MA 580: Numerical Analysis I

Lecture details

Instructor:	Alen Alexanderian
Lecture time/location:	Tue/Thurs 4:30–5:45, online (Zoom)
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Office Hours:	12:00–1:00 MW or by appointment

Course Description

This is a first graduate course in numerical analysis The topics covered in this course include: (1) vector and matrix norms, conditioning, errors and floating point arithmetic; (2) linear systems of equations (3) linear least-squares; (4) QR and SVD decompositions; (5) iterative methods for linear systems; (6) solution of nonlinear equations; (7) eigenvalue problems.

Time permitting, I will also discuss some special topics such as inverse problems, nonlinear optimization, or randomized linear algebra.

Textbooks

- I. C. F. Ipsen, Numerical Matrix Analysis, SIAM, 2009.
  http://catalog.lib.ncsu.edu/record/NCSU2514760
- C. T. Kelley, Iterative Methods for Linear and Nonlinear Equations, SIAM, 1995.
  http://catalog.lib.ncsu.edu/record/NCSU2512957
- Desmond J. Higham and Nicholas J. Higham, Matlab Guide: Second Edition, SIAM, 2005
  http://catalog.lib.ncsu.edu/record/NCSU3108706

These books are available (freely) online for NCSU users through NCSU library.

Other recommended literature

- David S. Watkins, Fundamentals of Matrix Computations, 3rd Edition. 2002.
- Lloyd N. Trefethen, David Bau, Numerical Linear Algebra 1st Edition. 1997.
- Kendall E. Atkinson, An Introduction to Numerical Analysis, second edition, Wiley, 1989.
- David Kincaid and Ward Cheney, Numerical Analysis, Brooks/Cole, 1996.
- James M. Ortega. Numerical analysis: A Second Course, volume 3 of Classics in Applied Mathematics. SIAM, second edition, 1990.
- Peter Deuflhard, Andreas Hohmann: Numerical Analysis in Modern Scientific Computing. An Introduction, 2nd edition, Springer, 2003.
- Alfio Quarteroni, Riccardo Sacco, Fausto Saleri: Numerical Mathematics, 2nd edition, Springer, 2007.
- Cleve Moler: Numerical Computing with Matlab, SIAM, 2007.

Course Delivery Changes Related to COVID-19: Please be aware that the situation regarding COVID-19 is frequently changing, and the delivery mode of this course may need to change accordingly, including from synchronous sessions to an asynchronous format. Regardless of the delivery method, we will all strive to provide a high-quality learning experience

Note: If I need to be out for an extended period of time, Dr. Zhilin Li will take over in my absence.

Grading Policy
The grading will be assigned on a 10-point scale: **A: 90 – 100, B: 80 – 89, C: 70 – 79, D: 60 – 69, F:** $\leq$ **60.** The cutoffs for the +/- grades are determined at the end of the semester. Your final grade in this course will be determined by marks earned on about six homework assignments involving a mix of theory and computational experiments (60%) a midterm (15%) and a final exam (25%).

Exams

- Midterm exam date: Friday, October 13
- Final exam date: Thursday, Nov. 19, 3:30–6:00PM

Homework The homework is weighted so heavily, because it includes the computational and theoretical exercises that are essential to understanding the course material. Also, an important part of your education at this stage is to learn how to present your results in the form of a professional-grade typeset report. Label each problem clearly, label equations as necessary, and produce high quality and easy to understand figures (use axis labels, captions, etc.) using for example Matlab. I encourage you to typeset your homework solutions in Latex (I will provide Latex source files for the homeworks). You must show complete work to receive full credit. This means that you should provide sufficient details such that others with similar background as yourself can reproduce your results.

Prerequisites
Calculus, background in linear algebra and ODEs, and some programming experience (we will use Matlab for the class assignments).

