Advanced Computational Physics - PHYS 406

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Office located in LSF L103H
MWF 8:30 - 9:20 AM LSF L106
Office Hours: By appointment, preferably via Zoom/Discord/Slack/Hangouts/Teams/Etc. I will definitely be available MTH 1:00 PM - 2:00 PM, but just ask if you want to meet at another time.

Required Text/Resources.

A Survey of Computational Physics, Robin Landau, Manuel Paez, and Cristian Bordeanu. Free ebook download.
Python 3.x (if you have no other preference, install Anaconda). Python 2.x is deader than dead. Don't use it.
A C++ compiler and (optionally) IDE. If you have no preference, Download Visual Studio Code - Mac, Linux, Windows.
TeX Live or other LaTeX distribution
An SSH client: For Windows, I like Bitvise SSH Client Download. You will also want Xming X server to allow you to see remote graphics. For Mac, just use openssh from the command line! You can use XQuartz for remote graphics.

Rule 0.

No one is born knowing how to code or do physics. If you are struggling, please speak with me (and/or accept my help when offered). If you are concerned that you "don't have what it takes," please speak with me so that I can tell you that ***that is not a real thing***.

Learning Goals

By the end of this course, the student will

- Be able to apply methods of computational physics to a variety of physical systems
- Be able to interpret and present the results of a calculation
- Be comfortable using an HPC cluster to execute parallel code

Zoom Info

Class Meeting Link: https://zoom.us/j/91959355651
"Office" Meeting Link: https://zoom.us/j/95277166362

Topics Covered (subject to change)

Simple Harmonic Motion
Damped Driven Oscillators
Coupled Oscillators
Matrix Operations
Coupled Oscillators and Normal Modes
Schrödinger Equation
Introduction to High Performance Computing
Diffusion Equation
Diffusion Equation with GPU Acceleration
Introduction to Computational Fluid Dynamics

Attendance

Attendance of all sessions (whether in-person or via the synchronous Zoom sessions) is required and will be factored into Participation. Students are encouraged but not required to have their webcams on to allow for more personal communication during the online sessions. Absences need not be documented, **but all students are responsible for all material covered and all assignments regardless of attendance.** Medical or other legitimate documented emergencies will be handled on a case-by-case basis, and I will do my best to work with you to make up missed material.

Evaluation

The final grade will be broken down in the following way

- Participation: 15%
- Homework Projects: 60%
- Final Project: 25%

In addition to attendance, the Participation grade will include the completion of shorter exercises during the class sessions. The Homework Projects are discussed below. The Final Project will be on a topic of the student's choosing and must display mastery of several of the methods and physical problems encountered in the course. We will discuss the Final Project more during the semester.

Format for project reports

Projects will generally be assigned weekly. **All projects must be submitted to Blackboard by 11:59 PM on the due date (i.e. before midnight).** Requests for extensions must be submitted well in advance of the due date and will only be honored in special cases. **Any assignment submitted late will be subject to a 4 point penalty.**
Students will submit a plan for completion of the project including both a rough timeline of when the components of the project will be begun (over a multi-day period!!!) and a code outline. The student is heartily encouraged to take this part of the assignment seriously.
The finished report will contain the following components

- Outline (submitted separately as described above) (**included in Participation**)
- Fully commented code. If the code does not produce the correct output, please include a thorough explanation of what you were trying to do. Please do not submit code that will run forever and/or freeze my computer. (**14 pts**, *significant partial credit for documented efforts*)
- A separate written report containing a brief introduction to the problem and methods, a discussion of all results, and an evaluation of your experience working on the project. (What went wrong? What went right? Were you able to stick to your timeline? Were some parts especially fun or too difficult? How would you approach the project differently?) (**6 pts**)

Python code can be submitted either as a Jupyter Notebook or as a .py file together with the output you obtained. C++ code will be submitted as a .cxx (or .cc or .cpp or whatever you prefer) file together with its output.

Academic Integrity

Discussion of the projects (both with me and with other students) is ***allowed and encouraged***. Each student must submit a separate report that is the sole product of that student's brain, keyboard, etc. (in other words, all cheating or plagiarism will be reported and handled as detailed in the Student Handbook). For my part, I will not discriminate against any student for any reason and will make any reasonable accommodations necessary to meet a student's needs upon request. No discriminatory or hostile behavior toward fellow students will be tolerated. If you experience or witness discriminatory, abusive, or other unwanted behavior, you should contact me, the Title IX Coordinator, or other appropriate authorities.