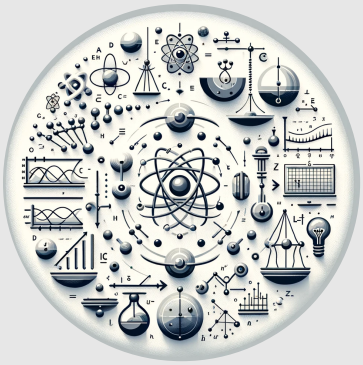

Computational Physics I

PHYS 3500K – Spring 2026

Instructor Info

Dr. Andreas Papaefstathiou

Office Hrs: M & W 1:00-3:00 PM or by appointment

Academic Building 260i, (Marietta Campus)

470-578-2702

http://facultyweb.kennesaw.edu/apapaefs

apapaefs@kennesaw.edu

Course Info

Prereq: Grade "C" or higher in PHYS 2212 and PHYS 2212L

Mon & Wed

3:30-4:45 PM & 5:00-6:15 PM

Academic Building 250 (Marietta Campus)

Course Overview

We will use introductory computer programming to analyze situations that are unique to physics. You will enhance your computational thinking by using these methods and learn to obtain high-accuracy approximate solutions to physics problems that are not solvable by analytic means. No prior programming knowledge will be assumed, and the basics of programming will be introduced.

Learning Objectives

At the completion of this course, you will:

- be able demonstrate knowledge of computer language syntax and the ability to structure code.
- will learn basic numerical techniques to solve integral and differential equations in physics.
- be able to perform numerical integration and discuss the accuracy of the result for applications in physics.

Required Text and Material

Main Textbook(s):

- An Introduction Scientific Computing JupyterBook, found at: `https://apapaefs.github.io/ScientificComputing/`, available freely online. This is expected to evolve during the semester.

Supplemental material will be provided during the lectures.

D2L

I will use D2L for course information and announcements. You can access D2L via: `http://d2l.kennesaw.edu/`. To sign on, use your KSU username and password. Please check D2L for announcements at least once or twice a day!

If you haven't already, I suggest that you download the Pulse app on your phones (links for: iOS or Android), which connects to D2L for instant notifications!

Course Repository

The Github repository `https://github.com/apapaefs/ScientificComputing` will be used in conjunction with D2L to share lecture notes and computer code. Solutions to exercises and problems will be provided in a separate repository during the course: `https://github.com/apapaefs/phys3500k_sp26_solutions`

Instructions will be given during class on how to access and use the repositories.

Homework Assignments

Homework will be assigned during the lectures and posted on D2L. We will discuss solutions to problems, and these will also be posted on github (`https://github.com/apapaefs/phys3500k_sp26_solutions`) following the deadline.

Please only ask for extensions if you have a valid emergency reason. If you believe you do have a valid reason, contact me via e-mail.

Please attempt the problems early, so that if you have any questions we can discuss them with sufficient time.

Important: Your code has to be your code entirely. Cheating of any form will not be tolerated, including the use of AI/LLMs to generate your solution. Your code should be appropriately commented to describe what is being done, line-by-line. Homework assignments should be returned in the form of a short "report", in the form of a JupyterLab notebook, with an introduction, main part and conclusions. An example will be given at the start of the course.

In-Class Quizzes

To test your on-going understanding of the course material, short in-class quizzes comprising of one or more questions will be given at the start of each class *on paper*.

Important: During the quizzes, no use of computers or cell phones will be allowed.

Communication

Only use e-mail to contact me (i.e. not D2L) at apapaefs@kennesaw.edu.

Please make sure that the subject line starts with "PHYS 3500K". Please also use your KSU e-mail address.

I will return all emails in 36-hours during the week and within 48 hours over the weekends.

Evaluation and Grading Policies

To be successful in this course, continuous effort is required. There will be no tests or final exam in this course. Weekly homework assignments, in-class quizzes, and a final project comprise the grading scheme.

