysis). **Completing the homework is a critical step in test preparation.**

Reading Quizzes

These online quizzes will test your knowledge of the textbook material. Reading quizzes are due before the class when this material will be covered.

Midterm Quiz

There will be one 50-minute in-class quiz for this course.

Final Exam

The final exam will be scheduled during the exam period. Students are required to write the Final Exam during the scheduled time, except under exceptional circumstances. Instructors reserve the right to reject unsatisfactory certificates. Please see university policies for further details.

Course-Specific Policies

Late Assignments: Any assignment submitted after the due date without an approved extension will incur a 10% per day penalty. Any work submitted more than 5 days late will receive a zero. Due date extensions can be granted for valid medical or other reasons.

Missed Classes/University Closure: In the event of a university-wide closure (likely in the winter term), any missed labs will not be made up. If a closure causes a missed lecture, we will complete the lecture material in the following weeks.

Academic Integrity: Generative artificial intelligence and large language models (e.g., ChatGPT) should not be used for any work in this course, unless an explicit exception is provided by the instructor.

You will work in a group in the lab components of this course. This means that some components will be completed together (e.g., lab work), but other components (e.g., reports) will be completed on your own. My expectation is that you will submit **your own work for project components submitted with your name only**.

Accessibility: Refer to the Student Accommodation Policy for information on how we work collaboratively with students to create and sustain an accessible educational environment. You are eligible for accommodations based on protected characteristics such as religion. If you have religious,

cultural, or community-significant observances that conflict with course requirements, reach out to me to collaboratively find alternatives for completing the course requirements. To begin the process of requesting a formal academic accommodation, contact the Student Accessibility Centre

Syllabus Appendix

Syllabus Appendix: Student Supports & University Statements, Policies, and Guidelines