Matrices and Matrix Calculations (M340L-ECE)

University of Texas at Austin, Fall semester, 2021

last update: September 19, 2021

- Unique: 55475
- Instructor: Rachel Ward (rward@math.utexas.edu). Coordinating Instructor: Arie Israel
- Lecture Time: TTh 2-3:30 pm
- Lecture Location: Zoom (before SEPTEMBER 27, 2021), EER 1.518 (after SEPTEMBER 27, 2021)
  Zoom link for Lectures: https://utexas.zoom.us/j/95236907079.
- Instructor Office Hours via Zoom: Monday, 12:00 PM - 2:00 PM (https://utexas.zoom.us/j/94447749669).
- TA Office Hours via Zoom: F 10-1pm (meeting ID available on Canvas Syllabus page).
- Course website and discussion forum:
  - Canvas: https://canvas.utexas.edu/.
  - Piazza: https://piazza.com/utexas/fall2021/m340lece.
- Textbook: Linear Algebra and Its Applications, 5th ed., by David C. Lay.
  - ISBN-13: 978-0321982384.

  Required reading for signal processing applications will be posted as Quest Learning Modules.
  - Quest: https://quest.cns.utexas.edu/.
- Optional reading material:
  1. Signals and Systems, edited by Richard Baranuik. Click for PDF
  2. Linear algebra, signal processing, and wavelets. A unified approach. Python version. By Oyvind Ryan. Click for PDF

  The Baranuik and Ryan texts may be useful as references for the signal processing applications covered in the second half of the course.

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 TA, and myself. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. If you have any problems or feedback for the developers, email team@piazza.com.
Find our class signup link at: https://piazza.com/utexas/fall2021/m340lece

I hold office hours, and I am happy to meet with you. Come as soon as you have questions - if you wait, it will be hard or impossible to catch up. If you email me, please include in the subject line your EID and the Unique Number for this class. Please check to see if your question is answered in the syllabus before emailing me.

M340L-ECE is a fast-paced course which covers a lot of material. To succeed in mastering this material, you will have to make a serious time-commitment to the course, including each week, attending two lectures, reading the textbook and Quest learning modules before attending lecture, and completing weekly online homework assignments (administered through Quest). The expectation is that the work you do beyond the three hours of class will require up to 10 hours per week of your time. The coursework is designed so that, if you make this time commitment, you will be able to follow and learn the material through the semester.

In lectures, my aim is to introduce and motivate concepts, and to work through examples demonstrating those concepts. I recommend that you copy down my explanations in your notes, along with other comments I make verbally that you think are worth recording. Writing helps maintain your concentration in lectures, and will provide you with a set of notes to refer to.

This course makes use of Quest Learning and Assessment, a web-based content and homework delivery system maintained by the College of Natural Sciences at The University of Texas at Austin. This homework service will require a $30 charge per student for its use, which goes toward the maintenance and operation of the resource. Please go to https://quest.cns.utexas.edu/ to log in to the Quest system for this class. During the beginning of this course, when you log into Quest, you will be asked to pay via credit card (Visa, MasterCard or Discover) on a secure payment site. You have the option to wait up to 14 days to pay while continuing to use Quest for your assignments. If you are taking more than one course using Quest, you will not be charged more than $60 per semester/quarter. Quest provides mandatory instructional material for this course, similar to a textbook. For payment questions, please email: questhelp@austin.utexas.edu.

There will be 1 Quest homework assignment per week, due (usually) on Friday at 5pm CT. These are multiple choice assignments. You can receive a positive or negative score for each question, depending on how many tries you need (so don't guess wildly). However, your score for an assignment can never be negative. The lowest 2 homework scores will be dropped.

Please note that the University of Texas has many resources which you may avail yourself of in case of need. There is the Dean of Students office, there is the Sanger Center in Jester which provides both review classes and tutors. There is also the Counseling and Mental Health Center; Student Services Bldg (SSB), 5th Floor, Hours: M-F 8am-5pm, 512-471-3515, www.cmhc.utexas.edu.

