Physics/Astronomy 305: Computational Physics

Spring 2017

Tuesdays & Thursdays, 11:00-12:15
Steward Observatory, Room 208

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Description: This course is really *two* courses at once: one in computer programming and the other in numerical mathematics. We will explore how these tools can be used to attack a variety of physics problems. The goal of the course is to provide you with some fundamental techniques for using the computer as a tool in exploring the physical world.

We will be employing the Python programming language, with perhaps a bit of C++ if time permits. The course is *not* a full-blown course in programming or in computer science. Indeed, many computer scientists or professional programmers would cringe at some of what we do. My goal is to introduce you to what a practicing physicist needs to know to get started in using the computer to solve problems in physics. We will cover just enough that you should be able to continue learning on your own as you encounter different and more difficult problems in the future.

The course will cover algorithms and methods from numerical analysis, linear algebra, Fourier theory, and the numerical solution of ordinary and partial differential equations.

We will draw our example problems from a wide variety of physics and mathematics, some of which you may not have encountered to date in your studies. Not to worry! You are not expected to become expert in all of the physics we touch upon; the problems chosen are intended simply to provide interesting case studies for our problem-solving skills. All of the physical and mathematical background necessary to undertake their solution will be provided in class.

Prerequisites: This course is designed for those with no previous experience with programming or of the Unix (Linux) operating system beyond that provided by PHYS 105.

Ideally, you should have completed the usual three-semester introductory physics sequence and at least one additional higher-level physics course. Again ideally, your mathematical preparation should include vector calculus, ordinary differential equations, Fourier series, and at least some linear algebra and partial differential equations.

While these are not formal prerequisites, the more math and physics you have under your belt, the easier and more profitable you will find this course. The same is true for programming experience. If you have doubts about whether this course is right for you, please see me at your earliest convenience.

If you took PHYS 105 last semester, you will know some Python programming. If you took an earlier incarnation of PHYS 305, you will have learned C++, not Python. In this case, do not panic!

This course will be a self-contained introduction to Python programming, and you will not be at a material disadvantage.

Computing Environment: We will be using the Linux operating system in this course. All currently-enrolled students have an account on `nimoy.as.arizona.edu`. You will have access to the computer lab in Steward Observatory 208 which has 22 desktop computers which can connect with the class server. Many of you will already have 24/7 access to Steward. Others may register their CatCard for this semester in the Astronomy departmental office. There is a pushbutton lock on room 208; the combination will be given out in class.

We encourage you to use your own computer instead of those provided, although you will still find it useful to collaborate in the computer lab. There are several options for using your own computer. Information on this will be distributed in class.

Texts: There is no official text for this course, but from time to time reading may be assigned in one or more texts. These will all be available on-line or for download though the University library. The first maxim to remember is this course is: *Google is your friend* Help in Python programming and documentation for all of the Python we will be using is available on-line.

Assignments: Problem sets will be assigned weekly at first. Later in the semester some will take two weeks to complete. You are encouraged to work together in figuring out how to do the problem sets; especially while debugging code, a second pair of eyes is extremely helpful in spotting errors. The actual coding and running of the assigned solution must, however, be done and be understood by each of you *individually*. Beware of not being able to explain why you did the assignment the way you did!

Warning!

Writing and debugging computer code takes time, even when you know what to do – more time than most problem sets you are used to. Do not start the problem sets the day before they are due. Start them as soon as they are assigned. You have been warned!

Grading: Your grade in this course will be based upon the average of your scores on the problem sets. The worst score among those assignments turned in on time will be left out of the average. Missing or late problem sets *will be counted as zero* in the average; *i.e.*, a missing assignment will not be counted as a "worst score" to be left out. A positive "correction" to your grade may be made for class participation.

There will be no exams, and specifically no final exam, in this course.

Late and missing assignments: Late assignments will not be graded, except when *prior* arrangement has been made with one of the instructors. If you have a legitimate reason such as a family emergency or travel to attend a conference or intercollegiate competition, we will be very accommodating. We will also grant extra time for a project which is substantially complete but which needs some extra work; we will not grant extra time for projects which have barely been started.

Office Hours: Some fraction of class time will often be allocated to working on the assignments. During this time, your instructors will peer over your shoulders and provide help. When we see that several of you are having a similar problem, we will stop and discuss possible solutions with the whole class.

I will remain in the computer lab for at least an hour (or until the last person leaves) after the end of each class to provide assistance. I am in my office much of the day and very often until late at night. Please do not hesitate to stop by for help, calling to see if I am in. If the door is closed, do not hesitate to knock! If I am not in my office, keep trying; I'm probably in a meeting and will be back within an hour.

I will have to travel to Washington, DC at least twice this semester and will keep the class abreast of my travel schedule. When I am not in town, *class will still meet* and will be taught by Evan and/or a guest lecturer.

Finally, I cannot guarantee that I will *promptly* read your email. If you need to contact me in a hurry, come find me, or call to see when I will be in.

Evan will be available for help in her office from 2 to 4 on Tuesdays and Thursdays, and will generally be available during normal working hours.

In this class, a few words of guidance from the instructors will often save hours of struggle. Do not underestimate the value of stopping by for help, early and often!

Attendance: You are not *required* to come to class – but neither are your instructors 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 all course material, handouts, what has been assigned as problem sets and any modifications thereto, as well as any hints, help, due dates, extensions, *etc.*.

If you know that you will be absent from class on a given day (for a legitimate reason, of course), please let us know in advance. We may be able to give you the appropriate class notes and/or any assignments. 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.

Incompletes: A grade of "Incomplete" will only be given in this course if a student has satisfactorily completed the majority of the work in the class and has a valid reason, *e.g.* a medical problem, for not completing the remainder of the course. Students must make arrangements with me *in advance* in order to receive an incomplete.

Academic Integrity: Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed (see above). Students are responsible for understanding and following the UA Code of Academic Integrity (`http://deanofstudents.arizona.edu/codeofacademicintegrity`). Students engaging in academic dishonesty diminish their education and bring discredit to the academic community and the campus. Students should avoid situations likely to compromise academic integrity.

Special Accommodation: If you anticipate barriers related to the format or requirements of this course, please meet with me so that we may discuss ways to ensure your full participation. If you determine that disability-related accommodations are necessary, please register with Disability Resources (621-3268; `drc.arizona.edu`) and notify me of your eligibility for reasonable accommodations. We can then plan how best to coördinate these.

Decorum: Students are expected to maintain a high level of decorum in the classroom. In particular, the use of cell phones or other devices to communicate (by voice or by text) during class is bad manners and should be eschewed. We will follow all University policies on disruptive behavior in an instructional setting: see `http://policy.arizona.edu/education-and-student-affairs/disruptive-behavior-instructional-setting`

Disclamer: Information contained in this course syllabus is subject to change with advance notice, as deemed appropriate by the instructor. NB: notice of such changes may only be given in class.