40%	Homework
20%	In-Class Quizzes
40%	Final Project

Grades will follow the scale: A = 89.5-100%; B = 79.5-89.4%; C = 69.5-79.4%; D = 60-69.4%; F $<$60%. Curving is at the discretion of the instructor.

The *two* lowest-scoring homework assignments will be dropped.

The *three* lowest-scoring in-class quizzes will be dropped.

Extra Credit: There will be extra credit in the assigned homework in the form of bonus questions, constituting 10-20% of each assignment. There will also be a 2% bonus end-of-course assessment quiz.

Final Project

The final project is important for the successful completion of this course, comprising 40% of the total grade.

A list of possible projects will be given at the start of the course. It is also possible to recommend projects yourselves, on which we will have to agree on.

Progress report: A progress report (1-2 pages) will be due on March 4$^{\text{th}}$ 2026, 3:30pm. This should summarize your progress towards this project. I will provide feedback on this report.

The grading of the final project will be based on the following three components:

1. A project report (10-15 pages, including an abstract, introduction, main part, results and conclusions).
2. The associated computer code produced. The code should be entirely reproducible, e.g. in a JupyterLab notebook, with appropriate commenting within the code, line-by-line.
3. A final project presentation to the rest of the class (6 minutes + 2 minutes for questions). This should describe the problem, your approach, and your conclusions. The presentations will take place on the day of the course's 'Final Exam', i.e. Monday, May 11$^{\text{th}}$ 2026, 3:30-5:30pm.

The grading scheme for the final project will be as follows:

10%	Progress Report (due on March 4$^{\text{th}}$ 2026, 3:30pm)
40%	Final Project Report (due on April 29$^{\text{th}}$ 2026, 3:30pm)
30%	Final Project Computer Code (due on April 29$^{\text{th}}$ 2026, 3:30pm)
20%	Presentation (on May 11$^{\text{th}}$ 2026, 3:30-5:30pm)

AI Policy

Generative Artificial Intelligence (AI) and Large Language Models (LLMs) are widely available and powerful tools. These tools can be used effectively in scientific research and learning.

There are several challenges to be aware when using these tools (see e.g. `https://grad.uw.edu/advice/effective-and-responsibl` for a more detailed overview):

- They can summarize material, but they are not always accurate or unbiased. The quality of the output depends on the algorithmic approach, the quality of the training data, and the user's understanding of the tools' limitations and biases as they write queries. Though the content generated may sound very plausible, it may be inaccurate such as including non-existent publications or incorrect citations of publications.
- People are prone to biases in their work, and AI can pick up those biases from the training data and even amplify them or introduce its own.

In research, AI can be a valuable tool for assistance but is not an accountable entity for the research outcomes since the ultimate responsibility of research lies with the human.

In this course, and in learning how to code, you are *not* strictly forbidden to use AI. These tools will be useful to you in your future careers. Use is allowed for debugging explanations and conceptual review, and not allowed to generate full solution code.

However, to facilitate your learning, you will have to use AI and LLMs as a tool, not as a substitute for thinking. Note that recent studies have shown that using LLMs can actually increase development time of code (see https://arxiv.org/pdf/2507.09089), but of course this is a subject of on-going research.

So here's some advice for using AI/LLMs in solving computational problems in this course:

- Do not use AI/LLMs to solve the assignments directly. As previously mentioned in this chapter, programming is an art, and you have to get your hands dirty to become proficient in it. In this course, I suggest that you use AI/LLMs as a sort of last resort.
- When you begin working on your assignment take the following route:
  1. Think about the necessary steps to solve the problem. What is the algorithm that you need to use? Is there some code in the book that you can already rely on? If so, try and understand how it works and use it as a starting point.
  2. Write your reasoning in comments in the code directly (using "“"“.
  3. Let's assume that you have most of your program written down, but now you want to add something new to it. Before using an LLM, use a search engine to find, e.g. a manual for the code. These contain descriptions of how to use the functionality, and very often they contain concrete examples. Copy an example that you understand, and use it as a basis.
  4. If the example does not work as intended, or there is an error, use a search engine to search for the error.
  5. If the above fails, ask an LLM to give you information on the error and how you may solve the particular issue.
  6. If AI suggested something, you must validate it via: reading official docs, writing a minimal reproducible example, adding 1-2 unit tests, and checking edge cases.

