DALHOUSIE UNIVERSITY

Computer Simulation in Science/Intro to Numerical Programming Syllabus

Department of Physics and Atmospheric Science

PHYC2050/Math2052 Winter 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.
We recognize 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: Penghao Xiao

(E-Mail: pxiao@dal.ca; Office: Dunn 230)

Lectures: *Monday, Wednesday, Friday 10:35-11:25 AM (credit hours: 3)*

Office hours: *Monday, Friday 1:30-2:30 PM* or *by Appointment*

Dunn building, Room 230

Course delivery: *In-person, Studley Killam Library 4106*

Tutorials: *Wednesday 11:35-12:25, by TA* Harold Smith Perez <hsmithperez@dal.ca>

MONA CAMPBELL BUILDING 2107

Course Description

An introduction to computer programming and numerical computation. A modern programming language, Python, will be used to model simple physical systems. Numerical algorithms are introduced to solve the models.

Course Prerequisites

PHYC 1190/1290 or MATH 1010 or equivalent.

Learning Objectives

The goal of this course is to help you overcome the barriers to solve scientific problems by computers. By the end of the course, you will be able to:

1. Write code with the Python programming language.
2. Appropriately analyze, plot, and present data.
3. Numerically solve linear and non-linear equations.

4. Numerically solve differential equations.
5. Conduct stochastic simulations.

Course Materials

- Textbook: "A student's Guide to Python for Physical Modeling, Second Edition", by J.M. Kinder and P. Nelson. (See http://physicalmodelingwithpython.blogspot.com)
- Others: Need to have access to Python3 on a computer. The easiest way to install is via Anaconda (https://www.anaconda.com/) or Miniconda (https://docs.conda.io/en/latest/miniconda.html).

Course Assessment

Assessment	Weight (% of final grade)	Date
Attendance	10%	Random survey
Midterm	10%	Wed, Feb. 25, in class
Assignments	50%	Approximately biweekly
Final Project	30%	Report due by April 17
Total	100%	

A minimum attendance of 80% is required to receive the full attendance mark.

Final Project: You will work in groups (~2 students) on a simulation project and submit one final report (including code). I will conduct a short interview (20 mins) for each team after receiving your report, to learn how you share the workload and what you learn. Your final mark will be based on the report and the interview. The report should be organized in five parts: introduction, method, results, conclusion and discussion, and appendix. Imagine it as a blog to explain this project and your findings.

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** (<50)
A- (80-84)	**B-** (70-72)	**C-** (55-59)	

Course Policies on Missed or Late Academic Requirements

- Late assignments can be turned in until solutions are returned, but a penalty mark (20% per day) will be deducted.
- Students may use the Student Declaration of Absence form for late assignments to avoid the late penalty. The form can be used 2 times in this course.

Course Policies related to Academic Integrity

You are encouraged to collaborate on assignments but ***not allowed to plagiarize or use generative AI (like ChatGPT or any LLM) to generate your code***. Never copy code without specific attribution: write your own code and comments! Midterm must all be done without collaboration. Make sure that you

explain what you are doing, which helps you earn more points. Also, leaving sufficient comments is the best practice in coding. It makes code maintenance much easier and debugging much faster.

Course Content

- Basics of computers (CPU, cathe, memory, disk; memory unit and size: bit, byte)
- Programming in PYTHON
    - Variable and value, data type and its operations
    - Control flow: branching, loops, break, continue
    - Function: variable scope, pass by value or by address, function as argument
    - List and array: iteration, mutation
    - Plot and File IO
- Numerical Algorithms:
    - Basics: Numerical errors, computational complexity, numpy array
    - Random process: 1D and 2D random walks, histogram for data analysis
    - Linear system: equations, regression
    - Nonlinear root finding (1D)
    - Recursion and dictionary
    - ODE and PDE: algorithms, stability, animation
    - Vector field: Eigen value and Eigen vector
    - Numerical integration, differentiation, and interpolation
- Object-orientated programming: objects, classes, attributes, methods

DALHOUSIE UNIVERSITY

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

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.