

Math 458, Numerical Methods, Fall 2022

Exterior Course Website: <http://www.stevenheilman.org/~heilman/458f22.html>

Prerequisite: 1 from (MATH 225 or MATH 245)

Course Content: Rounding errors in digital computation; solution of linear algebraic systems; Newton's method for nonlinear systems; matrix eigenvalues; polynomial approximation; numerical integration; numerical solution of ordinary differential equations.

Lecture Meeting Time/Location: Mondays, Wednesdays, and Fridays, 12PM-1250PM CPA 156

Instructor: Steven Heilman, stevenmheilman@gmail.com

Office Hours: Tuesdays, 2PM-4PM, on zoom [link posted on blackboard]

TA: Chuhuan Huang, chuhuanh@usc.edu

TA Office Hours: Kap 263 (the [Math Center](#))

Discussion Session Meeting Time/Location:

- 39680, Tuesdays and Thursdays, 10AM-1050AM, CPA 205
- 39681, Tuesdays and Thursdays, 11AM-1150AM, CPA 151

Textbook: There is no required textbook. The first course resource is a freely available book: Numerical Computing with Matlab by Cleve Moler (the inventor of Matlab), available online at: <https://www.mathworks.com/moler/chapters.html>. Some other textbooks that we will follow are: Numerical Analysis: Mathematics of Scientific Computing, Kincaid and Cheney
Numerical Mathematics and Computing, Cheney and Kincaid
Matrix Computations, Golub and van Loan

Software: Matlab is freely available as a download for USC students. You should download and install this software on your personal computer. Instructions for downloading and installing this software can be found here: <https://software.usc.edu/matlab/>. If you have not done so already, you should create a Mathworks account, associated to your USC email address (<https://www.mathworks.com/login>). Once you have installed Matlab, you should then install the NCM package (available at the bottom of this page: <https://www.mathworks.com/moler/chapters.html>). Once the NCM package is installed, you can access some of its features by just typing `ncmgui` in the Matlab command line.

Exam 1: Wednesday, September 28, 12PM-1250PM, CPA 156

Exam 2: Friday, November 4, 12PM-1250PM, CPA 156

Final Exam: TBD, Location TBD

Extra Credit Project: There will be an optional extra credit project, where students will create a computer program that plays a game (such as connect four or chess) in Matlab, and the top performers of a tournament will be awarded around 1% to 3% extra credit points for the course. The project would be due in the last week of class, and the "finals" of the tournament would occur in class during this time as well. Students can work in groups of up to three, and if a team wins some amount of extra credit, that credit will be split evenly among the participants. Also, copying any code from any online resource will result in automatic disqualification. Since I will be running

the finals on a Microsoft Surface Tablet (without much memory or processing power), you are not allowed to use any functions from any extra Matlab toolboxes, other than those functions in the most basic installation of Matlab. More details are TBD.

Email Policy:

- My email address for this course is stevenmheilman@gmail.com.
- It is your responsibility to make sure you are receiving emails from stevenmheilman@gmail.com, and they are not being sent to your spam folder.
- Do NOT email me with questions that can be answered from this document.

Exam Procedures: Students must bring their USCID cards to the midterms and to the final exam. Phones must be turned off. Cheating on an exam results in a score of zero on that exam. Exams can be regraded at most 15 days after the date of the exam. This policy extends to homeworks as well. All students are expected to be familiar with the [USC Student Conduct Code](#). (See also [here](#).)

Student Conduct: Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the Office of Equity and Diversity <http://equity.usc.edu/> or to the Department of Public Safety <http://capsnet.usc.edu/departement/departement-public-safety/online-forms/contact-us>. This is important for the safety whole USC community. Another member of the university community - such as a friend, classmate, advisor, or faculty member - can help initiate the report, or can initiate the report on behalf of another person. The Center for Women and Men <http://www.usc.edu/student-affairs/cwm/> provides 24/7 confidential support, and the sexual assault resource center webpage sarc@usc.edu describes reporting options and other resources.

Accessibility Services: If you are registered with accessibility services, I would be happy to discuss this at the beginning of the course. Any student requesting accommodations based on a disability is required to register with Accessibility Services and Programs (OSAS) each semester. A letter of verification for approved accommodations can be obtained from OSAS. Please be sure the letter is delivered to me as early in the semester as possible. OSAS is located in 301 STU and is open 8:30am-5:00pm, Monday through Friday.

<https://osas.usc.edu>

213-740-0776 (phone)

213-740-6948 (TDD only)

213-740-8216 (fax)

OSASFrontDesk@usc.edu

Other Resources: [An introduction to mathematical arguments](#)

Homework Policy:

- Homeworks are due roughly every week, at **10AM Thursdays**, i.e. at the beginning of the first discussion session on Thursdays.

