

**Spring 2022**  
**Foundations of Computational Mathematics 2**  
**MAD 5404-0001**

## Details

- Time: 12:00 – 12:50, MWF
- Room: 106 LOV
- Instructor: K. A. Gallivan
- Office: 421 LOV
- Email: [gallivan@math.fsu.edu](mailto:gallivan@math.fsu.edu), [kgallivan@fsu.edu](mailto:kgallivan@fsu.edu)
- Homepage: <http://www.math.fsu.edu/~gallivan>
- Office Hours: 10:00 – 12:00 MW and by appointment. These will be in-person or Zoom as requested. There will be a Zoom meeting active during every office hour session. The ID for the Zoom meeting will be announced via an announcement on the Canvas course page.
- Teaching Assistant:
  - Yue Shen
  - Office: 401 MCH
  - Email: [ys19d@my.fsu.edu](mailto:ys19d@my.fsu.edu)
  - Office Hours: 13:30 - 14:30 Tuesday and Thursday. In-person or Zoom
  - Zoom Link for Office Hours: <https://fsu.zoom.us/j/98789403185>
- Prerequisites: programming proficiency, Foundations of Computational Mathematics 1 or consent of instructor
- Text: A. Quarteroni, R. Sacco, and F. Saleri, Numerical Mathematics, Springer Texts in Applied Mathematics 37, Second Edition.
- Class Webpages:
  1. The class has a Canvas webpage that will be used for class emails, posting and submitting homework assignments, Zoom information about remote meetings and office hours and some class documents such as the syllabus.
  2. The main class page is accessible from my departmental homepage [www.math.fsu.edu/~gallivan](http://www.math.fsu.edu/~gallivan) by following the class link. 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.

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. Simultaneous Zoom sessions for the lectures will be arranged if needed.
- 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 and sections of the textbook.
- 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 on Zoom at agreed upon times. Group meetings are encouraged.
- Grades: Programs 25%, Exam 1 20% , Exam 2 20% and comprehensive Final 35 %.
- 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, typically 18:30 Eastern time, 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 written exercises assigned approximately weekly and programming assignments. The written 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 approximately one week after assignment. The programming assignments will be graded and contribute to your grade. They may include graded written problems related appropriate class material and/or to the programming task. They are due at the time specified in the assignment. Solutions to programming assignments will be accepted after the due date only with prior approval or with documentation of an excused absence.
- All programming assignments must be completed in a compiled and typed language, e.g., Fortran, C, C++, Java. Julia is also acceptable but variable types and data structures are expected to be defined and constructed explicitly. MATLAB and scripting languages are not

acceptable for the code implementing the algorithms used to solve the assignment but they may be used to control or support the testing and evaluation of your code.

- 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.
- 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 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. (Actual coverage will depend on time constraints.)

Topics:

1. Interpolation (Textbook Chapter 8)
  - Lagrange and Newton Interpolation, Complexity, and Interpolation error
  - Hermite Interpolation
  - Piecewise Interpolation and Splines
2. Orthogonal Polynomials and Approximation Theory (Textbook Chapter 10)
  - Minimax approximation and Chebyshev Economization
  - Fourier, Legendre, Chebyshev Series
  - Least Squares approximation – continuous and discrete
  - Trigonometric Interpolation and Discrete Fourier Transforms
3. Numerical Integration and Differentiation (Textbook Chapters 9 and 10)
  - Interpolatory quadrature and Newton-Cotes, composite rules
  - Adaptive quadrature
  - Gauss Quadrature and Discrete Fourier Transforms
  - Fast Fourier Transforms and their interpretation in terms of topics covered
  - Approximation of derivatives
4. Ordinary Differential Equations (Textbook Chapters 11 and 12)
  - General numerical approach
  - Multistep methods and their analysis
  - One-step methods and their analysis
5. (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](mailto:sdrc@admin.fsu.edu), <http://www.disabilitycenter.fsu.edu>.

## Public Health Protocols

In our classroom, it is expected that everyone will wear a proper, well-fitting mask. As our President has informed the university community, FSU expects everyone on campus to use face-coverings. In regions where virus rates are high, the CDC recommends that even vaccinated individuals wear masks in public indoor spaces, like classrooms, especially where social distancing is not possible. Florida infection and hospitalization rates are greater now than they were at the height of the 2020 surge due to the Delta variant, a more infectious and easily transmissible version of the COVID-19 virus. The best way to protect against serious illness is to be fully vaccinated, but not everyone among us can be. Because the Delta variant can infect even vaccinated individuals and can be spread by them to others, it poses a special threat to members of the community with underlying health conditions and children at home who are too young for vaccination.

For these reasons, FSU expects each member of the community to comply with the public health protocols our President set forth on August 9, 2021, including (1) wearing masks in public indoor

spaces, (2) getting fully vaccinated, (3) being tested for the virus if you have symptoms, and (4) staying home and away from others if you are sick. Please remember that you should NOT attend class in person if you have tested positive for COVID-19 or are quarantining after exposure. Finally, please bear in mind that the COVID-19 situation is fast-moving, and that university guidance on the issue may change at any time.

## **HB223 Recording**

In this class, consistent with state law and university policy, students are permitted to make recordings of class lectures for personal use only. As noted, sharing, posting, or publishing classroom recordings may subject you to honor code violations and legal penalties associated with theft of intellectual property and violations of other state law. Moreover, students and educators have expressed concern that recording classroom activities may negatively impact the learning experience for others, especially in classes that involve questions, discussion, or participation. To protect a learning environment in which everyone feels free to experiment with ideas, we ask you refrain from recording in ways that could make others feel reluctant to ask questions, explore new ideas, or otherwise participate in class. Students must monitor their recording so that they do not include participation by other students without permission. Students with disabilities will continue to have appropriate accommodations for recordings as established by the Office of Accessibility Services.