PHY206: Computational Physics

Spring 2021, 4 credits

TTh 11:30-1, Cousins 104

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Office hours: Open office hours will be on Zoom from 2-3PM on Wednesday, 3:30-5:30 on Thursday and 12:30PM-3PM Friday. Friday office hours will also be held in-person in the Cousins garage. Only students residing on campus or taking other in-person courses can attend in-person office hours. The Zoom link for office hours will be available on Moodle. I will have availability on other days – please don't hesitate to email or stop by my office.

Textbook:
Computational Physics by Newman (CreateSpace 2013). You may want to bring your text to class for reference.

Additional Requirements:
You will need a laptop computer that is fully functional. Please plan to bring your laptop to class every day. Before the first day of class please install Anaconda: www.anaconda.com. This is a science and math based Python distribution. If you have other versions of Python on your computer, you may want to first uninstall those. Please install the Python 3.7 version.

In addition, please sign up for an OverLeaf account at www.overleaf.com. OverLeaf is a free (for students) web-based LaTex editor.

Prerequisites: CSC-201, MAT-132, PHY-201 or permission of the instructor

OBJECTIVES OF THE COURSE

This course is designed to teach students in the physical sciences and engineering about computational tools and methods used by researchers and professionals. Numerical differentiation and integration, Monte Carlo methods, and data analysis and visualization will be addressed. Students will gain experience with science and math libraries in Python, Jupyter notebooks, LaTex, and Onshape.
By the end of this course a student will be able to:

- Use numerical methods to simulate physical systems.
- Use Python libraries to analyze and visualize large data sets.
- Publish computational work in a Jupyter notebook.
- Use LaTex to create professional quality reports.
- Use Onshape and a 3D printer to design and create a piece of hardware.

PEDAGOGICAL APPROACH

I am not a computer scientist, and I have almost no formal training in computer programming and computer science (with the exception of a graduate level numerical methods course). However I am a computational physicist, and have self-taught myself programming languages and computational techniques as needed over the past two decades. I strongly believe that guided exploration is the way to learn how to use the practical techniques and tools I hope you will walk away from this course with.

With that in mind, this class might be considered a "flipped, lab-based" course. I will expect you to read through portions of the text, as well as other resources I make available, before class. During class time, I will give you several problems, exercises, or small projects to work on at your own pace. I will not lecture, although I may warm up the class with some simple examples, and we will discuss portions of the reading that did not make sense to you. My presence in class is there to help guide you and advise you – but it is up to you to ultimately find your way to a solution to the problems and exercises I pose.

COURSE REQUIREMENTS

1. *Preparation and Pre-Class Assignments* – Reading and preparing for class is an essential part of this course. It will be incredibly difficult for you to walk into class and start working if you have not done the reading and prepared beforehand. Before class there will be a brief assignment on Moodle. These assignments will draw on the reading and other resources I will make available, and may review some of the background mathematics and physics that will be necessary for class the next day. Expect pre-class assignments to take you one hour. **Pre-class assignments must be completed by 10PM the night before class.** Pre-class assignments are graded for completeness, as long as an honest effort is made.

2. *Attendance and Class Participation* – Be an active participant in class. Asking and answering questions is an integral part of learning. Working throughout the entire class period is important – this is your primary time to get feedback and assistance from me. The classroom experience will be much more successful and productive if you are prepared for class. You are responsible for making up any work missed. Each student may take **4** absences for any reason. The **5th** absence will result in a one-letter-grade deduction from your course grade (B to C). The **6th** absence will result in an automatic FA grade for the course. Class can be attended via Zoom only if discussed with me at least 24 hours ahead of time. Without prior notification, you will be considered absent if you join the class via Zoom.

   In the classroom, all students will be expected to wear face masks that properly cover the nose and mouth at all times. Social distancing should be followed whenever possible, however realistically when we are examining code we might need to break the 6-foot rule. There will be the possibility to connect your computer to an external screen at times to help mitigate this. At the beginning of each class, all students will be asked to display their status on the Lifeguard app.

3. *Weekly Jupyter Notebooks* – During class time you will be working in Jupyter notebooks to complete coding exercises. These notebooks will be checked at the end of each week. Any work not finished in class must be completed outside of classtime, though it is expected that most work will be completed over the three hours we are together. Weekly notebooks must be submitted by **11:59 PM on Friday**. (Note that the weekly assignment will take a different form when we discuss 3D printing near the end of the semester). Weekly notebooks will be coarsely evaluated on a Very Good/Good/Acceptable/Unsatisfactory/Not Submitted scale.