To ensure the above points, you will need to add a disclosure at the start of each assignment. Some examples are:

- AI use statement: I used the AI tool <...> to understand what "“np.logspace"“ does.
- AI use statement: I used the AI tool <...> to debug a "“for"“ loop that kept giving me an error.

Even if you did not use AI, you will still need to add an AI statement:

- AI use statement: None

The use of an AI tool without acknowledgement is cheating and constitutes a violation of the KSU Code of Academic Integrity.

Course Dos and Don'ts

Please review these important points that will help you throughout the rest of your college career, and in your future careers.

- Regular attendance is essential for success in this class. If you miss a class, it is your responsibility to get the notes for missed lectures from another student. And please be on time!
- Occasionally, it may be necessary to make corrections, updates or changes to this syllabus. Corrections or changes to the syllabus will be announced on D2L and in class: you are expected to check D2L for announcements regularly (i.e. at least once or twice a day.)
- Cellular telephones, pagers, and similar devices must be turned off or placed in silent mode during lectures. Use of cell phones should be restricted to emergencies.
- In class, please avoid conversations and other disruptions that may distract other students during the lecture. If you have questions or comments, direct them to me.

- Rude and disrespectful student behavior will not be tolerated and administrative actions will be taken.
- Deadlines are deadlines for a reason. As a college student, you must plan accordingly and use your time wisely. In the "real world" you are expected to submit work on time to your boss so that you keep your job. I expect the same.
- If you have asked for an extension on your work and do not meet the guidelines for getting an extension, and are told "no", do not continue to email. No means no, and this is grounds for a referral to student conduct.
- Do not tell your professors or employers how to do their jobs. While you may not like your professor or employer, remember that they have more experience in and knowledge about the field than you. They are also your means for networking and finding gainful employment.
- Remember that your professional aptitude not only reflects on you as a student and employee, but as a person in general. Please be sure you understand these guidelines, and if you have any questions about appropriate communication or college-level problem-solving skills, let me know.

Withdrawal Policy

Students are solely responsible for managing their enrollment status in a class.

Non-attendance does not constitute a withdrawal.

The last day to withdraw without academic penalty is Friday, April 3rd 2026, 11:45 p.m..

Additional information on the withdrawal policy can be found at: `http://catalog.kennesaw.edu/content.php?catoid=51&navoid=3701#withdrawalfromclasses`.

The Academic Standing Appeal policy is explained at: `https://appeals.kennesaw.edu/withdrawal_appeal.php`.

Academic Integrity

Every KSU student is responsible for upholding the provisions of the Student Code of Conduct, as published in the Undergraduate and Graduate Catalogs. Section 5c of the Student Code of Conduct addresses the university's policy on academic honesty, including provisions regarding plagiarism and cheating, unauthorized access to university materials, misrepresentation/falsification of university records or academic work, malicious removal, retention, or destruction of library materials, malicious/intentional misuse of computer facilities and/or services, and misuse of student identification cards. Incidents of alleged academic misconduct will be handled through the established procedures of the Department of Student Conduct and Academic Integrity (SCAI), which includes either an "informal" resolution by a faculty member, resulting in a grade adjustment, or a formal hearing procedure, which may subject a student to the Code of Conduct's minimum one semester suspension requirement.

All students are responsible for knowing the information, policies and procedures outlined in the Kennesaw State University Codes of Conduct. The Code is available online at `http://scai.kennesaw.edu/`.

