

PHYS 510: Computational Physics I

Fall 2022

Lecture: Mondays 4:30 pm – 7:10 pm
Classroom: Online instruction
Instructor: Professor Chi Yang
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Email: cyang@gmu.edu
Office Phone: 703-993-4077
Office Hours: Tuesdays 2:30pm – 4:00pm, and by appointment

Required Textbook

Michael T. Heath, “Scientific Computing – An Introductory Survey,” Second Edition, McGraw-Hill, 2002. (Revised Second Edition, the Society for Industrial and Applied Mathematics (SIAM), 2018). The textbook can be downloaded from the following link using GMU VPN connection:

<https://epubs.siam.org/doi/book/10.1137/1.9781611975581>

Course Description

Scientific computing is playing an increasingly important role in almost all fields of science and engineering. This course serves as a foundation class for scientific computing and is designed to train you if you are pursuing a career in computational sciences (physics) and engineering. This course presents a broad overview of numerical methods for solving all the major problems in scientific computing, including linear and nonlinear equations, least squares, eigenvalues, optimization, interpolation, integration and differentiation, ordinary differential equations, and fast Fourier transform. Students will learn how computational methods are constructed, and how they are used to solve problems arising from the sciences and engineering.

Prerequisites

Sufficient recall of undergraduate linear algebra, differential equations and computer literacy including familiarity with MATLAB. The homework and project are expected to be done with MATLAB.

Lecture Notes

Lecture notes provided by the author of the required textbook can be downloaded from the textbook website:

<http://heath.cs.illinois.edu/scicomp/index.html>

About the Class

Lectures will be given online by sharing lecture slides and Matlab screens. The material you need for this class will be on the Blackboard. Lecture notes and homework assignments will be posted on the Blackboard. Announcement/email will be used to communicate with students after each class, which will

include the summary of the materials covered in the class, homework instructions, and the topics to be covered in the next class.

Course Schedule

The following table contains the schedule for the course. The course will cover Chapters 1-10 and 12 of required textbook, as well as some additional material.

Week	Date	Contents
1	08/22	Introduction, Errors & Uncertainties in Computations
2	08/29	Systems of Linear Equations
3	09/05	Labor Day, no class.
4	09/12	Linear Least Squares
5	09/19	Eigenvalue Problems
6	09/26	Nonlinear Equations
7	10/03	Interpolation
8	10/11	Numerical Integration and Differentiation (Class meet on Tuesday due to Columbus Day recess)
9	10/17	Optimization
10	10/24	Initial Value Problems for ODEs
11	10/31	Initial Value Problems for ODEs
12	11/07	Boundary Value Problems for ODEs
13	11/14	Fast Fourier Transform
14	11/21	Review
15	11/28	Project Presentations
16	12/07-14	Final Exam Period

Grading

Students will complete weekly homework assignments, consisting of exercises from the textbook and computational projects to be completed in MATLAB. There will be a final exam.

Homework:	50%
Project:	30%
Final Exam:	20%

MATLAB Computing Environment

The software package MATLAB will be used for analysis and presentation of data. MATLAB is a computing environment with programming capability, good graphics, and powerful library functions. George Mason University offers temporary free access to MATLAB. You can find GMU MATLAB license information from the following link:

<https://its.gmu.edu/service/software-listing-matlab/>

You can also access MATLAB through Mason Citrix Virtual Lab (<https://its.gmu.edu/service/citrix-virtual-lab/>). Alternatively, a PC or Macintosh version can be purchased in the bookstore.

MATLAB Tutorial Links

The following are some of MATLAB documents and tutorial links:

http://www.mathworks.com/academia/student_version/

<https://www.mathworks.com/help/matlab/>

<https://matlabacademy.mathworks.com/>

- MATLAB Onramp Get started quickly with the basics of MATLAB.

Academic Integrity

It is expected that students adhere to the George Mason University Honor Code as it relates to integrity regarding coursework and grades. The Honor Code reads as follows: “To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members of the George Mason University Community and with the desire for greater academic and personal achievement, we, the student members of the university community, have set forth this Honor Code: Student Members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work.” More information about the Honor Code, including definitions of cheating, lying, and plagiarism, can be found on the Office of Academic Integrity website, <http://oai.gmu.edu>.

References

- Paul L. DeVries and Javier E. Hasbun, “A First Course in Computational Physics,” 2nd Edition. Jones & Bartlett Learning, 2010.
- Steven C. Chapra, “Applied Numerical Methods with MATLAB for Engineers and Scientists,” 4th Edition, McGraw Hill, 2018.
- Amos Gilat and Vish Subramaniam, “Numerical Methods for Engineers and Scientists: An Introduction with Applications Using MATLAB,” J. Wiley, 2008.
- Amos Gilat , “MATLAB – An Introduction with Applications,” J. Wiley, 2008.
- Timothy Sauer, “Numerical Analysis,” 3rd Edition, Pearson 2018 (Text Website: Useful Matlab files are available at https://media.pearsoncmg.com/aw/aw_sauer_num_analysis_3/code/main.html)