Physics 3926F: Computer Simulations in Physics
Course Outline

1. Course Information

Physics 3926F, Fall 2024

List of Prerequisites:

Prerequisite(s): (Physics 1202A/B, Physics 1402A/B, Physics 1502A/B or the former Physics 1302A/B); one of Calculus 2303A/B, or Calculus 2503A/B, Numerical and Mathematical Methods 2276A/B, Numerical and Mathematical Methods 2277A/B, the former Applied Mathematics 2276A/B, the former Applied Mathematics 2277A/B. Integrated Science 1001X with a minimum mark of 60% can be used in place of Physics 1202A/B. Pre-or Corequisite(s): Applied Mathematics 2402A/B or Numerical and Mathematical Methods 2270A/B or the former Applied Mathematics 2270A/B; and Physics 2110A/B or Applied Mathematics 2814F/G or Statistical Sciences 2864A/B.

Unless you have either the requisites for this course or written special permission from your Dean's Designate (Department/Program Counsellors and Science Academic Advisors) to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

2. Instructor Information

Course Instructor: Prof. Gonca Erdemci-Tandogan
(audio name pronunciation)
Pronouns: she/her/hers
Email: gerdemci@uwo.ca

Note: If you have a question or would like to talk with me, you can send an email (must be from your Western email) or visit me during student hours. Please include "Physics 3926" in the subject line of your email.

Student Hours: TBA, in-person or via Zoom (when needed due to sickness). If any changes happen for certain weeks, it will be announced.

Phone: (519) 661-2111 ext. 82739

Course TA: Yasamin Modabber
Pronouns: she/her/hers
Email: ymodabbe@uwo.ca

What are 'Student Hours'?
Student hours are dedicated times through the week for the course instructor and TAs to meet with YOU. Pop in to introduce yourself, ask questions about the course, or discuss content from the course.

Inclusive teaching statement:

I am committed to fostering an environment for learning that is inclusive for everyone regardless of gender identity, gender expression, sex, sexual orientation, race, ethnicity, ability, age, class, etc. It is my hope that our class will support diversity of experience, thought, and perspective.
Names/pronouns: I welcome emails or in-person communications to let me know your preferred name or pronouns.

Land Acknowledgement:

Western University is situated on the traditional territories of the Anishinaabeg, Haudenosaunee, Lunaapeewak and Attawandaron peoples, who have longstanding relationships to the land and region of southwestern Ontario and the City of London. The local First Nation communities of this area include Chippewas of the Thames First Nation, Oneida Nation of the Thames, and Munsee Delaware Nation. In the region, there are eleven First Nation communities and a growing Indigenous urban population. Western values the significant historical and contemporary contributions of local and regional First Nations and all of the Original peoples of Turtle Island (North America).

3. Course Syllabus, Schedule, Delivery Mode

Welcome to Computer Simulations in Physics!

"*The purpose of (scientific) computing is insight, not numbers.*"-Richard Hamming, 1962

This is a project-oriented computation course using applications of numerical methods to problems in biophysics, medical physics, science of materials, atmospheric physics and astrophysics. Projects will involve choosing a physical problem, posing scientific questions, and implementing a computer simulation. Techniques for programming, analysis, and presentation will be developed.

Learning Outcomes: At the end of the course, students will be able to:

1. Create Python programs that use the core language and NumPy and SciPy modules, following best practices for scientific computing
2. Explain when and how computer simulations are used in physics research
3. Apply knowledge of Python to creating programs that analyze and/or simulate physical systems
4. Visualize the results of data analysis and numerical simulations through the creation of appropriate graphics
5. Compare, contrast, and apply numerical methods of solution for the ordinary and partial differential equations that commonly arise in physics and astronomy
6. Synthesize the solution of computational physics problems by documenting their physical basis, numerical solution, and graphical visualization

This course is about using computers to do physics and astrophysics. Some previous experience with Python is helpful but not mandatory. After reviewing the basics of Python we will learn how to use it to analyze and present data and to solve complex (astro)physical problems. We will apply computer

simulations to examples from several branches of physics and astronomy. Along the way, we will learn how to develop realistic numerical models of physical systems and some of the practical aspects of how to solve and interpret these models.

Topic Outline

Learning Python (with application to ODEs; Chapters 1, 2, and 10): weeks 1-4

- Arrays and data structures
- Plots
- Control structures, advanced data structures
- Functions versus scripts, good programming practice
- Writing/maintaining good documentation

Applications (Chapters 3, 6, 7): weeks 5-7, 9-13

- Ordinary differential equations (orbital motion, oscillators)
- Partial differential equations (diffusion, advection, waves)

Data analysis (Chapters 4 and 5): week 8, 9

- Interpolation and curve fitting
- Linear algebra
- Statistical descriptions of data
- Fourier methods

Introduction to Version Control: weeks as time permits from the above topics.
Introduction to Finite Difference Method (FDM) and Finite Element Methods (FEM): weeks as time permits from the above topics.

