Physics 305
Computational Physics
(Spring 2020)

Lectures: 12:30 PM - 1:45 PM TuTh in SO208

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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: basic introduction to the C/C++ and python language, basic introduction to the Unix/Linux operating system, numerical solution of linear and nonlinear 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.

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 C 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:

- Use the command line and the Linux/Unix operating system, compile C and execute python code, make plots with python
- Code basic programs in python.
- Code basic programs in C/C++.
- To program numerical algorithms.
- Solve numerically non-linear algebraic (systems) equations
- Differentiate functions/data numerically
- Integrate function/data numerically
- Solve numerically (systems of) ordinary differential equations
- Solve numerically partial differential equations
- Understand MCMC and basic Bayesian inference
- Understand basic Machine Learning concepts

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 in the phys305s20 folder on nimoy, 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 all the topics that we will cover (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 conversations with people sitting around them 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.

Some learning styles are best served by using personal electronics, such as laptops and iPads. These devices can be used ONLY for note taking. NO cellphones in class. Cellphones must be kept in a bag or pocket and on silent.

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 commit-

ted 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.