



Syllabus
Applied Mathematics & Statistics 553.385
Numerical Linear Algebra
Spring, 2022
(4 credits, EQ)

Description A first course on computational linear algebra and applications. Topics include floating-point arithmetic, algorithms and convergence, Gaussian elimination for linear systems, matrix decompositions (LU, Cholesky, QR), iterative methods for systems (Jacobi, Gauss-Seidel), approximation of eigenvalues (power method, QR-algorithm), and singular value decomposition. Theoretical topics such as vector spaces, inner products, norms, matrix norms, canonical forms of matrices (Jordan, Schur) are reviewed as needed. Matlab is used for all numerical exercises; no previous experience with computer programming is required.

Prerequisites

Linear Algebra (EN.553.291, AS.110.201, AS.110.212, or equivalent)
Calculus 3 (AS.110.202, AS.110.211, or equivalent)

Instructor

Dr. Sammy Khalife, khalife.sammy@jhu.edu,
Office: Wyman Park N418
Office hours: Monday 10-12am and on Zoom by appointment

Teaching Assistants

Hongyu Cheng, hongyucheng@jhu.edu
Office hours: Tuesday 3-4pm, in Wyman Park S425
Heed Liu, xliu168@jh.edu
Office hours: Wednesday 3-4pm, in Wyman Park S425

Meetings

Lectures: Mon, Wed, Fri, 9–9:50 am, Hodson 211
Sections: Thursdays, 9–9:50 am, Shaffer 2

Textbook

Required: R. L. Burden, J. D. Faires, and A. M. Burden *Numerical Analysis*, 10th Ed., Cengage Learning (2018). See <https://sites.google.com/site/numericalanalysis1burden>.

- Chapter 1: Mathematical Preliminaries and Error Analysis
- Chapter 6: Direct Methods for Solving Linear Systems
- Chapter 7: Iterative Techniques in Matrix Algebra
- Chapter 9: Approximating Eigenvalues (and 9.6 Singular Value Decomposition)

Recommended: K. Atkinson, *An Introduction to Numerical Analysis*, 2nd Ed., John Wiley & Sons (1989), especially Chapter 7, Linear Algebra, and L. N. Trefethen & D. Bau, *Numerical Linear Algebra*, SIAM (1997), see: <https://people.maths.ox.ac.uk/trefethen/text.html>

Online Resources

Blackboard & Gradescope : The course content (syllabus, lecture notes, homework subjects, ...) is made available on Blackboard. Occasionally, the website will also be used to provide reminders and additional information. The platform Gradescope will be integrated within Blackboard for you to upload your homework.

Piazza: This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates, the TAs, and myself. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. The signup link is available on Blackboard (tab: General information). If you have any problems or feedback for the developers, email team@piazza.com.

Course website: Main information is displayed on the course website: <https://pages.jh.edu/skhalif4/NumLA.html>.

Course Objectives

- (1) Learn how computers represent numbers and how to estimate error in numerical computations
- (2) Learn the mathematical algorithms underlying numerical linear algebra software, such as LAPACK and MATLAB
- (3) Learn basic MATLAB programming skills, particularly for numerical linear algebra
- (4) Learn how to solve numerically the practical problems of linear algebra arising in mathematics, science and engineering and to assess reliability of the solutions

Course Topics

- floating-point arithmetic
- algorithms and convergence
- Gaussian elimination for linear systems
- matrix decompositions (LU, Cholesky, QR)
- iterative methods for systems (Jacobi, Gauss-Seidel)
- canonical forms of matrices (Jordan, Schur)
- approximation of eigenvalues (power method, QR-algorithm, Krylov subspace methods)
- singular value decomposition
- basic MATLAB programming

Course Expectations & Grading

Grading: The student's final grade will be based upon homework and exams. The breakdown will be:

<u>Item</u>	<u>Percent of Grade</u>
Homework	50%
Midterm Exam	25%
Final Exam	25%

Throughout the semester the following grading rule will be used:

<u>Letter Grade</u>	<u>Percent of Total</u>
A-/A/A+	90-100%
B-/B/B+	80-89%
C-/C/C+	70-79%
D-/D/D+	60-69%
F	0-59%

Homework: Homework will consist of problems covering material up to 2 days before the due date. Please review the Homework Submission Guidelines below. Homework cannot be accepted for credit after solutions have been posted on-line. If a homework is missed and there is a valid excuse, then it will be removed from the student's total grade for the course, and the remainder of the homework assignments re-weighted.