Classes begin: September 5, 2024
Reading Week: October 12-20, 2024
Classes end: December 6, 2024

Although the Monday class session is listed as "lab" and the Wednesday session as "lecture", in practice both sessions will be largely self-paced lab sessions. This is a very student-centered course. There will be course lectures at the beginning of both sessions which will proceed as self-paced lab sessions, with the instructor and TA available for help.

Contingency plan

Although the intent is for this course to be delivered in person, should any university-declared emergency require some or all of the course to be delivered online, either synchronously or asynchronously, the course will adapt accordingly. The grading scheme will **not** change. Any assessments affected will be conducted online as determined by the course instructor.

4. Course Materials

Required Textbook:

Numerical Methods for Physics, Second Edition, Revised (Python) by Alejandro L. Garcia (2017, CreateSpace Independent Publishing, Amazon link and Bookstore link), ISBN 978-1548865498. We will follow this text closely and use many of its examples and programming projects. You must have access

to this textbook. Note that the text uses Python version 2.7 but the course will use Python 3.8-3.11; there are several important differences between versions that you need to be aware of.
A weekly checklist of activities and links to other resources will be posted to the OWL site (https://owl.uwo.ca) associated with this course. Students are responsible for checking OWL on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class.

Technical requirements:

- a laptop computer running any of Windows, Linux or MacOS
- Python development environment: many options are available and if you already have a favorite (e.g. Spyder, PyCharm, etc), feel free to keep using it. If you are new to Python IDEs, for this course we recommend Microsoft VS Code. Instructions on how to set up VS Code are on OWL.
- To facilitate team communication, the course may use MS Teams, Slack or some other method chosen by class members; details to be provided.

If students need assistance with the course OWL site, they can seek support on the OWL Brightspace Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

5. Methods of Evaluation

Research about learning strongly suggests that the most important factor in learning is doing the work of reading, writing, recalling, practicing, synthesizing, and analyzing. Learning happens best when people actively engage material on a consistent basis, and that is why we have high standards in this course. We are confident that, with appropriate effort, you **all** can meet those standards.

We also make an effort to reduce unintentional bias in grading by, for example and when possible, grading assignments one question at a time (grading all of question 1 before grading any of question 2), grading anonymously, and using rubrics.

Your course grade will be computed as follows:

Component	Weight
Lab assignments (12), due 11:59pm every Friday except the Reading Week	30%
Midterm: location TBA	30%
Project 1: due 11:59pm Friday, October 4	7%
Project 2: due 11:59pm Friday, November 1	8%
Project 3: due 11:59pm Friday, November 22	12%
Project 4: due 11:59pm Friday, December 13	13%
There is no final exam in this course.	N/A

The midterm exam is designed to assess your scientific programming skills. The exam will be on your computer, open-book, but no internet connection on your computer and no cell phone usage. Requesting assistance from another person is not permitted and will be considered cheating.

Twelve (12) laboratory assignments are scheduled weekly. Lab Assignments will be posted on OWL in advance and must be submitted (via Gradescope) by 11:59PM Eastern time on Fridays.

Learning to work on software in groups is part of the course. Some labs will be completed in groups and announcements will be made during the course.

All four *projects* are to be carried out individually. For each project, a written report must be submitted, along with Python code as necessary. The projects will be fully described in separate documents available on OWL well in advance of the due dates. The project assignments must be submitted to OWL. Because this course has an "essay" designation, at least 3 projects must be submitted in order to pass the course (regardless of marks in the other components); a student who submits only 2 projects will receive a maximum grade of 45. Additionally, in order to receive a course grade >45%, students must obtain a grade of at least 50% overall course components.

Note: The Department of Physics and Astronomy may, in exceptional cases, adjust the final course marks in order to conform to Departmental policy. Final grades will be rounded to the nearest integer, and grades ending in 9 (e.g. 69) are not automatically "bumped up" by 1 mark.

Evaluation Scheme for Missed Assessments and Assessment Flexibility:

Deadline with a No-Late-Penalty Period for Lab Assignments: Students are expected to submit each of the lab assignments by the deadline listed (11:59 pm on Fridays). Should extenuating circumstances arise, students do not need to request Academic Consideration and they are permitted to submit their lab assignment up to 48 hours (11:59 pm on Sundays) past the deadline without a late penalty. **Labs late more than the *No-Late-Penalty Period* will not be accepted.**

Academic Consideration requests may be granted only for extenuating circumstances that started before the deadline and lasted longer than *the No-Late-Penalty Period* (48 hours) and **only when students miss more than 2 labs.** After the solution of the assignment is posted, submissions will no longer be accepted even with Academic consideration granted.

This course has 12 labs, and the 10 labs with the highest marks are counted towards your final grade. Should extenuating circumstances arise, students do not need to request Academic Consideration for the first 2 missed labs. **Academic consideration requests will be denied for the first 2 missed labs.** Academic Consideration requests may be granted when students miss more than 2 labs. After the solution of the assignment is posted, submissions will no longer be accepted even with Academic consideration granted.