- Homeworks are submitted in blackboard, under the "Assignments" tab. You are allowed unlimited submission "attempts" for an assignment, but only the last submission will be graded. To avoid internet issues, I recommend making your first submission of an assignment well in advance of the deadline. (Note that phone tethering can also give you an internet connection to a computer.)
- Homeworks should be submitted as single PDF documents. One way to create a PDF document from paper homework assignments is the freely available [Adode Scan App](#).
- Late homework is not accepted.
- If you still want to turn in late homework, then the number of minutes late, divided by ten, will be deducted from the score. (The time estimate is not guaranteed to be accurate.)
- **Do not submit homework via email.**
- The **two lowest** homework scores will be dropped. This policy is meant to account for illnesses, emergencies, dropped internet connections, etc.
- You may not use the internet to try to find answers to homework problems.
- A random subset of the homework problems will be graded each week. However, it is strongly recommended that you try to complete the entire homework assignment.
- All homework assignments must be **written by you**, i.e. you cannot copy someone else's solution verbatim. However, collaboration on homeworks is allowed and encouraged.
- Homework solutions will be posted a few days after the homework is turned in.

Grading Policy:

- The final course grade is weighted as the larger of the following two schemes:
- Scheme 1: class participation (3%), homework (22%), the first midterm (20%), the second midterm (20%), and the final (35%).
- Scheme 2: class participation (3%), homework (22%), the largest midterm grade (30%), and the final (45%).
- The grade for the semester will be curved. However, I do not "curve down" since anyone who exceeds my expectations in the class by showing A-level performance on the exams and homeworks will receive an A for the class.
- If you cannot attend one of the exams, you must notify me within the first two weeks of the start of the quarter. Later requests for rescheduling will most likely be denied.
- Class participation is not the same as attendance. I will never explicitly take attendance, but I will notice if someone is frequently absent. Things that increase your class participation grade include: asking good questions, paying attention in class, showing up on time or early to class, etc. Things that decrease your class participation grade include: excessive talking or disruptions during class, frequent absences, excessive texting/smartphone usage in class, frequent tardiness, etc.

- You must take the final exam to pass the course.

Tentative Schedule: (This schedule may change slightly during the course.)

Week	Monday	Tuesday	Wednesday	Thursday	Friday
1	Aug 22: Matlab and NCM Toolbox	Aug 23	Aug 24: 2.1, Floating Point Arithmetic	Aug 25: Homework 1 due	Aug 27: 2.2, Loss of Significance
2	Aug 29: 3.1, One Variable Nonlinear Equations	Aug 30	Aug 31: 3.2, Newton's Method	Sep 1: Homework 2 due	Sep 2: 3.2, Newton's Method
3	Sep 5: No class	Sep 6	Sep 7: 4.1, Review of Linear Algebra	Sep 8: Homework 3 due	Sep 9: 4.1, Multiplying Matrices
4	Sep 12: 4.2, Gaussian Elimination, Cholesky Decomposition	Sep 13	Sep 14: 4.4, Matrix Norms, Errors	Sep 15: Homework 4 due	Sep 16: 4.8, Bounding Errors
5	Sep 19: 5.1, Eigenvalues, Power Method	Sep 20	Sep 21: 5.3, QR Decomposition, Least Squares	Sep 22: Homework 5 due	Sep 23: 5.4 SVD, Pseudoinverse
6	Sep 26: 5.4, Dimension Reduction, Random SVD	Sep 27	Sep 28: Exam 1	Sep 29: No homework due	Sep 30: 6.1, Polynomial Interpolation
7	Oct 3: 6.1, Polynomial Interpolation	Oct 4	Oct 5: 6.4, Spline Interpolation	Oct 6: Homework 6 due	Oct 7: 6.4, Spline Interpolation
8	Oct 10: 7.1, Numerical Partial Differentiation	Oct 11	Oct 12: 7.2, Numerical Integration	Oct 13: No class	Oct 14: No class
9	Oct 17: 7.2, Numerical Integration	Oct 17	Oct 19: 7.3, Gaussian Quadrature	Oct 20: Homework 7 due	Oct 21: 7.3, Gaussian Quadrature
10	Oct 24: 8.1, Solving ODEs	Oct 25	Oct 26: 8.1, Solving ODEs	Oct 27: Homework 8 due	Oct 28: 8.3, Runge-Kutta Methods
11	Oct 31: 8.4, Multi-step Methods	Nov 1	Nov 3: 8.7, Boundary-Value Problems	Nov 3: No homework due	Nov 4: Exam 2
12	Nov 7: 8.8, Shooting Methods	Nov 8	Nov 9: 8.9, Finite Differences	Nov 10: Homework 9 due	Nov 11: 8.10, Collocation
13	Nov 14: 9.1 PDEs	Nov 15	Nov 16: 9.2 PDEs	Nov 17: Homework 10	Nov 18: 9.3, PDEs
14	Nov 21: Leeway	Nov 22	Nov 23: No class	Nov 24: No class	Nov 25: No class
15	Nov 28: Leeway	Nov 29	Nov 30: Review of Course	Dec 1: Homework 11 due	Dec 2: Review of Course

Advice on succeeding in a math class:

- Review the relevant course material **before** you come to lecture. Consider reviewing course material a week or two before the semester starts.

- When reading mathematics, use a pencil and paper to sketch the calculations that are performed by the author.
- Come to class with questions, so you can get more out of the lecture. Also, finish your homework at least **two days** before it is due, to alleviate deadline stress.
- Write a rough draft and a separate final draft for your homework. This procedure will help you catch mistakes. Also, I would very much recommend [typesetting](#) your homework. Learning LaTeX is a very important skill to have for doing mathematics. [Here](#) is a template .tex file if you want to get started typesetting.
- If you are having difficulty with the material or a particular homework problem, review Polya's [Problem Solving Strategies](#), and come to office hours.