

**SYLLABUS**  
**MATH 6397**  
**SELECTED TOPICS IN MATH: NUMERICAL LINEAR ALGEBRA**  
**FALL 2023**

**Instructor:** Alexander Mamonov  
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**Class web page:** <https://www.math.uh.edu/~mamonov/MATH6397-F2023/index.html>  
**Classroom:** AH 301  
**Class hours:** TuTh 4:00PM - 5:30PM  
**Class numbers:** 20631

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**The information contained in this class syllabus is subject to change without notice. Students are expected to be aware of any additional course policies presented by the instructor during the course.**  
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All class policies, announcements, reviews, homework assignments, solutions, and grades are posted on Canvas: <https://canvas.uh.edu/>

**Prerequisite:** MATH 4377-4378 or MATH 6308-6309.

**Textbook:** Lloyd N. Trefethen, David Bau III, *Numerical Linear Algebra*, SIAM: Society for Industrial and Applied Mathematics

**Additional reading:**

- Gene H. Golub, Charles F. Van Loan, *Matrix Computations*, 4th Edition, Johns Hopkins University Press
- Yousef Saad, *Iterative Methods for Sparse Linear Systems*, 2nd Edition, SIAM: Society for Industrial and Applied Mathematics
- Yousef Saad, *Numerical Methods for Large Eigenvalue Problems*, John Wiley & Sons

**Objectives:** Upon completion of this course, the students are expected to gain the understanding of the fundamental concepts and techniques of numerical linear algebra including orthogonality and projectors, singular value decomposition, orthogonalization and QR factorization, least squares, conditioning and stability, direct methods for linear systems (LU and Cholesky factorizations), numerical methods for eigenvalue computation, and iterative methods for solving large linear systems (GMRES, Conjugate Gradients), etc.

**Assignments,** Bi-weekly homeworks and two in-class exams will be given.

**Exams and Grading:** There are no make-ups for the exams. The course grade is determined by the homeworks and exams with each having the following weights:

Homework	40%
Exam 1	30%
Exam 2	30%

**Topics:** The following material is covered (numbering according to textbook's "lecture" sections, the list is subject to change):

I Fundamentals

2. Orthogonal Vectors and Matrices
3. Norms
4. The Singular Value Decomposition

II QR Factorization and Least Squares

6. Projectors
7. QR factorization
8. Gram-Schmidt Orthogonalization
11. Least squares problem

III Conditioning and Stability

12. Conditioning and Condition Numbers
14. Stability
18. Conditioning of Least Squares Problems

IV Systems of Equations

20. Gaussian Elimination
21. Pivoting
22. Stability of Gaussian Elimination
23. Cholesky Factorization

V Eigenvalues

24. Eigenvalue Problems
25. Overview of Eigenvalue Algorithms
27. Rayleigh Quotient, Inverse Iteration
28. QR Algorithm without Shifts

VI Iterative Methods

32. Overview of Iterative Methods
33. The Arnoldi Iteration
35. GMRES
36. The Lanczos Iteration
38. Conjugate Gradients
39. Biorthogonalization Methods
40. Preconditioning

### **Academic Honesty Policy**

High ethical standards are critical to the integrity of any institution, and bear directly on the ultimate value of conferred degrees. All UH community members are expected to contribute to an atmosphere of the highest possible ethical standards. Maintaining such an atmosphere requires that any instances of academic dishonesty be recognized and addressed. The [UH Academic Honesty Policy](#) is designed to handle those instances with fairness to all parties involved: the students, the instructors, and the University itself. All students and faculty of the University of Houston are responsible for being familiar with this policy.

## **Reasonable Academic Adjustments/Auxiliary Aids**

The University of Houston is committed to providing an academic environment and educational programs that are accessible for its students. Any student with a disability who is experiencing barriers to learning, assessment or participation is encouraged to contact the Justin Dart, Jr. Student Accessibility Center (Dart Center) to learn more about academic accommodations and support that may be available to them. Students seeking academic accommodations will need to register with the Dart Center as soon as possible to ensure timely implementation of approved accommodations. Please contact the Dart Center by visiting the website: <https://uh.edu/accessibility/> calling (713) 743-5400, or emailing [jdcenter@Central.UH.EDU](mailto:jdcenter@Central.UH.EDU).

## **Excused Absence Policy**

Regular class attendance, participation, and engagement in coursework are important contributors to student success. Absences may be excused as provided in the University of Houston [Graduate Excused Absence Policy](#) for reasons including: medical illness of student or close relative, death of a close family member, legal or government proceeding that a student is obligated to attend, recognized professional and educational activities where the student is presenting, and University-sponsored activity or athletic competition. Under these policies, students with excused absences will be provided with an opportunity to make up any quiz, exam or other work that contributes to the course grade or a satisfactory alternative. Please read the full policy for details regarding reasons for excused absences, the approval process, and extended absences. Additional policies address absences related to [military service](#), [religious holy days](#), [pregnancy and related conditions](#), and [disability](#).

## **Mental Health and Wellness Resources**

The University of Houston has a number of resources to support students' mental health and overall wellness, including [CoogsCARE](#) and the [UH Go App](#). UH [Counseling and Psychological Services \(CAPS\)](#) offers 24/7 mental health support for all students, addressing various concerns like stress, college adjustment and sadness. CAPS provides individual and couples counseling, group therapy, workshops and connections to other support services on and off-campus. For assistance visit [uh.edu/caps](http://uh.edu/caps), call 713-743-5454, or visit a [Let's Talk](#) location in-person or virtually. [Let's Talk](#) are daily, informal confidential consultations with CAPS therapists where no appointment or paperwork is needed.

The [Student Health Center](#) offers a Psychiatry Clinic for enrolled UH students. Call 713-743-5149 during clinic hours, Monday through Friday 8 a.m. - 4:30 p.m. to schedule an appointment.

The [A.D. Bruce Religion Center](#) offers spiritual support and a variety of programs centered on well-being.

## **Need support now?**

**If you or someone you know is struggling or in crisis, help is available. Call CAPS crisis support 24/7 at 713-743-5454, or the National Suicide and Crisis Lifeline: call or text [988](https://988lifeline.org), or chat [988lifeline.org](https://988lifeline.org).**

## **Title IX/Sexual Misconduct**

Per the UHS Sexual Misconduct Policy, your instructor is a “responsible employee” for reporting purposes under Title IX regulations and state law and must report incidents of sexual misconduct (sexual harassment, non-consensual sexual contact, sexual assault, sexual exploitation, sexual intimidation, intimate partner violence, or stalking) about which they become aware to the Title IX office. Please know there are places on campus where you can make a report in confidence. You can find more information about resources on the Title IX website at <https://uh.edu/equal-opportunity/title-ix-sexual-misconduct/resources/>

### **Recording of Class**

Students may not record all or part of class, livestream all or part of class, or make/distribute screen captures, without advanced written consent of the instructor. If you have or think you may have a disability such that you need to record class-related activities, please contact the [Justin Dart, Jr. Student Accessibility Center](#). If you have an accommodation to record class-related activities, those recordings may not be shared with any other student, whether in this course or not, or with any other person or on any other platform. Classes may be recorded by the instructor. Students may use instructor’s recordings for their own studying and notetaking. Instructor’s recordings are not authorized to be shared with anyone without the prior written approval of the instructor. Failure to comply with requirements regarding recordings will result in a disciplinary referral to the Dean of Students Office and may result in disciplinary action.

### **UH Email**

Email communications related to this course will be sent to your CougarNet account. To access this email, [login](#) to your Microsoft 365 account with your CougarNet credentials.