Accommodations for Students with Disabilities

Students with qualifying disabilities under the Americans with Disabilities Act (ADA) and/or Section 504 of the Rehabilitation Act who require "reasonable accommodation(s)" to complete the course may request those from Office of Student Disability Services. Students requiring such accommodations are required to work with the University's Office of Student Disability Services rather than engaging in this discussion with individual faculty members or academic departments. If, after reviewing the course syllabus, a student anticipates or should have anticipated a need for accommodation, he or she must submit documentation requesting an accommodation and permitting time for a determination prior to submitting assignments or taking course quizzes or exams. Students may not request retroactive accommodation for needs that were or should have been foreseeable. Students should contact the office as soon as possible in the term for which they are seeking accommodations. Student Disability Services is located in the Carmichael Student Center in Suite 267 on the Kennesaw campus or Building A in Suite 160G on the Marietta campus. Please visit the Student Disability Services (SDS) website for more information, or call the office at 470-578-2666 (Kennesaw campus) or 470-578-9111 (Marietta campus).

Protecting Students' Privacy (FERPA)

Students have certain rights to privacy. These rights are mandated by federal policy. The Student Handbook contains information regarding Rights Pertaining to Student Records, and FERPA specific details are available on the Registrar's website.

A key requirement of the formal evaluation process is the protection of individual privacy rights concerning educational grading. The University's online learning system and email system is designed to prevent unauthorized individuals from gaining access to sensitive information or information protected by federal or state law. Consequently, faculty and students are

strongly encouraged to only communicate regarding course matters through the University's designated technology learning system.

Information should not be made public in any way in which a student's grades, social security number, or other personal information may be identified. Grade information may be shared with members of the KSU community who also have a legitimate educational interest in student success (e.g. academic advisors or members of the Behavioral Response Team). Faculty may be asked to provide early alert information if there is a concern that a student is at risk, academically or otherwise.

Campus Sexual Misconduct Policy

In accordance with federal and state law including, Title IX of the Education Amendments of 1972 ("Title IX") and Title VII of the Civil Rights Act of 1964 (Title VII), the University System of Georgia (USG), including Kennesaw State University, prohibits discrimination on the basis of sex in any of its education programs or activities or in employment. The USG is committed to ensuring the highest ethical conduct of the members of its community by promoting a safe learning and working environment. To that end, Kennesaw State University follows USG Board of Regents Policy Manual, Section 6.7. See `https://equity.kennesaw.edu/titleix/title-ix.php`.

For information about how to report sexual misconduct or how to obtain assistance, please go the following page: `https://scai.kennesaw.edu/procedures/sexual-misconduct.php`.

Netiquette: Communication Courtesy

All members of the class are expected to follow rules of common courtesy in all email messages, threaded discussions and chats.

Academic Feedback

Institutional Chief Academic Officers will encourage faculty to clarify for students, at the beginning of each course, the basis on which grades will be determined and to provide timely academic feedback as the course progresses (BOR Academic and Student handbook policy 2.18).

Other Policies

See the Student Handbook (`http://catalog.kennesaw.edu/`) for other policies and information.

KSU SMART Center

If you require tutoring assistance, the Science and Math Academic Resource and Tutoring (SMART) Center at KSU provides tutoring for all current KSU students in Math, Science, Engineering, Humanities, and Social Science courses. See `https://academicaffairs.kennesaw.edu/smart/index.php` for further details.

Course Delivery

KSU may shift the method of course delivery at any time during the semester in compliance with University System of Georgia health and safety guidelines. In this case, alternate teaching modalities that may be adopted include hyflex, hybrid, synchronous online, or asynchronous online instruction.

Copyright Law

It is the responsibility of KSU faculty and students to respect the rights of copyright holders and complying with copyright law. The University System of Georgia recognizes that the exclusive rights of copyright holders are balanced by limitations on those rights under federal copyright law, including the right to make a fair use of copyrighted materials and the right to perform or display works in the course of face-to-face teaching activities.

The University System of Georgia facilitates compliance with copyright law and, where appropriate, the exercise in good faith of full fair use rights by faculty and staff in teaching, research, and service activities. The University System of Georgia ensure compliance with copyright law in the following ways.

