

## **Phys 4807/5002: Computational Physics**

### **Fall 2020**

#### **Course description and objectives**

This course provides a thorough introduction of statistical methods used in experimental physics. Exercises will be performed with analysis code written in either python or C++. Fundamental concepts in probability theory are developed and statistical methods, including hypothesis tests, parameter estimation using the maximum likelihood and least squares method, and confidence interval calculations, are applied. Simulation of complex physical systems using Monte Carlo techniques is explored, including finding solutions using several numerical methods. The course introduces ways to quantify uncertainties in complex situations, which is important in physics, engineering and in other areas of science.

#### **Scheduled lectures**

Monday and Wednesday 14:35-15:55. About half will be replaced by video recordings.

#### **Instructor and TA**

Dag Gillberg, [dag@physics.carleton.ca](mailto:dag@physics.carleton.ca)

TAs: Shivam Garg ([shivamgarg@cmail.carleton.ca](mailto:shivamgarg@cmail.carleton.ca)), Gurpreet Kaur ([gurpreetkaur@cmail.carleton.ca](mailto:gurpreetkaur@cmail.carleton.ca))

#### **Textbook and material**

Statistical data analysis, Glen Cowan

ISBN: Paperback 9780198501558 - Hardback 9780198501565.

Additional material and assignments will be available at the course CUlearn page.

#### **Learning outcomes**

At the end of the course, the student should be able to:

1. have a firm grasp of the random nature of experimental physics and be aware of and able to use the common, important probability distribution functions
2. solve problems using numerical methods such as linear regression, numerical integration and minimization, and use Monte Carlo methods to simulate random processes
3. design and perform statistical hypothesis tests
4. conduct parameter estimation (measurements) using both the maximum likelihood and least squares methods
5. estimate confidence intervals and uncertainties
6. be familiar with multivariate techniques such as likelihood functions, Fisher discriminant, neural nets, decision trees and deep learning.
7. understand and critique statistical analyses performed in publications

## **Course structure and marking scheme**

There will be a combination of lecture and hands on exercises. Eight assignments (subject to change), midterm and final. Graduate students (Phys 5002) also get a take home, and might occasionally get an extra question on the assignments.

### **Grading Policy for Undergraduate Students (Phys 4807):**

Quizzes = 5%

Assignments = 45%

Midterm exam = 15%

Final exam = 20%

Oral exam = 15%

### **Grading Policy for Graduate Students (Phys 5002):**

Quizzes = 5%

Assignments = 35%

Midterm exam = 15%

Final exam = 20%

Oral exam = 15%

Take Home = 10%

**Quizzes:** These will be available at CU-learn.

### **Midterm and final examination**

90 minutes tests that will be written during a lecture slot. Note that this is planned to be done using the e-proctoring system, i.e. you need to connect via BigBlueButton and have your video camera turned on. Statement from the university:

Use of e-Proctoring system: This course has timed written assessments, which may consist of tests, midterms and/or final examinations. The Carleton University e-Proctoring system may be used in your assessments, and requires the use of webcams, microphones, and smartphones.

### **Oral examination**

This will be a 15 minute interview with each student, with questions on material in the course and potential clarification on the assignment questions.

## **Copyright**

Classroom teaching and learning activities, including lectures, discussions, presentations, etc., by the instructor and by students, are copy protected and remain the intellectual property of their respective author(s). All course materials, including pdf files and other materials, are also protected by copyright and remain the intellectual property of their respective author(s).

Students registered in the course may take notes and make copies of course materials for their own educational use only. You may not allow others to reproduce or distribute course materials. You may not make your own recordings of lectures or office hours. Students are not permitted to reproduce or distribute course materials publicly for commercial or non-commercial purposes.

## **Plagiarism and other forms of cheating**

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

Viewing or searching for solutions in any form before your assignment is submitted is forbidden and will be considered an academic offence. This includes any online resource, examples posted at Carleton or elsewhere, or from any other type of unauthorized source. Using any such resource for an examination of any kind (assignment, midterm, etc) is considered **plagiarism**, even if only part of the solution is used.

For more information see [Reg. 19 of the Grad calendar](#). Relevant university definitions of plagiarism:

- submitting a take-home examination, laboratory report or other assignment written, in whole or in part, by someone else;
- using ideas, algorithms, formulae, scientific or mathematical concepts, or ideas without appropriate acknowledgment in any academic assignment;
- submitting a computer program developed in whole or in part by someone else, with or without modifications, as one's own

Note that the university policy of penalties for plagiarism is significant:

First offence (2nd-year student or higher): A grade of F in the course.

Second offence: A grade of F in the course and a one-term suspension from studies.

Third offence: Expulsion from the University.

## **Deferred exams**

Deferred exams are generally only granted to students who cannot take the regularly scheduled exam due to illness.

