Spring 2025
Foundations of Computational Mathematics 2
MAD 5404-0001

Details

- Time: 10:40 – 11:30, MWF
- Room: 232 LOV
- Instructor: K. A. Gallivan
- Office: 421 LOV
- Email: kgallivan@fsu.edu
- Homepage: http://www.math.fsu.edu/~gallivan
- Office Hours: 8:00 – 10:00 MWF and by appointment
- For remote contact during office hours or other arranged meetings, use the Zoom meeting room link on my homepage.
- Teaching Assistant:
  - Yue Shen
  - Office: 403A MCH
  - Email: yshen6@fsu.edu
  - Office Hours: 14:00 - 16:00 Monday or by appointment
- Prerequisites: programming proficiency, Foundations of Computational Mathematics 1 or consent of instructor.
- Text: No textbook is required. Recommendations for reference texts will be given during the class.
- Class Webpages:
  1. The class has a Canvas webpage that will be used for class emails, posting and submitting homework assignments and some class documents such as the syllabus.
  2. The main class page is accessible from my departmental homepage www.math.fsu.edu/~gallivan by following the Teaching button on the top menu. Class notes, homework, programming assignments and announcements will be posted on the class website.
  3. You are expected to consult these websites in a timely and regular manner.
  4. The user and password information for portions of the class website linked to my departmental homepage will be sent to those registered in an Canvas class email/announcement. If you do not receive this information before the first class contact the instructor. Note that some times Canvas emails are viewed as spam so be sure to check for such an action.

5. Other books, papers, and software resources will be cited, posted or linked in the class notes, the homework, and on the class website linked to my departmental homepage. These are background material and suggested references. You will be expected to read a small subset identified in the lectures. The others are for your graduate academic development.

- Lectures will be in-person unless otherwise stated.
- Class Participation Policy: Participation in class by asking questions and responding to questions posed by the instructor is expected and strongly encouraged. The diverse background of the students implies several students will be unfamiliar with each topic and clarification by such questions and responses is vital to understanding. Students are expected to be prepared for class lectures and for any office visits. Students are encouraged to prepare carefully for class by reading relevant posted notes.
- Meetings with the instructor and TA are also expected and encouraged especially for discussions that are too lengthy for class. It is particularly important to have such meetings early and often for material about which you are uncertain. These will be held in person or on Zoom during office hours or at other agreed upon times. Group meetings are encouraged.
- Grades: Programs 20%, Exam 1 20% , Exam 2 20% and comprehensive Final 40 %.
- The Final Exam will be held at the appointed time on the FSU Final Exam schedule.
- Exams 1 and 2 will be given in the evening or at another mutually agreed upon time in the regular class room.
- Makeup exams require prior approval or, if not possible, standard university approved documentation of an excused absence.
- Electronic devices may be used to access class notes and related material during lectures. **Other uses of cell phones and similar devices are often disruptive to the lecture and are not permitted.**
- Homework: Homework will consist of programming assignments, written problems, and in-class quizes. The programming assignments will be graded. Graded written problems related to class material and/or to the programming task will occasionally be assigned along with the programming assignment. In addition, the graded written problems may be given in class as quizes on relevant slide sets or other assigned readings. All assigned homework is due at the time specified in the assignment. Solutions to graded assignments will be accepted after the due date only with prior approval or with documentation of an excused absence.

  You will also be given sets of written Study Problems. These exercises are to assist you in understanding the material and preparing for the exams. They do not contribute to your grade and you are not required to submit solutions. It is strongly recommended however that you do all assigned problems and consult the detailed solutions that will be provided a short time after assignment is made.
- It is preferred that programming assignments be completed in a compiled and typed language, e.g., Fortran, C, C++, Java. Other languages/environments Julia, MATLAB, Python and

scripting languages are acceptable also but there will be restrictions on what constructs can be used in your code implementing the algorithms. The use of environments such as MATLAB to control or support the testing and evaluation of your code is encouraged. Their graphical and other display tools are very useful in organizing the experimental results for your Program Report.

- All solutions for programming assignments must be submitted in the form described in "A Note on Reporting Programming Assignment Results" available on the class website.