4. *Mini Projects* – There will be five mini-projects over the course of the semester that will require you to synthesize ideas and present your work both as a Jupyter notebook and in a LaTex-generated PDF. Due dates will be listed on Moodle, details will be discussed in class. **Mini projects will generally be due Sundays at 11:59PM.**

5. *Simulation Project* **–** As a final project in this course, you will choose a complex physical system to model and develop a computational simulation of. You will be expected to complete background research to

understand the physics governing the behavior of the physical system you choose, and you will use your simulation to answer a novel question. The simulation project will culminate in a LaTex-generated PDF and may include a graphical component. **All assignments related to the final project will be due on Sundays at 11:59PM except for the draft and final submission. No late projects will be accepted.**

Late Assignments: Late submissions for the weekly Jupyter notebooks and mini-projects will generally not be accepted. However I do understand that we all get underwater from time-to-time. You may therefore ask for up to **2** 48-hour extensions during the course of the semester on these assignments.

Dropping the Course: The course may be dropped with a grade of W through Wednesday May 5th (provided that the student's work to that point has been of passing quality). After this date the grade of W will be assigned only in the case of withdrawal from the University or prolonged illness.

Academic Honesty:

The important stuff for this class:

The number one issue I have seen with students in programming classes is finding code online that does what you need it to do (for example, calculating the mass of a nucleus based on the semi-emprical formula), and copying it whole-hog into their assignment. You are welcomed and encouraged to use online resources to help you tackle the problems, exercises, and projects in this course. However you must cite code you use, and you must understand every line of your code. If you don't understand what it is doing and why – you can't use it. Often students (and bad researchers) have stuff in their code that is superfluous and just slowing down performance. Code must always be well-commented; your grade will be extremely adversely affected if you can't explain your work.

The usual academic honesty preamble:

Persons who come to Oglethorpe University for work and study join a community that is committed to high standards of academic honesty. The honor code contains the responsibilities we accept by becoming members of the community and the procedures we will follow should our commitment to honesty be questioned.
The students, faculty and staff of Oglethorpe University expect each other to act with integrity in the academic endeavor they share. Members of the faculty expect that students complete work honestly and act toward them in ways consistent with that expectation. Students are expected to behave honorably in their academic work and are expected to insist on honest behavior from their peers.

Oglethorpe welcomes all who accept our principles of honest behavior. We believe that this code will enrich our years at the University and allow us to practice living in earnest the honorable, self-governed lives required of society's respected leaders.

Our honor code is an academic one. The code proscribes cheating in general terms and also in any of its several specialized sub-forms (including but not limited to plagiarism, lying, stealing and interacting fraudulently or disingenuously with the honor council). The Code defines cheating as "the umbrella under which all academic malfeasance falls. Cheating is any willful activity involving the use of deceit or fraud in order to attempt to secure an unfair academic advantage for oneself or others or to attempt to cause an unfair academic disadvantage to others. Cheating deprives persons of the opportunity for a fair and reasonable assessment of their own work and/or a fair comparative assessment between and among the work produced by members of a group. More broadly, cheating undermines our community's confidence in the honorable state to which we aspire."

The honor code applies to all behavior related to the academic enterprise. Thus, it extends beyond the boundaries of particular courses and classrooms *per se*, and yet it does not extend out of the academic realm into the purely social one.

Examples of cheating include but are not limited to:

1.1 The unauthorized possession or use of notes, texts, electronic devices (including, for example, tablets, computers and smartphones), online materials or other such unauthorized materials/devices in fulfillment of course requirements.

1.2 Copying another person's work or participation in such an effort.

1.3 An attempt or participation in an attempt to fulfill the requirements of a course with work other than one's original work for that course.

1.4 Forging or deliberately misrepresenting data or results. Submitting results of an experiment, at which one was not present or present for less than the full time, as one's own.

1.5 Obtaining or offering either for profit or free of charge materials one might submit (or has submitted) for academic credit. This includes uploading course materials to online sites devoted, in whole or in part, to aiding and abetting cheating under the guise of providing "study aids." There is no prohibition concerning uploading exemplars of one's work to one's personal website or to departmental, divisional, University or professional society websites for purposes of publicity, praise, examination or review by potential employers, graduate school admissions committees, etc.

1.6 Violating the specific directions concerning the operation of the honor code in relation to a particular assignment.

1.7 Making unauthorized copies of graded work for future distribution.

1.8 Claiming credit for a group project to which one did not contribute.

1.9 Plagiarism, which includes representing someone else's words, ideas, data or original research as one's own and in general failing to footnote or otherwise acknowledge the source of such work. One has the responsibility of avoiding plagiarism by taking adequate notes on reference materials (including material taken off the internet or other electronic sources) used in the preparation of reports, papers and other coursework.

