Carleton University
Department Of Physics

Phys 2801: Computational Methods in Physics

Fall 2025

Course aim

This course introduces students to the use of computers and computational methods in physics. This includes use of operating systems, programming, code repositories, data structures, numerical methods, statistical data analysis and machine learning relevant for physics.

Scheduled lectures

Tuesdays and Thursdays, 16:05-17:25

Student hour: Fridays 13:00-14:00

Instructor and TA

Instructor: Dag Gillberg, dag@physics.carleton.ca, HP 2404
Teaching assistant: Cyrus Robertson Orkish, CYRUSROBERTSONORKISH@cmail.carleton.ca

Textbooks

No required textbook. Slides and example interactive Python notebooks will be provided on the course Brightspace page. Hence, no cost ($0) for course material.

Supplementary material

Numerical methods in physics with Python, second edition.

Learning outcomes

1. Students will be introduced to standard operating systems, commands, shell scripts, and programming languages used in physics data analysis
2. Students will learn to utilize a variety of data formats and structures and be able to implement visualization techniques
3. Students will review probability concepts and commonly used distributions and learn to apply these in the context of analysis of physics data including error estimation
4. Students will learn and test various techniques used in data analysis such as function fitting and uncertainty estimation, and learn to critique methodologies by identifying good vs bad practices and common pitfalls
5. Students will gain an introductory level understanding of the mechanism behind, and practical use of machine learning/artificial intelligence techniques in the context of physics, including critical evaluation of AI generated output

Prerequisites

PHYS 1001 **or** PHYS 1003 **or** PHYS 1007; and COMP 1005; **or** permission of the Department.

Learning assessment

The course has lectures in the standard lecture hall on Tuesdays and Thursdays, but also five tutorials in a separate hall on certain Tuesdays. This will be announced clearly both via email and on the Brightspace page. You need to **attend and complete each tutorial**. The assignments will often build on the tutorial and be due at a later point.

Tutorials: Not marked. You need to attend and complete all 5 tutorials to pass the class.

Assignments

There will be six assignments. They will require data analysis. Due on Fridays.

In-class evaluation

The lectures will contain Wooclap questions relating to the course material. You are allowed (and encouraged!) to discuss with your neighbour to try to figure out the answer on questions that most commonly are multiple choice but also sometimes numerical. Worth 5% of the mark in total. **Attendance:** you need to *answer >50% of the questions to get a non-zero mark*. Then 3%, 4% or 5% depending on the fraction of correct answers (<33%, 33–67% or >67%).

Midterm and final examination

The midterm will be an 80 minute written exam taken during a lecture slot.
The final exam will be a 3 hour written exam scheduled by the university.
You need to complete the 5 tutorials to pass the class

Marking scheme

- In-class evaluation: 5%
- Assignments 30%
- Midterm exam 25%
- Final exam 40%

Midterm and final examination

The midterm will be an 80 minute written exam taken during a lecture slot.
The final exam will be a 3 hour written exam scheduled by the university.

Jupyter accounts

Each student will get a Jupyter account that will allow you to access the Carleton physics Jupyter hub: https://jupyterhub.physics.carleton.ca. You will use this during tutorials and for assignments.

If you have any technical issues, please contact: computersupport@physics.carleton.ca

Use of AI in this course

In this course, we will study some of the fundamental mechanisms behind neural networks—the main driving technology behind modern artificial intelligence. We will also explore how AI tools can be applied to solving physics problems and practice critically evaluating their outputs. You are encouraged to experiment with AI tools as part of your learning process. However, you are still expected to master the material yourself, and all evaluations (midterm and final) will be completed without AI assistance. If you use AI in any part of an assignment, you must clearly acknowledge it. Always attempt the problem on your own first.

As our understanding of the uses of AI and its relationship to student work and academic integrity continue to evolve, students are required to discuss their use of AI in any circumstance not described here with the course instructor to ensure it supports the learning goals for the course.

Lecture plan

See intro slides on Brightspace. In short:
1. Basics of numerical analysis (Python, plotting, Jupyter), 2. Basic computing (bash, git, data structures), 3. Probability and statistics, 4. Data analysis, techniques and pitfalls, 5. ML (NN and AI), use and critically evaluate AI generated output

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Academic accommodation

Carleton is committed to providing academic accessibility for all students. For information about academic accommodation, see this website: https://students.carleton.ca/course-outline/. If you wish to discuss anything with the instructor, either drop in during the student hour (see time on the Brightspace page), or set up a meeting via email.

Plagiarism and other forms of cheating

Working through problems is essential in developing understanding of thermal physics. Students are permitted to discuss concepts and strategies related to solving the homework assignments. All work handed in, however, **must be their own**.

For more information, see:
https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/