Grading/Scheduling Changing Options Related to COVID-19: If the delivery mode has a negative impact on your academic performance in this course, the university has provided tools to potentially reduce the impact:

Enhanced S/U Grading Option:

https://studentservices.ncsu.edu/your-resources/covid-19/spring2020-sat-grading/.

Late Drop:

https://studentservices.ncsu.edu/your-resources/covid-19/spring2020-latedrop/

Be aware that if you use the enhanced S/U grading option, you will still need to complete the course and receive at least a C- to pass the course.

In some cases, another option may be to request an incomplete in the course. Before using any of these tools, discuss the options with your instructor and your academic advisor.

Auditing the Course: To audit the course, you must have the approval of your advisor and the Mathematics Department. In order to receive an AU, you must attend the majority of the sessions, and you must hand in all of the homework and take all of the tests. See: https://policies.ncsu.edu/regulation/reg-02-20-04/

for more information concerning course audits.

Incomplete Grades: Incomplete grades will be handled on an individual basis. Note, however, that if an extended deadline is not authorized by an instructor or department, an unfinished incomplete grade will automatically change to an F after either (a) the end of the next regular semester in which the student is enrolled (not

including summer sessions), or (b) the end of 12 months if the student is not enrolled, whichever is shorter. Incompletes that change to F will count as attempted courses on transcripts. The burden of fulfilling an incomplete grade is the responsibility of the student. The university policy on incomplete grades is located at https://policies.ncsu.edu/regulation/reg-02-50-03/.

Attendance Policy/Absence Policy/Late Assignments/Make-up Work: You are expected to attend all classes on time. Late assignments and make-up work will only be allowed for excused absences. You should contact me by email or in person before any anticipated excused absence. If you have an unanticipated excused absence (for example, a medical emergency), you should contact me within one week of returning to class.

For complete attendance and excused absence policies, please see:

https://policies.ncsu.edu/regulation/reg-02-20-03-attendance-regulations/

COVID-19 Related Absences: If you need to miss class because you have been advised that you may have been exposed to COVID-19 or you have a personal or family situation related to COVID-19 that prevents you from attending our sessions, please contact me. Together we will develop a plan to help you keep up with your coursework during any such absences. COVID-19 related absences will be considered excused. You do not need any additional documentation. (But, again, please make sure you contact me.)

Academic Integrity Statement and Academic Dishonesty: Students are required to comply with the university policy on academic integrity/honesty found in the Code of Student Conduct:

https://policies.ncsu.edu/policy/pol-11-35-01/

Violations of academic integrity will be handled in accordance with the Student Discipline Procedures (NCSU REG 11.35.02).

Cell Phone and Computer Use: Cell phones should be turned off during class. But if you have an emergency and need to keep your phone on during class, please let me know before class.

Digital Course Components: In this course we will use Zoom and Moodle. Please see the relevant technology requirements in

https://docs.google.com/document/d/1Bfrka-Y4qm3WouAGOnCm0YBAytykTjQjvEBErBkNDgc/edit.

If you need access to additional technological support, please contact the Libraries' Technology Lending Service: https://www.lib.ncsu.edu/devices.

Students may be required to disclose personally identifiable information to other students in the course, via electronic tools like email or web-postings, where relevant to the course. Examples include online discussions of class topics and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.

Moodle: All reading materials are housed on the course page in Moodle. I will also post videos the recorded lectures in Moodle, as well as .pdf files containing lecture content.

Zoom: Our lectures will be conducted synchronously via Zoom. The zoom link for our lectures is posted in Moodle page for our course. Typically, I will initially put all of you on "mute", but if you would like to talk, there is a button on the left side of the Zoom screen that will enable you to unmute yourself. Zoom enables us to have breakout rooms for small group discussions and we will utilize that function as well.

I will be recording our Zoom sessions and will be posting links to the recordings on our Moodle page. I will only record our mathematical discussions and not, for example, the parts of our sessions where we check in with each other. In order that all students in the class feel comfortable asking questions, and making conjectures, etc., you may not share the links with anyone outside of our class.