Assessment

Your grade will be determined as a weighted average of your homework, quiz, and exam scores, according to the following percentages: Homework (30%), Quizzes (20%), ~~Midterms (30%), Final Exam (20%)~~, Midterm (25%), Final Exam (25%).

- **Exams:** Half of your grade will be determined by your performance on exams.

  ~~Midterm Exam 1: 9/28, in class.~~

  ~~Midterm Exam 2: 11/9, in class.~~

  Midterm Exam: 10/19, in class

  Final Exam: Friday, December 10, 2 PM - 5 PM

  Final Exam Make-up: Tuesday, December 14, 2-5 PM

  - You must bring a valid photo ID to all exams.

  - The final exam will be comprehensive.
  - **You are allowed to bring 2 pages of notes (1 piece of paper, double sided) to the midterm exams. You are allowed to bring 4 pages of notes (2 pieces of paper, double sided) to the final exam.**
  - **Books, phones, and calculators cannot be used or visible during exams.**

- **Quizzes:** 20% of your grade will be determined by your performance on bi-weekly quizzes, to be administered in class. Your lowest quiz score will be dropped.

  - You must bring a valid photo ID to all quizzes.
  - **You are not allowed notes or other written material during quizzes.**
  - **Books, phones, and calculators cannot be used or visible during quizzes.**

- **Homework:** The remaining 30% of your grade will be determined by your performance on weekly homework assignments, to be administered through Quest. Your lowest 2 homework scores will be dropped.

- **Makeup Policy:** Students will be excused from the quizzes/exams in the event of a serious illness or another emergency of such gravity. In such a case you must contact the instructor via email before the test, with at least 24 hours advance notice, if physically possible. You will be asked to present documentation indicating your inability to take the test at the scheduled time. If you are excused from a midterm exam, its grade weight will be shifted equally to the remaining midterm exam(s). If you are excused from a quiz, its grade weight will be shifted equally to the remaining quizzes. If you are excused from the final exam, a make-up exam will be given.

- **Grading Policy:** The course components will be assigned the following weights:

  ~~Midterm 1: 15%~~
  ~~Midterm 2: 15%~~
  Midterm (October 19): 25%
  Final exam: ~~20%~~ 25%
  Quizzes: 20%
  Homework: 30%

  Updated scoring policy (single midterm): If your final exam score is higher than your midterm score, then the final exam will instead be worth 30% and the midterm 20%. In other words, your final score will be computed by the following formula:

$$S = \max\{0.3H + 0.2Q + 0.25M + 0.25F,\\ 0.3H + 0.2Q + 0.20M + 0.3F\},$$

  where H is your average homework score, Q is your average quiz score, M is your midterm score, and F is your final exam score.

  All your raw homework and test scores will be posted to the Canvas gradebook. **It is your responsibility to ensure that your grades are recorded properly on Canvas.** If you spot an error, please alert the instructional staff and we will fix it.

  Warning: During the course of the semester, the Canvas gradebook will attempt to calculate a running "Total Score" for each student. This calculation is inaccurate and should be ignored.

If you want to know your running aggregate score you must compute the averages yourself, taking into account the dropped scores, and the grading policy outlined above.

At the end of the course, your final score will be computed using the weights and rules described above. Your letter grade is determined by the weighted final score. I will decide the grade cutoffs at the end of the semester, based partly on class performance (so there will be some "grading to the curve").

The cutoffs will be no stricter than the following: D for 60 or above, C- for 70 or above, C for 73 or above, C+ for 77 or above, B- for 80 or above, B for 83 or above, B+ for 87 or above, A- for 90 or above, and an A for 93 or above. The scale may be more lenient than that, at my discretion. These are lower bounds for your letter grade!

Further information and policies

- **Deadlines for Dropping a Course**

  The last day to drop a class for a possible refund is **September 10th**. After **October 28th** it is not possible to drop a course except for extenuating (usually non-academic) circumstances.

- **Optional materials**

  Graphing calculators and Wolfram Alpha may be used to check the accuracy of your homework solutions, however, they may not be used during quizzes or exams. Since the main role of the homework is to learn the material well enough to take tests, you are strongly advised to work through the homework problems by hand.