Deadline with a No-Late-Penalty and Penalty Period for Projects: Students are expected to submit each of the projects by the deadline listed (11:59 pm on Fridays). Should extenuating circumstances arise, students do not need to request Academic Consideration and they are permitted to submit their project assignment up to 48 hours (11:59 pm on Sundays) past the deadline without a late penalty. Should students submit their project beyond the *No-Late-Penalty Period*, a late penalty of 10% per day

for up to 3 days per day will be applied. **Projects that are late more than 5 days (*No-Late-Penalty Period+3 days Penalty Period*) will not be accepted.**

Academic Consideration requests may be granted only for extenuating circumstances that started before the deadline and lasted longer than *the No-Late-Penalty Period* (48 hours). After the solution of the assignment is posted, submissions will no longer be accepted even with Academic consideration granted.

Missed midterm (Academic Consideration requests with supporting documentation must be made, see below): must be made up at a later date and cannot be handled through re-weighting other course components. The midterm make-up is tentatively scheduled for October 30. A missed make-up midterm cannot be reweighted to other course components; students who miss both the midterm and makeup will be offered the opportunity to write a second make-up with the next offering of the course.

General information about missed coursework
Students must familiarize themselves with the *University Policy on Academic Consideration – Undergraduate Students in First Entry Programs* posted on the Academic Calendar:
https://www.uwo.ca/univsec/pdf/academic_policies/appeals/academic_consideration_Sep24.pdf,

This policy does not apply to requests for Academic Consideration submitted for **attempted or completed work**, whether online or in person.

The policy also does not apply to students experiencing longer-term impacts on their academic responsibilities. These students should consult Accessible Education.

For procedures on how to submit Academic Consideration requests, please see the information posted on the Office of the Registrar's webpage:
https://registrar.uwo.ca/academics/academic_considerations/
All requests for Academic Consideration must be made within 48 hours after the assessment date or submission deadline.

All Academic Consideration requests must include supporting documentation; however, recognizing that formal documentation may not be available in some extenuating circumstances, the policy allows students to make one Academic Consideration request **without supporting documentation** in this course. However, the **Midterm** is excluded from this, and therefore **always requires formal supporting documentation.**

When a student *mistakenly* submits their one allowed Academic Consideration request **without supporting documentation** for the assessments listed above or those in the **Assessment Flexibility** section above, the request cannot be recalled and reapplied. This privilege is forfeited.

6. Generative Artificial Intelligence (AI) Policy

The assignments/projects/exams that you submit for this course must be original work produced by the individual student. The assignments/projects/exams that you submit for this course may not include text/code that was generated from AI tool prompt. You may (but are not required to) use AI tools to revise text (NOT codes) that YOU originally wrote (e.g. using Grammarly), in which case you must declare that use in the same way that you would declare your use of any other software written by someone else.

While generative AI tools (ChatGPT, etc.) can be useful for some tasks (e.g. Grammarly may be useful for revising text that YOU have written), it is not a replacement for critical thinking and writing. You must use them in a way that helps you learn, not hampers learning. Remember that these tools are not a replacement for your own learning of the material, critical thinking ability, writing skills and code algorithm development.

Academic integrity involves claiming credit only for work that you performed; the use of AI tools without acknowledgment violates this integrity. If you are found to have used AI tools inappropriately, this will be considered a violation of Western's academic integrity and scholastic offense policies. Please ask if you have questions about this topic or this policy.

7. Accommodation and Accessibility

Religious Accommodation

When conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request an accommodation for their absence in writing to the course instructor and/or the Academic Advising office of their Faculty of Registration. This notice should be made as early as possible but not later than two weeks prior to the writing or the examination (or one week prior to the writing of the test).

Please visit the Diversity Calendars posted on our university's EDID website for the recognized religious holidays:

https://www.edi.uwo.ca.

Accommodation Policies

Students with disabilities are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic Accommodation_disabilities.pdf.

8. Academic Policies

The website for Registrarial Services is http://www.registrar.uwo.ca.

In accordance with policy,
https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf,
the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at their official university address is attended to in a timely manner.

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf.

All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com).

Computer-marked multiple-choice tests and exams may be subject to submission for similarity review by software that will check for unusual coincidences in answer patterns that may indicate cheating.

All required papers may be subject to submission for similarity review by other software such as MOSS or Gradescope.

If required, tests and examinations in this course will be conducted using a remote proctoring service. By taking this course, you are consenting to the use of this software and acknowledge that you will be required to provide **personal information** (including some biometric data) and the session will be **recorded**. Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. More information about this remote proctoring service, including technical requirements, is available on Western's Remote Proctoring website at:
https://remoteproctoring.uwo.ca.

9. Support Services

Please visit the Science & Basic Medical Sciences Academic Counselling webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters: https://www.uwo.ca/sci/counselling/.

Students who are in emotional/mental distress should refer to Mental Health@Western (https://uwo.ca/health/) for a complete list of options about how to obtain help.

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at

https://www.uwo.ca/health/student_support/survivor_support/get-help.html.

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education at

http://academicsupport.uwo.ca/accessible_education/index.html

if you have any questions regarding accommodations.

Learning-skills counsellors at the Student Development Centre (https://learning.uwo.ca) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Additional student-run support services are offered by the USC, https://westernusc.ca/services/.