Course Syllabus

Course Information

Course Number	PHYS 305
Course Title	Computational Physics
Term	Spring 2025
Days & Times	MW 1:30-3:20pm
Location	Keller Hall 314

Professor Contact Information

Professor	Siqi Li
Email Address	siqili@hawaii.edu
Office Location & Hours	Watanabe Hall 206, Thursday 11am or by appointment.

Course Prerequisites, Co-requisites, and/or Other Restrictions

- 152 or 272 or 272A, and MATH 244 (or concurrent) or MATH 253A (or concurrent); or consent
- No programming experience is assumed
- It's highly recommended to bring your own laptop. If you have difficulty accessing a laptop, please contact me.

Course Description

This course provides an introduction to using numerical methods to solve physics problems. It is targeted towards students with a basic understanding of general physics, and no programming experience is assumed. We will learn to program in Matlab and Python. We will cover topics including derivatives, integration, differential equations, Monte Carlo methods, Fourier analysis, linear algebra, and data analysis.

Class format

This is a combination of a lecture and laboratory course.

Learning Objectives/Outcomes

At the successful completion of the course you will be able to

- Develop computational algorithms that adapt numerical methods to solving problems in theoretical, applied, and experimental physics
- Create your own python or matlab program to implement this algorithm, debug, compile, and run it, producing data which can then be used to assess the results of applying your algorithm
- Create computer-generated graphics to help display and disseminate your results
- Write a concise scientific report summarizing your computational physics results and graphics.

Writing Intensive aspects:

Physics 305 is "writing intensive (WI);" that is to say, it satisfies your WI requirements, fulfilling one of your WI courses. To satisfy the WI requirement, each lab assignment will require a brief report of typically 2-4pp including graphics/figures and equations (unless specified otherwise). To do well on these reports, you will have to strive to make them complete and concise, describing clearly the problem you attempted to solve and the results of your efforts, whether or not the outcome met your expectations. We will learn to develop graphics, plots, and displayed equations to support these reports.

Useful Resources

- Python tutorial: https://www.tutorialspoint.com/python/index.htm

- Matlab documentation: https://www.mathworks.com/help/matlab/
- Python 3 documentation: https://docs.python.org/3/
- Overleaf: https://www.overleaf.com/ . Sign up for a free account. Click "New Project" on the top left of your main page, and select "example project". Then you will see a template for all you need (how to type equations, include figures, add bibliography etc).

Assignments & Academic Calendar:
The descriptions and timelines contained in this syllabus are subject to change at the discretion of the instructor.

Grading
- Each homework assignment: 8%, total of 11 assignments
- Final project: 12%.

Course Policies

Late Work Policy	If the homework is turned in after the deadline, the grade for the homework shall be reduced by 20% for the first 24 hours, and 50% for the next 24 hours and will not be accepted after 48 hours.
Class Attendance	Regular class participation is expected.
Class Materials	Class materials that will be made available to all students registered for this class. These materials may be downloaded during the course, however, these materials are for registered students' use only and should not be posted publicly. Classroom materials may not be reproduced or shared with those not in class, or uploaded to other online environments.

Academic Integrity

The faculty expects students to uphold a high level of responsibility and academic integrity. The value of an academic degree is rooted in the integrity of the work completed by students; therefore, it is essential that students demonstrate a strong commitment to honesty and individual honor in their academic endeavors.

Academic dishonesty includes, but is not limited to, any statements, actions, or omissions related to enrollment applications, the awarding of degrees, or the submission of work that is not entirely one's own. Common forms of academic dishonesty include cheating, plagiarism, collusion, and falsification of academic records. Students found to be engaging in academic dishonesty may face disciplinary action.

Plagiarism, whether from the internet, recycled papers from other courses, or any other source, is strictly prohibited and will be addressed according to the university's plagiarism policy (refer to the general catalog for more details).

These descriptions in this syllabus are subject to change at the discretion of the Professor, and Welcome to the course!

Getting started with Matlab and Python:
Install matlab for free using UH login: https://www.hawaii.edu/sitelic/matlab/matlab.html. Recommended toolboxes: Curve Fitting Toolbox, Image Processing Toolbox, Optimization Toolbox, Partial Differential Equation Toolbox, Statistics and Machine Learning Toolbox, Symbolic Math Toolbox.
For python, we will use Google Colab. You must enable Google@UH Consumer Apps to use Google Colab for python scripting. This can be enabled at https://www.hawaii.edu/google/extra/.

Course schedule

Jan 13
- Introduction to the course

Jan 15
- Intro to programming: area of a circle, and plotting
- Assignment 1: calculating π.

Jan 20 - Holiday

Jan 22
- Assignment 1 due.
- Trajectory of a bouncing ball

Jan 27
- Trajectory of a bouncing ball
- Assignment 2

Jan 29
- Numerical integration

Feb 3
- Assignment 2 due.
- Numerical integration

Feb 5
- Random walk

Feb 10
- Assignment 3 due.
- Random walk

Feb 12

- Monte Carlo

Feb 17 - Holiday

Feb 19

- Assignment 4 due
- Assignment 5: Monte Carlo

Feb 24

- Radioactive decay I: fitting

Feb 26

- Assignment 5 due
- Radioactive decay II: fitting

Mar 3

- Assignment 6: modeling, fitting

Mar 5

- Numerical solutions to differential equations I

Mar 10

- Assignment 6 due
- Numerical solutions to differential equations II

Mar 12

- Assignment 7: differential equations

Mar 17, 21 - Spring Recess

Mar 24

- Assignment 7 due
- Linear algebra

Mar 26 - Holiday

Mar 31

- Assignment 8: FODO cells in particle accelerators.

Apr 2 - TBD

Apr 7

- Assignment 8 due

- Fourier transform

Apr 9
- Fourier transform

Apr 14
- Assignment 9: Fourier analysis

Apr 16
- Image processing

Apr 21
- Assignment 9 due.
- Data analysis / Image processing
- Assignment 10: laser profile images.

Apr 23
- Optimization.

Apr 28
- Assignment 10 due.
- Optimization.
- Assignment 11: cost function.

Apr 30
- Final project

May 5
- Assignment 11 due.

May 7
- Work on final project

May 14 - Final project due