PHY407F Computational Physics Syllabus

Forewords:

We wish to acknowledge this land on which the University of Toronto operates. For thousands of years it has been the traditional land of the Huron-Wendat, the Seneca, and most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

While this course was advertised as both in-person and online, it will be online for most practical matters. Lectures will be online, synchronous. Labs will also be online, synchronous, though the lab room (MP257) will be open for those, wishing to use the workstations AND who enrolled for the in-person component of the course. However, no instructor or TA will be present (note: this might change in the coming days as the situation remains fluid). Office hours will be online.

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Lab TAs:

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Final Project marker: Fabiola Trujano Jiménez (final project marker) fabiola.trujanojimenez@mail.utoronto.ca

THE MOST IMPORTANT POINT ABOUT SUCCESS IN THIS COURSE: To save yourself work, do all your labs with a partner. You can only pair up and you cannot form larger groups. You can switch who you pair up with from lab to lab. Both you and your partner can hand in the same lab, just make sure to sign up for the same "Lab Group" on Quercus when you submit. If you don't have a lab partner, you will be basically doing twice as much work as you really need to. See the Assignment Policy sheet.

Topics: 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 project.

Typical weekly schedule (all hours are quoted in Eastern Time)

- Monday: pre-lecture questions due before lecture (after week 1), lecture 12-1 pm
- Wednesday: Lab 9-12.
- Thursday: Office hours R1-3.
- Friday at 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 pm: Lab due, next lab and next pre-lecture questions assigned.

Lectures: Mondays noon-1, synchronously on BB Collaborate (access via Quercus portal). 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.

Course videos and materials belong to your instructor, the University, and/or other source depending on the specific facts of each situation and are protected by copyright. In this course, you are permitted to download session videos and materials for your own academic use, but you should not copy, share, or use them for any other purpose without the explicit permission of the instructor. For questions about recording and use of videos in which you appear please contact your instructor.

The lecture component will usually be short. Students are invited to prepare their questions about the upcoming lab and ask them in the second part of the lecture.

N.G. will provide his 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. The notes are also available, and probably more up-to-date, at https://github.com/PHY407-UofT/lectures-2020. At the beginning of the term, you will see the notes as they were at the end of the Fall 2018 term, but they will be updated as we progress.

Labs: Wednesdays 9-12, MP257 for the in-person component, and online on gather.town (https://gather.town/) for everyone. Gather town is a blend between Zoom and the Zelda games as they looked in the 90's: you can move around a 2D map of a room and share your screen, voice and webcam with whomever is in your virtual vicinity, the size of which you can adjust. There is also a chat feature. You can also raise your hand to attract your room instructor's attention, and you have some control over when your webcam + mic are open ("always", "never", "closed when tabbed away and not connected to anyone"). Gather.town only works with Firefox and Chrome (though Chromium-based browsers, such as Brave, might work). We will have three gather.town sessions running concurrently at a given time, links and passwords will be provided to you before each lab. You may want to create an account to keep a history of the links.

Labs will not be recorded.

We will assign groups of two to given rooms, as attendance in a room is limited to 50 participants.

⚠ We will test gather.town in this course. Should this test fail, we will revert to another piece of software (Zoom, MS Teams or BB Collaborate). ⚠

Office Hours: Office hours will take place online, also on gather.town, every Thursday between 1 pm and 3 pm EST. Links will also be provided shortly before.

Tentative timeline

Week	Week of …	Text ch	Lab topic
01	14-18 Sep	2-3, 4.3	Intro to python and programming, pseudocode
02	21-25 Sep	4, 5.1-5.3	Numerical errors, integration techniques: trapezoid rule, Simpsons rule, errors on integrals, choosing #steps
03	28 Sep – 2 Oct	5.5-5.11	Gaussian quadrature, infinite ranges, multiple integrals, derivatives, interpolation
04	5-9 Oct	6	Solving linear & nonlinear systems: Gaussian elimination, pivoting, LU decomp, eigensystems, QR, relaxation, binary search, Newton's method, secant method, golden ratio search
05	12-16 Oct	7	Fourier Transforms: DFT, 2D DFT, FFT (*Thanksgiving: N.G. will record the lecture*)
06	19-23 Oct	8	ODEs 1
07	26-30 Oct	8	ODEs 2
08	2-6 Nov	9	PDEs 1
09	9-13 Nov		*Reading week*
10	16-20 Nov	9	PDEs 2
11	23-27 Nov	10	Random Processes
12	30 Nov – 4 Dec	10	Monte Carlo techniques
13+	7+ Dec		Term Project

The course website is on Quercus, including organizational info, lecture notes, pre-lecture problems, labs, announcements, discussion board, etc. Check it frequently, it is your main, and virtually only, resource for this course.

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.

Make sure you are familiar with content of the tutorials on the computational physics webpage to get started, at

https://computation.physics.utoronto.ca/

This website is still relatively recent. If you notice missing or incorrect elements, please let us know.

Course Text: Computational Physics by Mark Newman (2nd edition, 2013). Available at the UofT bookstore or at your favourite online bookstore.

