PHY407H Computational Physics
Fall 2022 Syllabus

Lectures, labs, and office hours will be online synchronous. The final exam is the only in-person course component.

The course website is on Quercus, including organizational info, lecture notes, quizzes, labs, announcements, etc. Check it frequently, as it is your main resource for this course.

Instructor: Prof Miriam Diamond, mdiamond@physics.utoronto.ca
            MP 801A,   647-705-9716

TAs:
- Gabe Dublin (lab), gabe.dublin@mail.utoronto.ca
- Mikhail Schee (lab), mikhail.schee@mail.utoronto.ca
- Evelyn Macdonald (lab), evelyn.macdonald@mail.utoronto.ca
- Ahmed Rayyan (lab), a.rayyan@mail.utoronto.ca
- Sahibjeet Singh (final project marker), ssingh@physics.utoronto.ca
- Quark & Qubit the Guinea Piggies (motivational assistants)

Course Description: This is an introduction to scientific computing in physics. Students will be introduced to computational techniques used in a range of physics research areas. By considering select physics topics, students will learn computational methods for function analysis, ODEs, PDEs, eigenvalue problems, non-linear equations and Monte Carlo techniques. "Survival skills" in scientific computing, such as command line programming, debugging, solution visualization, computational efficiency and accuracy will be developed. The course is based on python and will involve working on a set of computational labs throughout the semester as well as a final exam.

Grading Scheme:
- Pre-lectures: 10% (best 10 out of 11 quizzes, 1% each)
- Labs: 60% (best 10 out of 11 reports, 6% each)
- Final Exam: 30%

Required Textbook: Computational Physics by Mark Newman (2nd edition, 2013). Available at the UofT bookstore. The following website has the first few chapters available for free, plus excellent resources (e.g. python code snippets): http://www-personal.umich.edu/~mejn/cp/ .

Prerequisites and background: PHY224H and 254H are prerequisites. Preparation of other physics courses is strongly recommended. CSC courses can be helpful, though only marginally so, and certainly not required. It is highly recommended you get started by making sure you are familiar with the content of the tutorials at https://computation.physics.utoronto.ca/

Typical weekly schedule (all hours are quoted in Eastern Time)
- Monday: pre-lecture Quercus quiz due before lecture (after week 1), lecture at 12:00 PM (noon)
- Wednesday: lab 9:00 AM - 12:00 PM
- Thursday: office hours 10:00 - 11:30 AM
- Friday at 12:00 PM (noon): last time to ask questions about the lab to the TAs or instructor. No answer will be guaranteed after this time, since all of us typically have busy research schedules on Friday afternoons.
- Friday at 5:00 PM: lab due, next lab and next pre-lecture questions assigned.

Pre-lecture quizzes: Composed of multiple-choice / true-false questions based on the upcoming week's readings from the textbook. Must be completed (on Quercus) before the lecture, with a score of 0 automatically assigned if missed.

Lectures: Mondays 12:00-1:00 PM, synchronously on Zoom (link posted on Quercus). This course, including your participation, will be recorded on video and will be available to students in the course for viewing remotely and after each session on Quercus.

You are encouraged to prepare your questions about the upcoming lab and ask them in the latter part of the lecture. The professor will post her notes on Quercus before the corresponding lecture starts. You are responsible for the material covered in the lectures, even if it is not in the text or the posted lecture notes.

Labs: Wednesdays 9:00-12:00, online on gather.town (https://gather.town/ , links and passwords provided on Quercus). Gathertown is a blend between Zoom and a 90's video game: your avatar can move around a 2D map of a room and share your screen, voice and webcam with whomever is in your virtual vicinity. There is a chat feature, you can raise your hand to attract the TA's attention, and you have some control over when your webcam + mic are open. Labs will not be recorded.

Lab activities are computational exercises that you can work on during the lab time, as well as on your own before or afterward. They involve a variety of physics concepts and introduce you to some major scientific computing tools. It is highly recommended to do all your labs with a partner (but you cannot form a group larger than 2.) You can switch who you pair up with from lab to lab. If you don't have a lab partner, you will be basically doing twice as much work as required. See the Lab Assignment Policy document for more detail.

Lateness penalty for lab reports: lose 10% for each 24-hour period. If you submit after 5:00 PM the following Monday, your submission will not be marked, as you will get 0.

Office Hours: Office hours will take place online (Zoom link provided on Quercus), every Thursday 10:00-11:30 AM, with a lab TA.

Topics Schedule: (subject to change)

Week	Dates	Textbook Chapters	Lab topic
0	12-17 Sep	2-3, 4.3	Intro to python and programming, pseudocode
1	19-24 Sep	4, 5.1-5.3	Numerical errors, integration techniques: trapezoid rule, Simpsons rule, errors on integrals, choosing #steps
2	26 Sep – 1 Oct	5.5-5.11	Gaussian quadrature, infinite ranges, multiple integrals, derivatives, interpolation
3	3-8 Oct	6	Solving linear & nonlinear systems: Gaussian elimination, pivoting, LU decomp, eigensystems, QR, relaxation, binary search, Newton's method, secant method, golden ratio search
4	10-15 Oct	7	Fourier Transforms: DFT, 2D DFT, FFT (*Thanksgiving Monday: prof will record the lecture*)
5	17-21 Oct	8	ODEs 1
6	24-29 Oct	8	ODEs 2
7	21 Oct - 5 Nov	9	PDEs 1
	7-13 Nov		*Reading week*
8	14-19 Nov	9	PDEs 2
9	21-26 Nov	10	Random Processes
10	28 Nov – 3 Dec	10	Monte Carlo techniques
11	5-10 Dec		Prof's demos of fun stuff