- **Special concerns**

  Students with special concerns, such as athletes who might miss class meetings, students with religious observances that interfere with class meetings, or students with disabilities who need special accommodation, should all notify the instructor by **September 21st** about these special needs.

- **Disabilities**

  If you are a student with a disability, or think you may have a disability, and need accommodations please contact Services for Students with Disabilities (SSD). You may refer to SSD?s website for contact and more information: https://diversity.utexas.edu/disability/. If you are already registered with SSD, please deliver your Accommodation Letter to me as early as possible in the semester so we can discuss your approved accommodations.

- **Academic Dishonesty**

  Academic dishonesty, such as cheating in tests or plagiarizing work, will not be tolerated, and may result in a failing grade and other measures under the rules of UT.

- **Mental Health Services**

  The Counseling and Mental Health Center is located on the fifth floor of the Student Services Building (SSB), with hours Monday through Friday, 8AM-5PM, and may be reached at 512-471-3515 (appointments) and 512-471-CALL (crisis line).

Schedule

Warning: Weekly coverage may change depending on the progress of the class.

wk.	Content	Main Ref.	Add. Ref.
1	• Aug 26: Linear Systems & Gauss Elimination.	• Lay 1.1, 1.2	• LM 00, 01
2	• Aug 31: Matrix-Vector Equations: $A\mathbf{x} = \mathbf{b}$. • Sept 2: Matrix Algebra & Invertibility.	• Lay 1.3, 1.4, 1.5 • Lay 2.1, 2.2, 2.3	• LM 00, 01 • LM 00, 01
3	• Sept 7: Intro to Matrix Transformations and Linear Independence • Sept 9: Determinants & Invertible Matrix Theorem.	• Lay 1.7, 1.8 • Lay 3.1, 3.2, 3.3	• • LM 00, 01
4	• Sept 14: Vector Spaces & Subspaecs. • Sept 16: Fundamental Matrix Subspaces.	• Lay 4.1 • Lay 4.2	• LM 02 • LM 05
5	• Sept 21: Linear Independence & Spanning Property. • Sept 23: Bases & Linear Transformations.	• Lay 4.3 • Lay 4.2, 4.3, 4.4	• LM 04 • LM 04, 06
6	• Sept 28: Change of Basis, Dimension, and Rank. • Sept 30: Inner Products & Orthogonal Sets	• Lay 4.5, 4.6, 4.7 • Lay 6.1, 6.2	• n/a • LM 08
7	• Oct 5: Orthogonal Projections. • Oct 7: Gram-Schmidt.	• Lay 6.3 • Lay 6.4	• LM 08 • LM 09
8	• Oct 12: QR Factorization & Least Squares. • Oct 14: Complex Algebra & Complex Exp. Signals.	• Lay 6.4, 6.5 • LM 07	• LM 09 • n/a
9	• Oct 19: Midterm Exam (no lecture) • Oct 21: Fourier Series.	• • LM 10	• • n/a
10	• Oct 26: Discrete Signal Processing: Time & Frequency Bases. • Oct 28: Discrete Fourier Transform.	• LM 11 • LM 12	• n/a • n/a
11	• Nov 2: Eigenvalues/Eigenvectors. • Nov 4: Diagonalization.	• Lay 5.1, 5.2 • Lay 5.3, 5.4	• LM 13 • LM 14
12	• Nov 9: Complex Eigenvalues. • Nov 11: Discrete Time Dynamical Systems & Markov Chains.	• Lay 5.5 • Lay 5.6	• LM 13, 14 • LM 15
13	• Nov 16: LTI Systems. • Nov 18: LTI Systems & Circular Convolution.	• LM 16 • LM 17	• n/a • n/a
14	• Nov 23: LTI Systems & Digital Filters. • Nov 25: Thanksgiving (no lecture).	• LM 18 •	• n/a •
15	• Nov 30: FFT. • Dec 2: FFT/Final Exam Review.	• LM 19 • LM 19	• n/a • n/a