1.10 Submitting one's own work for a course that was previously submitted for the same course, or another course, without proper citation.

1.11 Lying, such as: Lying about the reason for an absence to avoid a punitive attendance penalty or to receive an extension on an exam or on a paper's due date; fraudulently obtaining Petrel Points by leaving an event soon after registering one's attendance and without offering to surrender the associated Petrel Point, or by claiming fictitious attendance for oneself or another; forging or willfully being untruthful on documents related to the academic enterprise, such as on an application for an independent study or on a registration form.

1.12 Stealing, such as: Stealing another's work so that he/she may not submit it or so that work can be illicitly shared; stealing reserve or other materials from the library; stealing devices and materials (such as computers, calculators, textbooks, notebooks and software) used in whole or in part to support the academic enterprise.

1.13 Fraudulent interaction on the part of students with the honor council, such as: Willfully refusing to testify after having been duly summoned; failing to appear to testify (barring a *bona fide* last-minute emergency) after having been duly summoned; testifying untruthfully.

Students pledge that they have completed assignments honestly by attaching the following statement to each piece of work submitted in partial fulfillment of the requirements for a course taken for academic credit:

"I pledge that I have acted honorably." (Followed by the student's signature)

The honor code is in force for every student who is enrolled (either full- or part-time) in any of the academic programs of Oglethorpe University at any given time. All cases of suspected academic dishonesty will be handled in accordance with the provisions established in this code. The honor council has sole jurisdiction in matters of suspected academic dishonesty. Alternative ways of dealing with cases of suspected academic fraud are prohibited. In cases of alleged academic dishonesty on the part of students, the honor council is the final arbiter. Reference the current Oglethorpe University Bulletin for information concerning all aspects of the honor code.

GRADING POLICY

Grading scale:

A.....90-100 (A-....90-92)
B.....80-90 (B-....80-82,B+....87-90)
C.....70-80 (C-....70-72,C+....77-80)
D.....60-70 (D+....67-70)
F.....0-60

Note that Incomplete (I) is given only under the rarest of circumstances. Refer to section 5.20.2 of the 2014-2016 Bulletin for a summary of requirements.

Your grade will be computed as follows:

Pre-class Activities	10%
Weekly Jupyter Notebooks	20%
Mini-Projects	30%
Simulation Project	40%

Course Schedule PHY206 (*These dates are very tentative and subject to change)*

Tuesdays		Thursdays	
2/9	Introductions/ Basic Python	**2/11**	Numpy Arrays & Basic Plotting
2/16	Integrals	**2/18**	Integrals
2/23	Integrals	**2/25**	Derivatives **Mini-Project 1 Due**
3/2	ODEs	**3/4**	ODEs
3/9	ODEs	**3/11**	ODEs **Mini-Project 2 Due**
3/16	PDEs	**3/18**	PDEs
3/23	*Independent Research and 1-on-1 meetings*	**3/25**	*Independent Research* **Project Proposal Due**
3/30	Monte Carlo	**4/1**	Monte Carlo
4/6	Stochastic Methods	**4/8**	Stochastic Methods **Mini-Project 3 Due**
4/13	Data & PANDAS	**4/15**	Data & PANDAS **Background Research Due**
4/20	Data & PANDAS	**4/22**	Data & PANDAS **Mini-Project 4 Due**
4/27	3D Printing	**4/29**	3D Printing **Progress Report Due**
5/4	3D Printing	**5/6**	3D Printing **Mini-Project 5 Due**

Important Dates

February 8 - First day of classes
March 23, March 25 – Independent Research Time
May 5 – Last day to withdraw
May 10 – Last day of classes. **Final project rough draft due.**
May 18 – **Final project final draft due.**

Suggested Study Schedule:
This is just a suggestion and is obviously highly malleable depending on your schedule and other commitments. I hope this gives you some sense of the expectations of this course and helps you to set up your own personal work-flow schedule.

Sunday	Work on the mini-project or final project assignment	1-2 hr
Monday	Read and prepare for Tuesday's class Complete pre-class assignment	1 hr 1-2 hr
Tuesday	Attend class Finish Jupyter notebook if needed	1.5 hr 0.5 hr
Wednesday	Read and prepare for Thursday's class Complete pre-class assignment	1 hr 1-2 hr
Thursday	Attend class Finish Jupyter notebook if needed	1.5 hr 0.5 hr
Friday	Work on the mini-project or final project assignment Attend office hours if needed	1-2 hr
Total Time		**10-14 hrs**