Computer Software: for more info, see the document called "Requirements, guidelines and suggestions regarding software", distributed as an appendix to this syllabus. Some of the most important points:

- Gathertown only works reliably with Firefox and Chrome (though Chromium-based browsers, such as Brave, might work).
- The programming language for this course is python 3.
- GitHub (https://github.com/) is a hosting service for collaborative projects. It is recommended, but not required, that you try using it when working on your labs. The professor will post all lecture notes and lab materials for the course in her public GitHub repository, https://github.com/mdiamon/PHY407-UofT .

For academic advising or any undergraduate inquiries: please consult with the Physics Undergraduate Coordinator, Hala Larizza-Ali (ugcoord@physics.utoronto.ca; MP301; 416 978-7057).

Course lecture recordings and the instructor's notes are only for the exclusive use of enrolled students, for their personal learning. Lecture recordings and instructor's notes are not to be shared in any way beyond enrolled students. Students are not to put any of these materials into the public domain, sell them, or give them to a person or company that is using them to earn money. The University will support the instructor in asserting and

pursuing her rights, and copyrights, in such matters. For questions about the recording of lectures in which you appear / are heard, please contact the instructor.

Plagiarism detection ("essays" here refer to lab assignments and final exam)**:** Normally, students will be required to submit their course essays to the University's plagiarism detection tool for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the tool's reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of this tool are described on the Centre for Teaching Support & Innovation website (https://uoft.me/pdt-faq).

Academic integrity: All students, faculty and staff are expected to follow the University's guidelines and policies on academic integrity. For students, this means following the standards of academic honesty when writing assignments, collaborating with fellow students, and writing tests and exams. Ensure that the work you submit for grading represents your own honest efforts. Plagiarism—representing someone else's work as your own or submitting work that you have previously submitted for marks in another class or program—is a serious offence that can result in sanctions. Speak to me or your TA for advice on anything that you find unclear. To learn more about how to cite and use source material appropriately and for other writing support, see the U of T writing support website at http://www.writing.utoronto.ca . Consult the Code of Behaviour on Academic Matters for a complete outline of the University's policy and expectations. For more information, please see https://www.artsci.utoronto.ca/current/academic-advising-and-support/student-academic-integrity and https://www.academicintegrity.utoronto.ca/ .

Accommodations: Students with diverse learning styles and needs are welcome in this course. If you have an acute or ongoing disability issue or accommodation need, you should register with Accessibility Services (AS) at the beginning of the academic year by visiting https://studentlife.utoronto.ca/service/accessibility-services-registration-and-documentation-requirements/ . Without registration, you will not be able to verify your situation with your instructors, and instructors will not be advised about your accommodation needs. AS will assess your situation, develop an accommodation plan with you, and support you in requesting accommodation for your course work. Remember that the process of accommodation is private: AS will not share details of your needs or condition with any instructor, and your instructors will not reveal that you are registered with AS.

As a student at the University of Toronto, you are part of a diverse community that welcomes and includes students and faculty from a wide range of cultural and religious traditions. The course instructor will make every reasonable effort to avoid scheduling tests, examinations, or other compulsory activities on religious holy days not captured by statutory holidays. Further to University Policy, if you anticipate being absent from class or missing a major course activity (such as a test or in-class assignment) due to a religious observance, please let the instructor know as early in the course as possible, and with sufficient notice (at least two to three weeks), so that we can work together to make alternate arrangements.

The University of Toronto strives to provide a family-friendly environment. You may wish to inform the professor if you are a student with family responsibilities. If you are a student parent or have family responsibilities, you also may wish to visit the Family Care Office website at familycare.utoronto.ca.

Specific Medical Circumstances: A Verification of Illness (also known as a "doctor's note") is not required this term. Students who are absent from academic participation for any reason (e.g., COVID, cold, flu and other illness or injury, family situation) and who require consideration for missed academic work should report their absence through the online absence declaration. The declaration is available on ACORN under the Profile and Settings menu. Students should also advise their instructor of their absence. If an absence extends beyond 14 consecutive days, or if you have a non-medical personal situation preventing you from completing your academic work, you should connect with your College Registrar. They can provide advice and assistance reaching out to instructors on your behalf. If you get a concussion, break your hand, or suffer some other acute injury, you should register with Accessibility Services as soon as possible.

Mental Health: As a student, you may experience challenges that can interfere with learning, such as strained relationships, increased anxiety, substance use, feeling down, difficulty concentrating and/or lack of motivation, financial concerns, family worries and so forth. These factors may affect your academic performance and/or reduce your ability to participate fully in daily activities. Everyone feels stressed now and then – it is a normal part of university life. Some days are better than others, and there is no wrong time to reach out. There are resources for every situation and every level of stress. There are many helpful resources available through your College Registrar or through Student Life (http://studentlife.utoronto.ca and http://www.studentlife.utoronto.ca/feeling-distressed). An important part of the University experience is learning how and when to ask for help. Please take the time to inform yourself of available resources.

Equity, Diversity and Excellence: The University of Toronto is committed to equity, human rights and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. U of T does not condone discrimination or harassment against any persons or communities.