

Numerical Analysis II

Math 447/CDS 410, Sander, Spring, 2021

Lecturer: Dr. E. Sander (esander@gmu.edu)

Textbook: T. Sauer, *Numerical Analysis*, Pearson, 3rd Edition. Useful files are available from the [textbook website](#)

Class Time occurs on Tuesdays and Thursdays 9-10:15am on Zoom. This course is mainly in the form of active learning sessions in which students work in groups on projects, with lectures as needed. This is a required part of the course.

Office hours: TBA after collecting preferences.

Blackboard: Blackboard is the home for all class activities. Any updates, assignments, etc. will appear on Blackboard.

Matlab: The software package Matlab will be required for analysis and presentation of data. Matlab is a computing environment with programming capability, good graphics, and powerful library functions. The university negotiated a new site license that gives much better access than ever before. To get access to Matlab, please go to the [GMU Matlab Access Website](#).

If Matlab is new for you, I strongly suggest you sign up for a [GMU Math Scientific Computing Workshop](#) introducing Matlab. These courses are offered for no charge to all GMU Math students and are a handy way to get up and running quickly. Matlab tutorials can be found readily on the internet. There is a pretty good one at Mathworks, and another one in the textbook's appendix.

Course description: The course will focus on advanced numerical methods, connecting ideas from the areas of computational mathematics, operations research and computer science, and using modeling and simulation to solve problems from physics, biology and engineering. From the methodological point of view, students will learn methods for the solution of algebraic equations, differential equations, audio and image processing, and optimization. Mathematical analysis from the textbook will be supplemented with articles from relevant application areas in science and engineering. Methods will be studied in the context of solving representative scientific and engineering problems. Here is a tentative list of project topics.

- Differential equations
 - Euler Bernoulli beam
 - Tacoma Narrows bridge
 - Lorenz attractor and chaos; Orbital mechanics
 - Buckling of coronary stents; Heat flow on a cooling fin
 - Epidemic models; predicting spread of COVID-19
- Optimization and least squares
 - Robotics
 - Global Positioning System
 - Protein-folding and conformation; Eigenvalues and Google
- Signal processing
 - Fourier analysis and interpolation
 - Noise reduction and filtering
 - Audio compression, AAC and MP3 etc.
 - Discrete cosine transform and JPEG standard; Compression of images

Projects: For each project, students are required to learn mathematical techniques relevant to the project solution, and to acquire basic competency in the application area of science or engineering through assigned readings. Secondary goals for the course are working proficiency in software packages, including Matlab. Student participation will be done on the basis of group projects. Each group will consist of 2-3 students who will collaborate on all aspects of the problem solution. Typical projects will consist of four parts:

- Theoretical study and readings from the application area, identification of the underlying scientific and engineering principles of the problem
- Mathematical formulation of a solution path using computational methods learned in class
- Code creation in Matlab, following established principles from computer science and its application to computationally solve the problem
- Description of results, using text and graphics in a creative way. The description should be easily understandable by peers in the class.

Emphasis will be placed on clear communication of results through text and graphics. Finished write-ups for the projects will be submitted by the student working groups in HTML documents as part of oral class presentations at the completion of each project.

Grading: Grades will be based on projects, which include: attendance and participation in the collaborative in-class active learning sessions, as well as write-ups, and presentations.

Honor Code: The University Honor Code is to be followed. Sharing information of any kind about exams, theoretical homework, or Matlab assignments will result in a grade of zero. Any violations will be submitted to the University Honor Committee.

Office of Disability Services: All academic accommodations must be arranged through the ODS. Please speak to me if this applies to you.