These recordings are for use in our current class (and possibly for use in future educational purposes). By your continued participation in this recorded course, you are providing your permission to be recorded.

Diversity, Equity, and Inclusion: Diversity, equity, and inclusion are important to the success of our students at NC State. Every student, every faculty member, and every staff member who comes to NC State enriches us through their varied perspectives, knowledge, and backgrounds. Our classroom is one in which every student is respected and feels heard. In an effort to affirm and respect the identities of transgender students in the classroom and beyond, please contact me if you wish to be referred to using a name and/or pronouns other than those listed in the student directory. I welcome any additional suggestions you have for including the value of diversity, equity, and inclusion in this course.

Accommodations for Disabilities: Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Resource Office at Holmes Hall, Suite 304, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (REG02.20.01).

Non-Discrimination Policy: NC State prohibits discrimination, harassment, and retaliation that are based upon a person's race, color, religion, sex (including pregnancy), national origin, age (40 or older), disability, gender identity, genetic information, sexual orientation, or veteran status (individually and collectively). If you feel that you have been the subject of prohibited discrimination, harassment, or retaliation, you should contact the Office for Institutional Equity and Diversity (OIED) at 919-513-0574.

NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at `http://policies.ncsu.edu/policy/pol-04-25-05` or `http://oied.ncsu.edu/divweb`.

Health and Well-Being Resources: These are difficult times, and academic and personal stress are natural results. Everyone is encouraged to take care of themselves and their peers. If you need additional support, there are many resources on campus to help you:

- Counseling Center (link)
- Health Center (link)
- NC State CARES Team: As members of the NC State Wolfpack community, we each share a personal responsibility to express concern for one another and to ensure that our campus remains a healthy and safe environment for learning. Occasionally, you may come across a classmate whose personal behavior concerns or worries you, either for your classmate's well-being, for your well-being or for the well-being of others. When this is the case, I would encourage you to report the behavior to the NC State CARES team: Share a Concern.
- If you or someone you know are experiencing food, housing or financial insecurity, please see the Pack Essentials Program (Pack Essentials).

Additional COVID-19 Information: Due to the Coronavirus pandemic, public health measures have been implemented across campus. Students should stay current with these practices and expectations through the Protect the Pack website `https://www.ncsu.edu/coronavirus/`.

We are most concerned about your health and the health of the students, faculty, and staff across campus. If you test positive for COVID-19, or are told by a healthcare provider that you are presumed positive for the virus, please follow university guidelines, including self-reporting (Coronavirus Self Reporting): Self-reporting is not only to help provide support to you, but also to assist in contact tracing for containing the spread of the virus.

Community Standards related to COVID-19: We are all responsible for protecting ourselves and our community. Please see the community standards (released on 7/28/2020) and Rule 04.21.01 regarding Personal Safety

Requirements Related to COVID-19.

NC State Rules and Regulations: Students are responsible for reviewing the NC State University Policies, Rules, and Regulations (PRRs) which pertain to their course rights and responsibilities, including those referenced both below and above in this syllabus:

- Equal Opportunity and Non-Discrimination Policy Statement with additional references at https://oied.ncsu.edu/equity/policies/
- Code of Student Conduct

Important Resources for Students:

- NC State Keep Learning, tips for students taking courses remotely:
  https://dasa.ncsu.edu/academics/keep-learning/
- Introduction to Zoom for Students:
  https://youtu.be/5LbPzzPbYEw
- Learning with Moodle, a student's guide to using Moodle:
  https://moodle-projects.wolfware.ncsu.edu/course/view.php?id=226
- Protect the Pack FAQs:
  https://www.ncsu.edu/coronavirus/frequently-asked-questions/
- NC State Protect the Pack Resources for Students:
  https://www.ncsu.edu/coronavirus/reactivating-campus/resources-for-students/