Fall 2020
Foundations of Computational Mathematics 1
MAD 5403

Details

- Time and Place : MWF 10:10 – 11:00, On-line Zoom Lectures
- Instructor: K. A. Gallivan (5-0306, 318 Love Building, gallivan@math.fsu.edu)
- Homepage: www.math.fsu.edu/~gallivan
- Office Hours: by appointment (arrange time via email)
- Programming Course/Recitation Session
  - Time: M 18:45 – 20:00, On-line Zoom Lectures
  - Webpage: www.math.fsu.edu/~`jgonzale/acm-computing-seminar`
- Teaching Assistant:
  - Joshua Gonzalez (jwg18c@my.fsu.edu)
  - Homepage: www.math.fsu.edu/~`jgonzale`
  - Office Hours: 13:00 – 14:30 Tuesday and Thursday
  - Email: jwg18c@my.fsu.edu
  - Phone: 713-392-5589
- Prerequisites: programming proficiency, familiarity with finite dimensional vector spaces and basic linear algebra or consent of instructor
- Text: A. Quarteroni, R. Sacco, and F. Saleri, Numerical Mathematics, Springer Texts in Applied Mathematics 37, Second Edition.
- Class Information: Class notes, homework, programming assignments and announcements will be posted on the class website (follow the teaching link from www.math.fsu.edu/~gallivan). You are expected to consult the website in a timely and regular manner. The user and password information for portions of the class website will be sent to those registered in an email/Canvas announcement. If you do not receive this information before the first class contact the instructor. Canvas will be used to post zoom information about the lectures, to join the zoom lectures and for class email announcements.
- Other books, papers, and software resources will be cited, posted or linked in the class notes, the homework, and on the class website. 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 given on zoom. The meeting information will be posted weekly on the class Canvas page. Initial zoom information will be sent in email/Canvas announcement to those registered.

- Students outside the USA in time zones that are not conducive to attending the real-time zoom lectures at 10:10 Eastern Time should contact the instructor and alternative arrangements will be made.

- 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. They will be proctored over zoom. Students outside the USA in time zones that are not conducive to attending the real-time zoom exams should contact the instructor and alternative arrangements will be made.

- 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 mathematical, engineering and scientific computation. It is the first course of a sequence 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 of the course sequence, we study 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. These include basic methods for solving algebraic and differential equations, optimizing cost functions, approximating data/functions and using the approximations to evaluate key components of computational mathematical problems and applications.

The emphasis of the first course 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 in the text. (Acutal coverage will depend on time constraints.)

Topics:

1. Floating point representation and arithmetic
2. Conditioning and stability of numerical methods
3. Interpolation (Textbook Chapter 8)
    - Lagrange and Newton Interpolation, Complexity, and Interpolation error
    - Hermite Interpolation
    - Piecewise Interpolation and Splines
4. 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
5. Numerical Integration and Differentiation (Textbook Chapters 9 and 10)
    - Interpolatory quadrature and Newton-Cotes, composite rules
    - Adaptive quadrature
    - Gauss Quadrature
    - Approximation of derivatives
6. Ordinary Differential Equations (Textbook Chapters 11 and 12)
    - General numerical approach
    - Multistep methods and their analysis
    - One-step methods and their analysis

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 Universitys 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.