Exams: The Final Exam will be cumulative, but focussed primarily on the material covered since the Midterm. There is *no* senior option for this course. Make-ups for the Midterm and Final Exams may be available if exams are missed due to illness or family emergency. Make-up exams are only available if discussed with the instructor at least 1 day before the date of the exam. If an emergency arises after that time and there is a valid excuse, then the exam will be removed from the student's total grade for the course, and the remainder re-weighted accordingly. Proper documentation of the emergency must be presented before either of these options can be offered.

Attendance: Students are not formally penalized for missing lectures/sections. However, it is the student's responsibility to arrange to obtain notes for any missed classed and to turn in any homework due on the date of the missed class. Also statistics of participation by each student will be monitored and may play a role deciding grades in borderline cases.

Homework Submission Guidelines

Please make sure your name is on your homework submission. Please write neatly. The unreadable is ungradeable. Please submit your problems in the order they appear on the assignment sheet. Please make sure to show all work and document any assumptions you are making. If you use special computer software (e.g., MATLAB, Python, Excel, etc.) to complete your homework/project, please read, and adhere to, the Software Usage Guidelines (see below). Homework is due by 5pm Eastern US time on the posted date unless otherwise instructed.

Software Usage Guidelines

You may use any applicable software to do homework assignments, e.g. MATLAB, Python, Excel, etc. Please include not only printouts of results but also all relevant codes. The homework should be uploaded on Gradescope. If you also print the codes out, then please try to save paper by printing double-sided or half pages (2-to-1, one-sided). The answers from the computer must include the requisite amount of explanation. Unless specifically instructed otherwise, you may use symbolic computation software for theoretical problems, but again you must include printouts of relevant code.

Key Dates

Key dates (exams, etc.) are at <https://pages.jh.edu/skhalif4/NumLA/schedule.html>

Assignments & Readings

To be released

Ethics

The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition.

In addition, the specific ethics guidelines for this course are:

- (1) If you work in a group you *must* write up your solutions separately. Anything that looks too much like someone else's work is likely to be considered cheating. Such assignments will receive a grade of zero and you may be subject to other disciplinary action.
- (2) If you work in a group on coding for homework, the group cannot create a joint computer printout and copy it for all group members. Even if you work in a group, you must still do the software work yourself and turn in your own output.
- (3) You are free to use any online material (books, articles, Wikipedia pages, etc.) to assist you in the solutions of homework, but any such material must be cited in your submission with an appropriate

reference (e.g. url). If material is taken without credit from an online (or any other) source, it will be considered plagiarism.

- (4) If the midterm or final exam are given as take-homes (which will be decided by class vote), then you must attest in writing that you have not been assisted by any classmate, friend or family member.

Report any violations you witness to the instructor.

You can find more information about university misconduct policies on the web at these sites:

- Undergraduates: <http://studentaffairs.jhu.edu/student-life/student-conduct/resources-conduct-ethics/>
- Graduate students: <http://e-catalog.jhu.edu/grad-students/graduate-specific-policies/>

