

# PHY 386: Scientific Programming (Fall 2024)

Instructor: Doug Armstead

SUNY Cortland, Physics Department

## Course Meeting Times

MWF 9:10 – 10 AM

## Standing Office Hours

MTW 3 – 4pm

### **Or by appointment:**

These are just the times I guarantee. I'm available other times so feel free to drop by or to contact me to set up an appointment.

## Contact Info

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## Course catalog description

Computer programming for the purposes of solving problems in physics and engineering with a primary focus on numerical integration of differential equations.

Prerequisites: MAT 336 OR (PHY 202 AND MAT 236)

## Course student learning outcomes

Upon successful completion of this course, the student will be able to

1. Design numerical algorithms to calculate solutions to a range of problems in physics and engineering
2. Calculate approximate solutions to problems that cannot be solved, or simply solved, with analytical techniques
3. Explain the operation of common algorithms related to root finding and calculus
4. Use the appropriate data types for a given problem, including scalars, arrays, and matrices
5. Implement fundamental programming structures such as loops and conditional statements to perform calculations
6. Identify when a code is not working correctly and apply debugging procedures to solve the problem

## Writing Intensive learning outcomes

1. Students will undertake an effective writing process, making informed decisions about their writing with input from their instructor.
2. Students will write effectively in specific disciplinary genres.

## Required course materials

- Access to a computer on which you can install and run Anaconda (a Python environment)
- *Modeling and Simulation in Python* by Allen B. Downey, ISBN 978 171 850 2161

## Course website

Reading, assignments, and resources will be posted to the course website:

<https://facultyweb.cortland.edu/douglas.armstead/F24/PHY386.html>

### My goals for this course

Physics 386 is a transitional course between the introductory physics and mathematics courses and the advanced, 400-level courses. In this course you will apply many of the theoretical tools you studied in these introductory courses to a wider range of problems and learn how to use numerical techniques to create find solutions to problems that are unsolvable using theory alone. My goals for this class are that you:

- learn the fundamentals of programming and know how write effective code;
- develop a sense of confidence with programming so that it becomes a skill for you to use in your 400-level classes;
- learn how to debug code and recognize the process of debugging as a practical life skill;
- find the utility in these new tools and create a final project about which you are excited;
- and come away with a sense of having learned a general skill set that will help you in any future career path.

### Assessment weighting

Lab Reports	50%
Homework	20%
Final Exam	20%
Independent project	10%

### Number of assignments in each assessment category

3 lab reports
5 problem sets
the final exam will cover algorithm design & programming
final report on your independent project

### Score ->Grade conversion

	$87\% \leq \mathbf{B+} < 90\%$	$70\% \leq \mathbf{Cs} < 80\%$
$92\% \leq \mathbf{A}$	$82\% \leq \mathbf{B} < 87\%$	$60\% \leq \mathbf{Ds} < 70\%$
$90\% \leq \mathbf{A-} < 92\%$	$80\% \leq \mathbf{B-} < 82\%$	$\mathbf{E} < 60\%$

### Course policies and explanation of assessment categories

**Attendance:** Attendance in class is mandatory, we will be using class time to work collaboratively on projects and practice our computer programming skills. Each unexcused absence in lab will incur a 2% penalty to your course grade.

**Lab Reports:** You will conduct a total of three programming labs. A programming lab will be a more involved, intermediate stage project that will require you to invest a substantial effort outside of class to complete. Each report itself will likely be 5 pages in length, for a total of 15 pages of writing. This does not count revisions or the pages of writing that will necessarily be present in your code.

A lab report is required for each of your projects. Lab reports must have: A statement of the problem, conceptual design of the model, document tests showing that you have properly debugged the code, and a nicely organized presentation of the output. A copy of the actual code must be attached. A detailed report rubric will be provided to you and discussed in class.

**Revisions:** You are required to submit first and second drafts of two of lab reports A and B. The third lab report, due in the final week of the semester, will be evaluated on the submitted draft and you will not have the opportunity to revise this report. *The two revised reports are an essential part of the course, you cannot pass the course without doing both revisions.* Instructor feedback may focus on the discussion in the report proper or may focus on code, or both. Revised reports will be due one week after feedback is given.

**IMPORTANT NOTE ON PLAGIARISM:** Computer codes are works of original writing, like an essay, poem, or book. Copying code without giving credit is an act of plagiarism and carries with it the full consequences of any other kind of academic integrity violation. You can avoid this situation by making sure that the code you submit for evaluation is your own creation.

**FINAL NOTE ON PLAGIARISM:** Simply changing variable names or making other cosmetic changes to a code does not constitute an original creation and is therefore stealing and plagiarism. While codes generated for a specific purpose may tend to look alike, you know that your code is not plagiarized if you actually thought about it, created it yourself, wrote each line, and can explain the meaning of each line. Please discuss and collaborate with each other, just make sure that you understand what you are doing and can justify the placement of every letter and function in your code.

**Homework:** We will be studying the fundamentals of computer programming through discussion in lecture and through the wealth of examples presented in our textbook. You will have homework most weeks. While you are free to collaborate, all submitted work must be your own. That means no copying or otherwise directly using another students' work, no use of solution manuals or posted solutions from any outside source, and no use of internet resources like Chegg.

