MATH 347.001: Linear Algebra for Applications
Fall 2024 (updated 8/19/2024)

Instructor:
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TAs:
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ULA:
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Schedule:
- **Lectures**: T/Th from 2:00-3:15 PM in **Phillips 215**
- **Office hours**:
  - Wednesday 2:00-3:00 (Andreas): Phillips 414
  - Thursday 11:00-12:00 (Ethan): Math Help Center (Phillips ???)
  - Thursday 3:30-4:30 (Shahar): Phillips 322
  - Friday 11:30-12:30 (Junyan): Phillips 404 or Zoom by appointment (junyanl@unc.edu)
  - or by appointment

Requisites:
- Prerequisites: MATH232/235 and sufficient knowledge of calculus and trigonometry.

Description:

Linear Algebra is of utmost importance in all areas of mathematics and in many, many applications, so we are hoping to work hard to give you a solid background in this fundamentally essential course. We must learn the basics of the theory though before we can hope to really understand and explore applications. This course should provide a framework for many further courses in physics, statistics, geometry, analysis, economics, biology, computer science, and more!

My goal is to cover Chapters 1-7 and selected topics in Chapters 8,10,11 and 12, time permitting. Topics include systems of equations, matrices, Gaussian elimination, vector spaces, linear transformations, orthogonality, Gram-Schmidt procedure, least squares, determinants, eigenvalues and eigenvectors, singular value decomposition (principal component analysis), and applications. Numerical components may be added using Matlab/Mathematica.

Textbook:
- Introduction to Linear Algebra, Fifth Edition (2016), by Gilbert Strang. Previous Editions are also acceptable. 6th Edition is slightly different but should be okay to use as well.
- See additional references and materials below.

Class Structure:

- There will be in-class worksheet assignments in most of the lectures. Students have until 4pm after each class to upload their answers to Gradescope. The instructor will show some of the detailed solution procedures in class.
- Students are encouraged to post questions on Piazza, see more below.
- Students are encouraged to form study groups for this class.
- Students are encouraged to prepare for each lecture by reviewing the textbook and/or watching videos (see resources below).
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Online Resources:

- **Canvas**: Course information, materials, announcements, and gradebook.
- **Edfinity:** Homework, accessed via Canvas (pay sign up fee as needed).
- **Gradescope**: All course submissions (homework, worksheets and exam), accessed via Canvas.
- **Check-in App**: Class attendance. Download the app at https://uccheckin.unc.edu/.
- **Piazza**: Class discussions and Q&A. Please use it instead of emailing the instructor or the TAs directly. Please try to avoid private posts, so that the entire teaching team and other students can answer for the benefit of all students.
  Sign up at https://piazza.com/unc/fall2024/math347001 (access code RREF)

Grading:

- **Homework (20%)**: To be submitted electronically only on Edfinity/Gradescope. 1 lowest homework grade will be dropped. Late homework will NOT be accepted in any circumstance.
- **Midterm 1 (20%)**
- **Midterm 2 (20%)**
- **Final exam (30%)**
- **Class attendance and participation (10%)**: Check-in and In-class worksheets. Register your attendance (https://uccheckin.unc.edu/) and submit worksheets on Gradescope by the end of each lecture. 2 lowest participation grades will be dropped. Late worksheet submissions will NOT be accepted in any circumstance. Worksheets will NOT be graded without class attendance.

Midterms and Final exam:

There will be two in-class midterms exams. See Canvas and in-class announcements for more details.

The comprehensive Final exam will be on Saturday 12/7 at 12:00pm (per the Registrar's Office final examination schedule). The final exam is given in compliance with UNC's final exam regulations and calendar and will not be given prior to this exam date. Any make-up exam after this date must be directly coordinated with the instructor and will require having an official examination excuse (https://advising.unc.edu/announcement/final-exam-excuse-request/).

There will be NO makeup midterm exams. The grade of the final exam may be used to replace the lowest (or missed) midterm grade if the final exam grade is higher.

Grading Scale:

93 or above: A, 90 to 92: A-
87 to 89: B+, 83 to 86: B, 80 to 82: B-
77 to 79: C+, 73 to 76: C, 70 to 72: C-
67 to 69: D+, 60 to 67: D
Below 60: F

Honor code:

It is expected that each student will conduct themself within the guidelines of the UNC Chapel Hill Honor System. All academic work should be done with the highest level of honesty and integrity that the University demands. All work is individual. You may discuss various approaches to homework problems with others but must draft your answers by yourself.

Attendance Policy

Attendance and completion of in-class worksheets are strongly encouraged (see above). Attendance and participation are evaluated using the check-in App (https://unccheckin.unc.edu/) and worksheet submissions. The following three situations qualify for University Approved Absences:

1. Authorized University activities
2. Disability/religious observance/pregnancy, as required by law and approved by Accessibility Resources and Service and/or the Equal Opportunity and Compliance Office (EOC)
3. Significant health condition and/or personal/family emergency as approved by the Office of the Dean of Students, Gender Violence Service Coordinators, and/or the Equal Opportunity and Compliance Office (EOC).

The instructor may work with students to meet attendance needs that do not fall within University approved absences (e.g., a job interview or club activity). Please communicate with me early about potential absences. Please be aware that you are bound by the Honor Code when making a request for a University approved absence.