Personal Wellbeing

- If you are sick please notify me by email so that we can make appropriate accommodations should this affect your ability to attend class, complete assignments, or participate in assessments. The Student Health and Wellness Center is open and operational for primary care needs. If you would like to speak with a medical provider, please call 410-516-8270, and staff will determine an appropriate course of action based on your geographic location, presenting symptoms, and insurance needs. Telemedicine visits are available only to people currently in Maryland. See also this [link](#).
- Johns Hopkins COVID-19 Call Center (JHCCC), which can be reached at 443-287-8500 seven days a week from 7 a.m. to 7p.m., supports all JHU students, faculty, and staff experiencing COVID-19 symptoms. Primarily intended for those currently within driving distance of Baltimore, the JHCCC will evaluate your symptoms, order testing if needed, and conduct contact investigation for those affiliates who test positive. More information on the JHCCC and testing is on the coronavirus information website at <https://covidinfo.jhu.edu/health-safety>.
- All students with disabilities who require accommodations for this course should contact me at their earliest convenience to discuss their specific needs. If you have a documented disability, you must be registered with the JHU Office for Student Disability Services (385 Garland Hall; 410-516-4720; studentdisabilityservices@jhu.edu) to receive accommodations. See the OSDS website <http://web.jhu.edu/disabilities>.
- Students who are struggling with anxiety, stress, depression or other mental health related concerns, please consider connecting with resources through the JHU Counseling Center. The Counseling Center will be providing services remotely to protect the health of students, staff, and communities. Please reach out to get connected and learn about service options based on where you are living this fall at 410-516-8278, online at <http://studentaffairs.jhu.edu/counselingcenter>.
- Student Outreach & Support is fully available to help support students. Students can self-refer or refer a friend who may need extra support or help getting connected to resources. To connect with SOS, please email deanofstudents@jhu.edu, call 410-516-7857, or students can schedule to meet with a Case Manager by visiting the Student Outreach & Support website and follow Schedule an Appointment.

Classroom Climate

Please join me in creating a welcoming and vibrant classroom climate. Note that you should expect to be challenged intellectually by me, the TAs, and your peers, and at times this may feel uncomfortable. Indeed, it can be helpful to be pushed sometimes in order to learn and grow. But at no time in this learning process should someone be singled out or treated unequally on the basis of any seen or unseen part of their identity.

If you ever have concerns in this course about harassment, discrimination, or any unequal treatment, or if you seek accommodations or resources, I invite you to share directly with me or the TAs. I promise that we will take your communication seriously and to seek mutually acceptable resolutions and accommodations. Reporting will never impact your course grade. You may also share concerns with the department chair (Fadil Santosa, fsantos9@jhu.edu), Director of Undergraduate Studies (Donniell Fishkind,

dfishkil@jhu.edu), the Assistant Dean (Darlene Saporu, dsaporu@jhu.edu) for Diversity and Inclusion, or the Office of Institutional Equity (oie@jhu.edu). In handling reports, people will protect your privacy as much as possible, but faculty and staff are required to officially report information for some cases (e.g. sexual harassment).

University Policy on Incompletes

The university recognizes that the Spring 2022 semester is surrounded with uncertainty and many students may find themselves in unexpected situations where study is difficult if not impossible. Students who are confronted with extraordinary circumstances that interfere with their ability to perform their academic work may request an incomplete grade from the instructor. While approval of such a request is not automatic, it is expected that faculty will make every effort to accommodate students dealing with illness in the family and other pandemic-related hardships. The instructor and student must establish a timetable for submitting the unfinished work with a final deadline no later than the end of the third week of the Spring 2022 semester. Exceptions to this deadline require a petition from the instructor to the student's academic advising office before this date. When entering an Incomplete grade in SIS, faculty must include a reversion grade which represents the grade the student will receive if s/he does not complete the missing work by the agreed-upon deadline.

Deadlines for Adding, Dropping and Withdrawing from Courses

Students may add a course up to **February 4, 2022**. They may drop courses up to **March 6, 2022** provided they remain registered for a minimum of 12 credits. Between **March 6 and April 15, 2022**, a student may withdraw from a course with a W on their academic record. A record of the course will remain on the academic record with a W appearing in the grade column to indicate that the student registered and then withdrew from the course.

For more information on these and other academic policies, see [this link](#).

ABET Outcomes

- Ability to apply mathematics, science and engineering principles (a).
- Ability to design a system, component, or process to meet desired needs (c).
- Ability to identify, formulate and solve engineering problems (e).
- Ability to use the techniques, skills and modern engineering tools necessary for engineering practice (k).