Physics 305
Computational Physics
(Fall 2020)

This class is scheduled to be taught in the LIVE ONLINE modality

Meeting Times: This class will meet at 1:00 PM - 1:50 PM on MWF via Zoom. Our synchronous meetings will give us the opportunity to discuss lecture material and develop algorithms through interactive programming exercises.

Staying Current: You are required to complete regular problem sets and a class project on your own time. All assignments will be announced, submitted, and graded through the D2L course website.

Instructor: Prof. Elisabeth Krause
Offices: SO322
Email: krausee@arizona.edu
Prof. Krause's Office hours: Wednesday 11:30 am - 12:30 pm on zoom (access through D2L calendar)

TA: Marco Jiminez
Email: marcojv@email.arizona.edu
Marco Jiminez' office hours: TBD (access through D2L calendar)

Course description: Phys 305 is a course for students of Physical Sciences that introduces basic computational methods for solving mathematical problems motivated from the physical sciences. Often problems drawn from actual physics will form the basis for the examples that will serve to master the techniques and algorithms taught.

Prerequisites: During the course we will use the UNIX/LINUX operating system, and a mix of C/C++ and python (more python than C). You should have completed Phys 105. Your mathematical preparation should include linear algebra, differential and integral multivariate calculus, and at least some ordinary and partial differential equations. Although, basic introduction to the more advanced mathematical topics will be provided during the course.

While the above are no formal prerequisites, the more programming experience, physics and math you have mastered, the smoother and more beneficial the course is going to be for you.

Topics to be covered: Introduction to the python language, numerical solution of linear and non-linear algebraic equations, interpolation, numerical differentiation and integration of arbitrary functions, solution of ordinary differential equations, solution of boundary value problems for ordinary differential equations, solution of hyperbolic, parabolic and elliptic partial differential equations, Monte Carlo Markov Chains, and a short excursion into basic Machine Learning algorithms. Basic introduction to the C programming language after Thanksgiving (not required for homework).

The class will focus heavily on hands-on experience and implementation of algorithms from scratch in and out of the classroom.

Assignments: The **homework will be due on Fridays at 5pm** (approximately 1 problem set every week at the beginning and later every two weeks for a total of 8 homework sets). You are encouraged to work together, especially in figuring out how to do the problem sets, how to implement an algorithm, and when debugging. **However, the actual coding and running of the assigned solution must be done and be understood by each of you individually.** You must make sure that your code compiles, and runs before turning in your homework. For every homework, you will be asked to write a few programs in python and describe the reasoning behind them and their output. Also, always make sure you add comments to your code that explain what you do. All homeworks will be turned in electronically through D2L. **No credit** will be given for late homeworks, but the lowest score of the 8 homeworks will not count towards the course grade. If you have a well documented legitimate reason (such as family emergency, serious sickness or a university function) for not turning in a particular homework, we will be accommodating.

Each student will also have to complete, present in front of the class, and be able to answer questions on a term project. The term project will require the development of computer code that combines a number of the numerical methods we will discuss during the semester and will be longer and more complex than any individual homework. The two last classes will be reserved for the presentation of the term projects.

Course Objectives and Expected Learning Outcomes: At the end of this course, students will be able to:

- Exercise analytic reasoning to solve physics problems with computer algorithms
- Code and understand programs in python (intermediate complexity)
- Write code to perform numerical differentiation and integration
- Solve numerically (systems of) ordinary differential equations and partial differential equations
- Write code to perform statistical analyses

Grading: Your course grade will be based on homeworks (70%), and a term project (30%). There will be no final exam. The class will not be curved. The correspondence between final percentages and letter grades will be: **A**:85%–100%; **B**:70%–85%; **C**:50%–70%, **D**:30%–50%; **E**:0%–30%.

Incomplete/Withdrawal: Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

Texts: There is no official text for this course. You can find notes on everything you need to get started on D2L, including a guide to python. The text "Numerical Recipes in C"

by Press, Teukolsky, Vettering, & Flannery (2nd edition) has been the standard reference in the field for many years and offers an in depth presentation of many topics covered in this (and many more). In general keep in mind that the world wide web is your friend. Help in programming, tutorials etc. are widely available online.

Attendance: Class attendance is optional, but we will often start homeworks assignments in class, so by not coming to class you will miss out on help other students will be benefit from. In addition, your instructors are not required to explain to you what you missed by not coming to class. You are responsible for knowing everything that goes on in class, including announcements, course materials, handouts, what has been assigned as homework, as well as any hints, help, due dates, extensions, etc. Especially due dates could be changed, if the majority of the class has found a problem set particularly challenging.

If you have a legitimate reason for not attending on a given day, please let us know in advance. We may be able to give you the appropriate class notes. If you have cleared your absence with us in advance, make sure that you contact us promptly upon return to find out what you may have missed.

All holidays or special events observed by organized religions will be honored for those students who show affiliation with that particular religion.

Course Website: In this class we will make use of D2L. It is your responsibility to check D2L regularly for course announcements/updates and assignments.

Classroom Behavior Policy: To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Students are asked to refrain from disruptive comments or chat messages during lecture. Students observed engaging in disruptive activity will be asked to cease this behavior. Those who continue to disrupt the class will be asked to leave lecture or discussion and may be reported to the Dean of Students.

Academic advising: If you have questions about your academic progress this semester, or your chosen degree program, please note that advisors at the Advising Resource Center can guide you toward university resources to help you succeed.

Life challenges: If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office can be reached at 520-621-2057 or DOS-deanofstudents@email.arizona.edu.

Physical and mental-health challenges: If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520-621-9202. For After Hours care, call (520) 570-7898. For the Counseling Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.

Equipment and software requirements: For this class you will need daily access to the following hardware: laptop or tablet with microphone; regular access to reliable internet signal; ability to download and run the following software: zoom, python, jupyter notebooks.

Class Recordings: Lectures will be recorded via zoom and made available solely through D2L and will not be shared outside this class. *You are not required to enable your video during recordings. Note that these class recordings include the participant names; if you prefer your full name not to be recorded, you can change your zoom participant name to a nick name.* For lecture recordings, which are used at the discretion of the instructor, students must access content in D2L only. Students may not modify content or re-use content for any purpose other than personal educational reasons. All recordings are subject to government and university regulations. Therefore, students accessing unauthorized recordings or using them in a manner inconsistent with UArizona values and educational policies are subject to suspension or civil action.

Zoom Etiquette: Please mute yourself when not talking, and use the *raise hand* feature in zoom to ask questions. Comments typed in to the zoom chat can be read by every meeting participant; please be mindful in your communication. You are welcome to change your zoom participant name to your preferred name, and to indicate your preferred pronouns as part of your participant name. You are not required to enable your video.

Threatening Behavior Policy: The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

Code of Academic Integrity: Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.

UA Nondiscrimination and Anti-harassment Policy: The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy.

Accessibility and Accommodations: At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, https://drc.arizona.edu/) to establish reasonable accommodations.

Subject to Change Statement: Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.