# Physics Tools: Experiment Syllabus

## Department of Physics and Atmospheric Science

### PHYC 2150 Fall 2023

*Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.*

*Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.*

## Course Instructor(s)

| Name | Email | Office Hours |
|---|---|---|
| Chongyin Yang | c.yang@dal.ca | Tuesday, 11:30 - 12:30, or by appointment (email), Dunn 224 |

## 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 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.

## Student Resources

It is important that you check your assigned Dalhousie e-mail account daily. Announcements pertaining to the course will be made via e-mail. This is one 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 be determined based on student availability (given the small class size), and will occur in person or via Microsoft Teams as appropriate/convenient. 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 Structure

*Course Delivery*

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.

*Lectures*

Tuesday 14:35 - 15:25 (Dunn 304)

*Laboratories*

Tuesday 08:35 - 11:25 (Dunn 221E)

Tuesday 15:35 - 17:25 (Dunn 221E)

## Course Materials

- An Introduction to Error Analysis, John R. Taylor, Publisher: University Science Books (2nd edition) 1997. Hard copy available online for approximately $70.
- Lab Notebook or Binder (Quad rule paper required)

## Assessment

| Assessment | Score [%] |
|---|---|
| Data Visualization in Python Assignment | 6 |
| Problem Solving Assignments | 16 |
| Data Acquisition and Device Control Project | 14 |
| Guided Research Project | 19 |
| Independent Research Project | 30 |
| Final Exam | 20 |
| Total | 100 |

*Assignments*

Data Visualization in Python Assignment

An important component of experimental physics is generating useful visualizations of your data. To support your learning, you will learn about data visualization and complete one assignment focused on this topic.

Problem Solving Assignments

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

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 before the project begins.

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 before the project begins.

*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 before the project begins.

*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. If you miss the exam due to illness or distress, within one week of the exam you must provide a medical certificate signed by a physician that clearly states that you were not fit to write the exam. Instructors reserve the right to reject unsatisfactory certificates. A Student Declaration of Absence is NOT acceptable for an exam.

Conversion of numerical grades to final letter grades follows the Dalhousie Grade Scale

| | | | |
|---|---|---|---|
| A+ (90-100) | B+ (77-79) | C+ (65-69) | D (50-54) |
| A (85-89) | B (73-76) | C (60-64) | F (0-49) |
| A- (80-84) | B- (70-72) | C- (55-59) | |

## Course Policies on Missed or Late Academic Requirements

Late Assignments:

Any assignment submitted for marking after the due date 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. Please email me before the due date, if requesting an extension.

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 these extra weeks.

## Learning Objectives

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

# University Policies and Statements

## Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

## Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: https://www.dal.ca/about-dal/internationalization.html

## Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

## Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html)

## Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

## Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: http://www.dal.ca/cultureofrespect.html

## Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

## Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

## Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at:
https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html

## Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.