The first few chapters are available free online at the following location so if you aren't sure that you are going to take the course, you can hold off a couple of weeks before buying the text. There are also excellent resources on this webpage such as python programs you will use, see

http://www-personal.umich.edu/~mejn/cp/

Grading Scheme:	Pre-lectures:	10% (10 quizzes, 1% each)
	Labs:	66% (11 reports, 6% each)
	Final Project:	24%

Pre-lecture quizzes: These involve readings from the text and a short online quiz that must be completed before the lecture. Lateness penalty: 0 if missed.

Labs: These are more involved computational exercises that you can work on during the lab time, as well as on your own before or after the lab. They will involve a variety of physics concepts and introduce you to some major scientific computing tools (see supporting documents on Quercus). Lateness penalty: you lose 1/3 of your original mark for each 24-hour period (meaning that you get to zero if you submit after Monday at 5 pm). See supporting document for more detail.

Final project: see supporting document for more info. Choose one topic, for example from the list of suggestions, explore it with the methods you saw in this course, and write a report on it. Deadline: Thursday, Dec. 10th at 11:59 pm. Lateness penalty: no penalty if submitted by Dec. 18th at 11:59 pm, 0 if later.

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

- The programming language for this course is python 3. **Not python 2! If your code fails to execute on your marker's machine because you used python 2, you will lose marks.** If you don't know how to check your python version, use your favourite search engine.
- **We will not let you submit Jupyter notebooks as lab reports!** Should you hate us for it, please see the "Requirements, guidelines and suggestions regarding software" for a lengthier explanation.

- For your lab project, follow the rules above, plus the fact that you can only use the following packages: ○ Numpy,
  ○ Pylab, ○
  Scipy, and ○
  Matplotlib.

  If you want to use another package (Pandas, TensorFlow...), ask us first! We need to make sure that the code you submit will work on the marker's machine. The safest way to ensure that there will be no problem is to install and run everything through the Anaconda distribution (but ask us nonetheless).

Academic integrity, adapted from the Academic integrity web page of the University of Toronto: Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters (https://governingcouncil.utoronto.ca/secretariat/policies/codebehaviour-academic-matters-july-1-2019) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

In papers and assignments:

1. Using someone else's ideas, words or solutions without appropriate acknowledgement; (note in PHY407: all work submitted is meant to be individual or in groups; you are not to use someone else's solution)
2. Submitting your own work in more than one course without the permission of the instructor;
3. Making up sources or facts;
4. Obtaining or providing unauthorized assistance on any assignment.

On tests and exams:

1. Using or possessing unauthorized aids;
2. Looking at someone else's answers during an exam or test;
3. Misrepresenting your identity; and
4. When you knew or ought to have known you were doing it.

In academic work:

1. Falsifying institutional documents or grades;
2. Falsifying or altering any documentation required by the University, including (but not limited to) doctor's notes; and
3. When you knew or ought to have known you were doing so.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If students have questions or

concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, they are expected to seek out additional information on academic integrity from their instructors or from other institutional resources. Note that you are expected to seek out additional information on academic integrity from me or from other institutional resources (for example, the University of Toronto website on Academic Integrity, https://www.academicintegrity.utoronto.ca/).

Normally, **students will be required to submit their course essays to Turnitin.com** 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 Turnitin.com reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of the Turnitin.com service are described on the Turnitin.com web site.

Note that Turnitin does not make any decision, it just sends us a report, but it is up to your marker to decide if the passages highlighted by the tool represent plagiarism. You can choose to opt out of Turnitin, under our conditions of use. If you do so, **let us know before Wednesday, Sep. 16th at noon**, so that we can find alternative arrangements.

Accommodations: If you have a learning need requiring an accommodation, the University of Toronto recommends that students immediately register at Accessibility Services at

http://www.studentlife.utoronto.ca/as

Location: 4th floor of 455 Spadina Avenue, Suite 400 (may be closed in Covid times)
Voice: 416-978-8060
Fax: 416-978-5729
Email: accessibility.services@utoronto.ca

The University of Toronto supports accommodations of students with special learning needs, which may be associated with learning disabilities, mobility impairments, functional/fine motor disabilities, acquired brain injuries, blindness and low vision, chronic health conditions, addictions, deafness and hearing loss, psychiatric disabilities, communication disorders and/or temporary disabilities, such as fractures and severe sprains, recovery from an operation, serious infections or pregnancy complications.

The University provides reasonable accommodation of the needs of students who observe religious holy days other than those already accommodated by ordinary scheduling and statutory holidays. Students have a responsibility to alert members of the teaching staff in a timely fashion to upcoming religious observances and anticipated absences and instructors will make every reasonable effort to avoid scheduling tests, examinations or other compulsory activities at these times.

The University of Toronto strives to provide a family-friendly environment. You may wish to inform me 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.

Please reach out to NG as early as possible to communicate any anticipated absences related to religious observances, learning needs, and family responsibilities, and to discuss any possible related implications for course work. Confidentiality of learning needs is respectfully and strictly maintained.

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.