Course at a glance:

Weekly Schedule (tentative; exam dates are final):

Topic	Week #	Dates
Introduction Chapter 1	1	8/20 8/22
Chapter 1	2	8/27 8/29
Well-being day Chapter 2	3	9/3 9/5
Chapter 2	4	9/10 9/12
Chapter 3	5	9/17 9/19
Chapter 3	6	9/24 9/26
Midterm 1	7	**10/1** 10/3
Chapter 3	8	10/8 10/10
Chapter 4 Fall Break	9	10/15 10/17
Chapter 4	10	10/22 10/24
Chapter 4 Chapter 5	11	10/29 10/31
Chapter 5 **Midterm 2**	12	11/5 **11/7**
Chapter 5	13	11/12 11/14
Chapter 6	14	11/19 11/21
Chapter 6 Thanksgiving Break	15	11/26 11/28
Chapter 7	16	12/3
Final Exam		**12/7**

Textbook and other references:

The main textbook for this course is *Introduction to Linear Algebra, Fifth Edition (2016), by Gilbert Strang.* Previous Editions are also acceptable.

You are encouraged to use other sources of information as well. You can learn the detailed calculation steps using the *Linear Algebra Toolkit*. You may want to check the demos from https://demonstrations.wolfram.com/ and Interactive Linear Algebra textbook. You can watch Professor Strang's lectures at MIT and experiment with the tutorials at https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/.

Additional information and references I (and you too) may use:

1. Strang's textbook: Professor Strang is a world-famous computational mathematician. You will need to keep the computation and applications in mind when reading his textbook to understand how the topics are covered. As many students are more interested in the applications, not the rigorous mathematical proofs, we decided to use this textbook as the official textbook. This textbook covers SVD and application topics better compared with other textbooks.
2. "Linear Algebra with Applications" by Otto Bretscher leans towards the pure aspects of linear algebra. I am using the 5th edition (which was used in the past as the standard textbook in this department). In this textbook, one always normalizes whenever possible. For example, the standardized Gauss elimination and the standardized QR decomposition. There is a good amount of rigorous proofs in this textbook.
3. I also use the textbook "Interactive Linear Algebra" by Dan Margalit, Joseph Rabinoff. There are interactive examples for everyone to better understand the concepts and steps.

To learn the step-by-step Gauss elimination and Gram-Schmidt, we also use the following two toolboxes:

1. *Linear Algebra Toolkit*, the GE/RREF algorithm is the same as the one in Otto's book and Interactive Linear Algebra textbook. Prof. Strang's textbook decided not to rescale the leading one until the final step. I decided to do what most pure mathematicians do – normalize (standardize) whenever possible for clarity (instead of reducing the number of operations in the calculation)
2. iem.jar: Interactive Educational Modules in Scientific Computing. You can either download the module directly from the author's site, or from Canvas resources. This is a good tool to understand the least squares, QR, eigenvalues, and SVD. The QR algorithm used here is the same as Otto's textbook. Again Prof. Strang's textbook decided to normalize the orthogonal vectors in the last step. The online Interactive Linear Algebra textbook also decided to normalize in the final step. The final results are the same.

For advanced students - many of the algorithms you learned in this class will need modification when running on computers. One has to consider accuracy, stability, and efficiency. These are the topics covered in "Numerical Linear Algebra".

Title IX resources

Any student who is impacted by discrimination, harassment, interpersonal (relationship) violence, sexual violence, sexual exploitation, or stalking is encouraged to seek resources on campus or in the community. Please contact the Director of Title IX Compliance (Adrienne Allison – Adrienne.allison@unc.edu), Report and Response Coordinators in the Equal Opportunity and Compliance Office (reportandresponse@unc.edu), Counseling and Psychological Services (confidential), or the Gender Violence Services Coordinators (gvsc@unc.edu; confidential) to discuss your specific needs. Additional resources are available at safe.unc.edu.

Accessibility Resources and Services (ARS)

The University of North Carolina at Chapel Hill facilitates the implementation of reasonable accommodations, including resources and services, for students with disabilities, chronic medical conditions, a temporary disability or pregnancy complications resulting in barriers to fully accessing University courses, programs and activities.
Accommodations are determined through the Office of Accessibility Resources and Service (ARS) for individuals with documented qualifying disabilities in accordance with applicable state and federal laws. See the ARS Website for contact information: https://ars.unc.edu or email ars@unc.edu.

Counseling and Psychological Services (CAPS)

CAPS is strongly committed to addressing the mental health needs of a diverse student body through timely access to consultation and connection to clinically appropriate services, whether for short or long-term needs. Go to their website: https://caps.unc.edu/ or visit their facilities on the third floor of the Campus Health Services building for a walk-in evaluation to learn more.

Artificial Intelligence (AI) Use Policy:

AI should help you think. Not think for you.
The following uses of generative AI tools are permitted in this course: topic selection, brainstorming and idea generation, research, source validation, outlining and planning, drafting, media creation, peer review, revising, and polishing. Any use of AI tools (e.g., ChatGPT, BARD, etc.) in the creation of your work must be **declared in your submission and explained**.

Syllabus Changes:

The instructor reserves the right to make changes to the syllabus, including schedule, assignment due dates, and test dates. These changes will be announced as early as possible.