1. The USG informs and educates students, faculty, and staff about copyright law, including the limited exclusive rights of copyright holders as set forth in 17 U.S.C. § 106, the application of the four fair use factors in 17 U.S.C. § 107, and other copyright exceptions.
2. The USG develops and makes available tools and resources for faculty and staff to assist in determining copyright status and ownership and determining whether use of a work in a specific situation would be a fair use and, therefore, not an infringement under copyright law;
3. The USG facilitates use of materials currently licensed by the University System of Georgia and provides information on licensing of third-party materials by the University System; and
4. The USG identifies individuals at the University System and member institutions who can counsel faculty and staff regarding application of copyright law.

Inclement Weather Policy

During the course of the year, Kennesaw State University may decide to close campus or operate on a delayed schedule in cases of inclement weather.

The University will announce campus closures and delayed schedules in several ways. The cell phone number on file with the university will automatically receive KSU Alerts, so make sure your information in OwlExpress is accurate at all times. An email will also be sent to your university account.

In addition, announcements will be made by a notice on the Kennesaw State University home pagehttps://www.kennesaw.edu.

Face Coverings and Illness

Based on guidance from the University System of Georgia (USG), masks are encouraged based on individual preference and assessment of personal risk.

If you are feeling ill, please stay home and contact your health professional. In addition, please email your instructor to say you are missing class due to illness.

Class Schedule (Tentative)

Week 1	Jan 12	*Chapter 1:* Introduction to the course, programming, and programming in Python.
	Jan 14	Chapter 1.
Week 2	Jan 19	HOLIDAY
	Jan 21	Chapter 1.
Week 3	Jan 26	Chapter 1.
	Jan 28	*Chapter 2:* Computer number representations, machine precision, types of errors, subtractive cancellations and error assessment.
Week 4	Feb 2	*Chapter 3: Randomness and Random Walks.* Random sequences, Random number generation, Random walks.
	Feb 4	Chapter 3.
Week 5	Feb 9	*Chapter 4: Differentiation and Integration.* Differentiation algorithms, Integration algorithms.
	Feb 11	Chapter 4.
Week 6	Feb 16	Chapter 4.
	Feb 18	Chapter 4.
Week 7	Feb 23	*Chapter 5: Monte Carlo Methods.* Monte Carlo Simulations, Monte Carlo Integration.
	Feb 25	Chapter 5.
Week 8	Mar 2	*Chapter 6: Matrix Computing, Trial-and-Error Searching and Data Fitting.* Linear equations, Bisection, Newton-Raphson Method, Least-Squares Fitting.
	Mar 4	Chapter 6. PROJECT PROGRESS REPORT DUE
Week 9	Mar 9	BREAK
	Mar 11	BREAK
Week 10	Mar 16	Chapter 6.
	Mar 18	Chapter 6.
Week 11	Mar 23	*Chapter 7: Ordinary Differential Equations* Euler's Method, Euler-Cromer Method, Runge-Kutta Methods, Chaos.
	Mar 25	Chapter 7.
Week 12	Mar 30	Chapter 7.
	Apr 1	Chapter 7.
Week 13	Apr 6	

	Apr 8	Chapter 7.
Week 14	Apr 13	*Chapter 8: An Introduction to Nonlinear Dynamics and Chaos.* Flows on the Line, Linear Stability Analysis, Two-Dimensional Systems, Fixed Points and Linearization, The Lorenz Equations
	Apr 15	Chapter 8.
Week 15	Apr 20	*Chapter 9.* Boundary Value and Eigenvalue Problems
	Apr 22	*Chapter 10:* Partial Differential Equations
Week 16	Apr 27	TBC
	Apr 29	TBC – FINAL PROJECT REPORT AND FINAL COMPUTER CODE DUE
Week 17	May 4	TBC – LAST DAY OF CLASSES
Week 18	May 11 (3:30 – 5:30 PM)	FINAL PROJECT PRESENTATIONS