- Plagiarism is a violation of the university honor code. With respect to the solutions of programming problems in the homework, it is not acceptable to engage in plagiarism. You may discuss the programming problems with each other **but any significant discussion must cited, i.e., it should be treated like the citation of any outside material used in your solutions. Such a citation must include names and the substance of the discussion.** All students must design and implement their own code. All students must write individually the description of the code, its complexity, the experimental design, the empirical results and the interpretation of the results. **No student should provide any portion of their code to any other student in class.** If you find a library code (not written by a student in class) that performs a portion of the task **it must be cited – including the specific source of the code and its function.** You are still responsible for describing correctly its implementation and time/space complexity in your solutions. Credit for the program will be prorated based on the amount of functionality performed by a cited library code relative to the functionality required to solve the assigned problem. **Citations when writing solutions to the analytical problems included in a graded homework or programming assignment and applicable penalties for plagiarism are covered by these same policies.** The first offense of submitting a solution without the appropriate citation will result in 0 credit for the programming/experimental portion of the assignment or the particular solution to the analytical problem. Multiple offenses may result in referral to the university for discipline according to university regulations.

- The uncited use of any tool such as ChatGPT or other generative AI is plagiarism and will be treated as such. The cited use of such tools will be treated like the use of a library as discussed in the previous item.

- University Attendance Policy: Excused absences include documented illness, deaths in the family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. These absences will be accommodated in a way that does not arbitrarily penalize students who have a valid excuse. Consideration will also be given to students whose dependent children experience serious illness.

- Class Attendance Policy: With the exception of the first class meeting, attendance is not required but **it is strongly advised**. A student absent from class bears the full responsibility for all subject matter and procedural information discussed in class.

Content

This course covers mathematics and methods that form the basis of the techniques of scientific computation. This semester is the second of two meant to prepare beginning graduate students for graduate research work and advanced courses in numerical methods and to be able to solve basic problems on a computer. Although many of the methods have existed for a long time (consider the origins of Newton's Method; and Gauss Quadrature), today these methods are typically implemented on computers. When someone talks about solving science or engineering problems on computers, such as automobile or aircraft design, weather prediction or financial modeling, they are referring to programs that approximate and solve the equations that model the system under study.

In the two semesters we will study the basic methods for solving equations, certain optimization problems, approximating functions and using the approximations to evaluate key components of computational mathematical problems and applications. solving those approximations.

The second course assumes knowledge of the topics covered in the first course. The emphasis is on approximation theory and techniques, their application to quadrature and the integration of differential equations, the effects of finite precision arithmetic and the stability of the numerical algorithms considered. Below are the expected topics and sections to be covered. (Acutal coverage will depend on time constraints.)

Topics:

1. Floating Point Arithmetic, Conditioning, and Numerical Stability
2. Interpolation
    - Lagrange and Newton Interpolation, Complexity, and Interpolation error
    - Hermite Interpolation
    - Piecewise Interpolation and Splines
3. Orthogonal Polynomials and Approximation Theory
    - Minimax approximation and Chebyshev Economization
    - Fourier, Legendre, Chebyshev Series
    - Least Squares approximation – continuous and discrete
    - Trigonometric Interpolation and the Discrete Fourier Transform
4. Numerical Integration and Differentiation
    - Interpolatory quadrature and Newton-Cotes, composite rules
    - Adaptive quadrature
    - Gauss Quadrature and Discrete Fourier Tranforms
    - Fast Fourier Transforms and their interpretation in terms of topics covered earlier
    - Approximation of derivatives
5. Ordinary Differential Equations
    - General numerical approach

- Multistep methods and their analysis
- One-step methods (Runge-Kutta) and their analysis

6. (Time Permitting) Numerical Differencing and Partial Differential Equations

Objectives

This class studies the theory and techniques required to analyze, design, implement, and evaluate efficient and robust numerical algorithms. Fundamental problems are used to introduce and completely develop this material. The class covers tools that have been developed to solve problems numerically, generally on a computer. Thus, you will be expected to be able to implement the techniques and to solve problems with them. In addition, you will be expected to know how the methods were derived; how to analyze their robustness and computational efficiency; and when they are and are not appropriate to use.

Syllabus Changes

Except for changes that substantially affect implementation of the evaluation (grading) statement, this syllabus is a guide for the course and is subject to change with advance notice.

Honor Code

The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to " ... be honest and truthful and ... [to] strive for personal and institutional integrity at Florida State University." (Florida State University Academic Honor Policy, found at https://dof.fsu.edu/honorpolicy.htm.)

Americans with Disabilities Act

Students with disabilities needing academic accommodation should during the first week of class:

1. register with and provide documentation to the Student Disability Resource Center;
2. contact the instructor indicating the need for accommodation and what type.

This syllabus and other class materials are available in an alternative format upon request. For more information about services available to FSU students with disabilities, contact the :

Student Disability Resource Center
874 Traditions Way
108 Student Services Building
Tallahassee FL, 32306-4167
644-9566 (voice), 644-8504 (TDD), sdrc@admin.fsu.edu, http://www.disabilitycenter.fsu.edu.