# University policies

## Grade Definition:

In accordance with the Carleton University Undergraduate Calendar Regulations, the letter grades assigned in this course will have the following percentage equivalents:

A+ = 90-100	B+ = 77-79	C+ = 67-69	D+ = 57-59
A = 85-89	B = 73-76	C = 63-66	D = 53-56
A- = 80-84	B- = 70-72	C- = 60-62	D- = 50-52
F = <50			

WDN = Withdrawn from the course

ABS = Student absent from final exam

DEF = Deferred

FND = (Failed, no Deferred) = student could not pass even with 100% on final exam

Standing in a course is determined by the course instructor subject to the approval of the Faculty Dean. This means that grades submitted by the instructor may be subject to revision. No grades are final until they have been approved by the Dean.

## Academic Regulations, Accommodations, Plagiarism, Etc.:

University rules regarding registration, withdrawal, appealing marks, and most anything else you might need to know can be found on the university's website, here:

<http://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/>

## Academic Integrity

The University Senate defines plagiarism as “presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one’s own.” This can include:

- reproducing or paraphrasing portions of someone else’s published or unpublished material, regardless of the source, and presenting these as one’s own without proper citation or reference to the original source;
- submitting a take-home examination, essay, laboratory report or other assignment written, in whole or in part, by someone else;
- using ideas or direct, verbatim quotations, or paraphrased material, concepts, or ideas without appropriate acknowledgment in any academic assignment;
- using another’s data or research findings;
- failing to acknowledge sources through the use of proper citations when using another’s works and/or failing to use quotation marks;
- handing in “substantially the same piece of work for academic credit more than once without prior written permission of the course instructor in which the submission occurs.”

**Plagiarism is a serious offence** that cannot be resolved directly by the course’s instructor. The Associate Dean of the Faculty conducts a rigorous investigation, including an interview with the student, when an instructor suspects a piece of work has been plagiarized. Penalties are not trivial. They can include a final grade of “F” for the course.

## **Course Copyright**

Classroom teaching and learning activities, including lectures, discussions, presentations, etc., by both instructors and students, are copyright protected and remain the intellectual property of their respective author(s). All course materials, including PowerPoint presentations, outlines, and other materials, are also protected by copyright and remain the intellectual property of their respective author(s).

Students registered in the course may take notes and make copies of course materials for their own educational use only. Students are not permitted to reproduce or distribute lecture notes and course materials publicly for commercial or non-commercial purposes without express written consent from the copyright holder(s).

## **Academic Accommodations**

Text from <https://students.carleton.ca/course-outline/>

Carleton University is committed to providing access to the educational experience in order to promote academic accessibility for all individuals.

Academic accommodation refers to educational practices, systems and support mechanisms designed to accommodate diversity and difference. The purpose of accommodation is to enable students to perform the essential requirements of their academic programs. At no time does academic accommodation undermine or compromise the learning objectives that are established by the academic authorities of the University.

### ***Pregnancy Obligation:***

Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit the Equity Services website

[carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf](http://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf)

### ***Religious Obligation:***

Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit the Equity Services website

[carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf](http://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf)

### ***Academic Accommodations for Students with Disabilities:***

If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at **613-520-6608** or [pmc@carleton.ca](mailto:pmc@carleton.ca) for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. For more details, visit the Paul Menton Centre website <https://carleton.ca/pmc>

- The deadlines for contacting the Paul Menton Centre regarding accommodation for final exams for the Fall exam period is **November 13, 2020** and for the Winter exam period is **March 12, 2021**.

### ***Survivors of Sexual Violence:***

As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: <https://carleton.ca/sexual-violence-support>

### ***Accommodation for Student Activities:***

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the policy at <https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf>

### **Assistance for Students:**

Career Services: <https://carleton.ca/career/>

Academic Advising: <https://carleton.ca/academicadvising/>

Co-operative Education: <https://carleton.ca/co-op/>

Centre for Student Academic Support: <https://carleton.ca/csas/>

Writing Services: <https://www.carleton.ca/csas/writing-services/>

Peer Assisted Study Sessions (PASS): <https://carleton.ca/csas/group-support/pass/>

Math Tutorial Centre: <https://carleton.ca/math/math-tutorial-centre/>

Science Student Success Centre: <https://sssc.carleton.ca/>

### **Freedom of Information and Protection of Privacy:**

Carleton University is committed to protecting the privacy of those who study or work here (currently and formerly). To that end, Carleton's Privacy Office seeks to encourage the implementation of the privacy provisions of Ontario's *Freedom of Information and Protection of Privacy Act* (FIPPA) within the university.

In accordance with FIPPA, please ensure all email communication with staff/faculty is via your Carleton email account. To get your Carleton email you will need to activate your MyCarletonOne account through Carleton Central. Once you have activated your MyCarletonOne account, log into the MyCarleton Portal.

### **Important Dates:**

<https://calendar.carleton.ca/academicyear/>

<https://carleton.ca/registrar/registration/dates-and-deadlines/>