**Final Exam:** The final exam will focus on theoretical aspects of the class (i.e. core concepts from computer programming and algorithm design), but may also include content from specific programming exercises. No late exams will be permitted without a valid reason, as outlined in the college catalog.

**Independent project:** Completion of an independent project and presentation of the project in the final week of the semester is required to complete this class. For students more interested in the mathematical/theoretical side of programming, this project should focus on applying the methods of this course to a problem from mechanics that is well suited to numerical analysis. Further details will be provided as we enter the second half of the semester.

## Course Schedule

Note that this is a tentative schedule and is subject to change as necessary. In addition to regular lecture meetings where we will discuss core programming concepts and more algorithm development for particular problems, we will also use class time for writing and testing code. This means that you should always come to class having prepared by completing the assigned reading, working on various aspects of code development, and having your programming environment up and running.

Week	Starting	Topic	Ch.	Lab Report
1	8/26	Intro to Modeling /basic programming /graphing	1&2	-
2	9/4	Refining models/expanding data types (Labor Day)	3&4	-
3	9/9	Using existing data/ iterating models/ organizing thinking	5&6	-
4	9/16	Better models/ projections/ comparing	7&8	-
5	9/23	Case studies, part I	10	-
6	9/30	Systems of differential equations/ making sense of results	11&12	A
7	10/9	Sweeping parameters (Fall Break)	13	-
8	10/14	Another ODE system (Thermal)	15&16	-
9	10/21	Another ODE system, this time with interpolation and an ODE solver.	17&18	-
10	10/28	Case studies, part II	19	-
11	11/4	2 <sup>nd</sup> order ODEs, drag	20&21	B
12	11/11	2 <sup>nd</sup> order ODEs, 2-D motion	22&23	-
13	11/18	2 <sup>nd</sup> order ODE's, rotations	24&25	-
14	11/25	Case studies, part III (Thanksgiving Break)	26	-
15	12/2	Interface w/ mechanics	-	C

**Final Exam:** Wednesday Dec 9, 8:30-10:30am

## **SUNY Cortland Policies and Statements**

**Academic Integrity Statement:** All students are expected to uphold academic integrity standards. Plagiarism is defined as taking the ideas of others and using them as one's own without due credit. Students who cheat in examinations, course assignments, or plagiarize in this course may be disciplined in accordance with university rules and regulations. SUNY Cortland College Handbook, Chapter 340.

**Disability Statement:** As part of SUNY Cortland's commitment to a diverse, equitable, and inclusive environment, we strive to provide students with equal access to all courses. If you believe you will require accommodations in this course, please place a request with the Disability Resources Office at [disability.resources@cortland.edu](mailto:disability.resources@cortland.edu) or call 607-753-2967. Please note that accommodations are generally not provided retroactively so timely contact with the Disability Resources Office is important. All students should consider meeting with their course instructor who may be helpful in other ways. SUNY Cortland College Handbook, Chapter 745.

**Diversity Statement:** SUNY Cortland is dedicated to the premise that every individual is important in a unique way and contributes to the overall quality of the institution. We define diversity broadly to include all aspects of human difference. The College is committed to inclusion, equity, and access and thus committed to creating and sustaining a climate that is equitable, respectful and free from prejudice for students, faculty and staff. We value diversity in the learning environment and know that it enhances our ability to inspire students to learn, lead and serve in a changing world. We are committed to promoting a diverse and inclusive campus through the recruitment and retention of faculty, staff and students. As a community, we hold important the democracy of ideas, tempered by a commitment to free speech and the standards of inquiry and debate. To this end, we are dedicated to developing and sustaining a learning environment where it is safe to explore our differences and celebrate the richness inherent in our pluralistic society. SUNY Cortland College Handbook, Chapter 130.

**Inclusive Learning Environment Statement:** SUNY Cortland is committed to a diverse, equitable and inclusive environment. The course instructor honors this commitment and respects and values differences. All students enrolled in this course are expected to be considerate of others, promote a collaborative and supportive educational environment, and demonstrate respect for individuals with regard to ability or disability, age, ethnicity, gender, gender identity/expression, race, religion, sex, sexual orientation, socio-economic status or other aspects of identity. In an environment that fosters inclusion, students have the opportunity to bring their various identities into conversation as they find helpful, but are not expected to represent or speak for an entire group of people who share aspects of an identity. If you have any questions or concerns about this statement, contact the Institutional Equity and Inclusion Office at 607-753-2263. <http://www2.cortland.edu/about/diversity/>

**Title IX Statement:** Title IX, when combined with New York Human Rights Law and the New York Education Law 129-B, prohibits discrimination, harassment and violence based on sex, gender, gender identity/expression, and/or sexual orientation in the education setting. The federal Clery Act and NY Education Law 129-B provide certain rights and responsibilities after an incident of sexual or interpersonal violence. When a violation occurs, victims and survivors are eligible for campus and community resources. Where the College has jurisdiction, it may investigate and take action in accordance with College policy. If you or someone you know wishes to report discrimination based in sex, gender, gender identity/expression, and/or sexual orientation, or wishes to report sexual harassment, sexual violence, stalking or relationship violence, please contact the Title IX Coordinator at 607-753-4550, or visit <http://www2.cortland.edu/titleix> to learn about all reporting options and resources.

Updated by SUNY Legal on February 1, 2018.