Tom Roby's Math 2210Q Home Page Fall 2019
Applied Linear Algebra



Questions or Comments?

- *For questions about the **course material** or structure:* Please ask in the approriate discussion forum in Piazza/HuskyCT. (If you ask me such questions by email, I will redirect you there.) You can also talk to your classmates or me during class and right afterwards.
- *For questions about using HuskyCT:* Once you are logged in to HuskyCT, click Student Help in the top bar.
- *For questions about enrollment or suggestions for improving future versions of the course:* Please email the Professor: Tom Roby (delete initials from end).
- *Professor's Homepage:* http://www.math.uconn.edu/~troby
- Office: MONT 239; Phone: 860-486-8385.
- Office hours: Thurs 1:55–2:45 (right after class), Mon 9PM via Zoom and by appointment in MONT 239. I'm happy to answer questions or schedule appointments by email, which I check frequently (except for course content questions, which should go to the Piazza online discussion).

Class Information

COORDINATES: Classes meet Tuesdays and Thursdays 12:30-1:45 in MONT 421. The registrar calls this Section 007, #5610.

PREREQUISITES: MATH 1132 (Calulus II), 1152 (Honors Calculus II), OR 2142 (Advanced Calculus II).

TEXT: You will need to obtain a copy of the textbook, which is David C. Lay: *Linear Algebra and Its Applications*. Any edition you can find from the 3rd on should be fine for this class, except that the problem numbers may vary slightly. I recommend any version that you can get cheaply. The homework solutions are written for the 4th Ed.; a few of the numerical problems have different numbers, and a few of the theoretical problems have different problem numbers.

WEB RESOURCES: The homepage for this course will be available and updated at http://www.math.uconn.edu/~troby/math2210f19.

HuskyCT: We will make limited use of HuskyCT, because of its many deficiencies. A copy of the course schedule (below) will be posted there that includes links to solutions for selected HW exercises (which are for your personal use only, not to be shared). For classroom discussions, we will use Piazza, and assignments will generally be graded in hardcopy.

SOFTWARE: In most areas of mathematics it is frequently helpful to use computer software not only for computations, but also to explore examples, search for patterns, or test conjectures. For linear algebra there are several extensive and sophisticated commercial software packages, including MATLAB, Maple, and Mathematica. Matlab is particularly good at linear algebra for applications. All of these can be expensive, depending on your site license, but are currently available to UConn students.

An excellent alternative to the above is the free open-source computer algebra system Sage. There are many commands for linear algebra, and a textbook (linked below) has been written that makes significant use of Sage examples. Sage also provides a full-fledged programming environment via the Python programming language, but you don't need to be a programmer to use it. I highly recommend trying it out online, and installing a copy on your computer.

GRADING: Your grade will be based on two midterm exams, a final exam, worksheets, homework and participation.

The breakdown of points is:

Midterms	Final	Quizzes	Worksheets	Homework	Participation
20% each	30%	10%	10%	5%	5%

EXAMS: The exam dates are already scheduled, so please mark your calendars now (midterms in our classroom on **Thursday 26 September** and **Thursday 31 October** at the usual time; the final is TBD by registrar, sometime during the week of 9–15 December). All exams (like math itself at this level) are cumulative. No makeups will be given; instead if you have an approved reason for missing an exam, the final will count for the appropriately higher percentage. If you miss the final for reasons **approved by the Dean of Students**, then you will have one chance to take a make-up final exam in the second or third week of the following term.

QUIZZES: Quizzes will be given each Thursday (except midterm exam days), covering (a) sections from the previous week (at the level of HW exercises). There are no makeup quizzes; however, your lowest two quiz scores will be dropped. Here is a sample Practice Quiz so you know ahead of time what the format will be. (Solutions will be provided below.)

STUDENT WORKFLOW: In the course schedule, each section in the text has a single line indicating the topic, which may correspond to multiple video lectures. For each section you should:

- WATCH the VIDEO LECTURE(S) & take notes (pdfs of slides are available);
- DO the XIMERA ACTIVIES as a self check;
- DO the WORKSHEET problems during classtime and SUBMIT them by the deadline.
- USE the PIAZZA DISCUSSION BOARD, CLASSROOM INTERACTIONS, and OFFICE HOURS **anytime** you get seriously stuck;
- CHECK your WORKSHEET against the solutions (posted the morning after the due date);
- READ the TEXTBOOK to fill in gaps, see an alternate presentation, straighten out confusing points;
- DO as many HW problems as you can (prioritizing the **mandatory** ones, and SUBMIT them the TUESDAY after that section is covered;
- CHECK your HW against the solutions (posted the morning after the due date);

Most weeks we will cover three sections of the text, so many days have multiple sections due. The typical pattern will be as follows.

Tuesdays we will engage with worksheets for two sections, say A and B (so you should have already watched the videos and done the ximera activities for A and B before then). You will also hand in HW for the previous week.

Thursdays, you will hand in the worksheets from the previous Tuesday and take a quiz on the previous week's material. (This pattern may be disrupted some by midterms and review sessions.)

This course will be **fast-paced** and cover quite a bit of material. I strongly encourage you to **work ahead whenever possible**, since you never know when circumstances beyond your control may conspire to set you behind. The video lectures for the entire semester are already available.

VIDEO LECTURES: There are short video lectures, one or more for each section. I recommend (a) trying to watch them at higher speed (1.4x -- 2x) if they make sense, (b) rewinding to rewatch any parts you find confusing, and (c) watching them again later in the course to review (e.g., before exams).

XIMERA: Ximera provides an interactive platform for self-testing your understanding of the material. There is one Ximera activity for each section/topic. These will only count as **extra credit**towards your participation grade since they are meant to be formative rather than summative.

PIAZZA: The Piazza discussion board allows you to ask questions and interact with one another (and the instructor) between class meetings. . We use Piazza because of its excellent ability to include math notation using LaTeX/MathJax. The quality and quantity of your posts in Piazza count towards your participation grade. If you don't have questions, please try to help out your fellow students who might be confused.

PARTICIPATION: Ximera, Piazza, asking good questions in class and working productively in your groups all count towards your participation grade.

WORKSHEETS: Every section has a worksheet of basic problems, which you will be working on collaboratively with others during classtime. Worksheets are due a the start of the following class. These will be graded more for completion than for accuracy.

HOMEWORK: Recommended homework is assigned for each section, and is due in class on TUESDAY of the week following when that section is covered. The problems are grouped as *Mandatory (Mand.)* and *Recommended (Rec.)*. In order to be well-prepared for exams you should be able to do all the homework problems. As with the worksheets, solutions to these (for the 4th edition) will be released shortly afterwards, and they will be graded more for completion than accuracy. If you are using a different edition of the text, a few of the numerical exercises may differ, but you can ask on the discussion board what the correct answer is if you're really stuck after looking at the solution.

You may find some homework problems to be challenging, leading you to spend lots of time working on them and sometimes get frustrated. This is natural. I encourage you to work with other people in person or electronically. It's OK to get significant help from any resource, but in the end, please write your own solution in your own words. **Copying someone else's work without credit is plagiarism and will be dealt with according to university policy.** Equally importantly, it is a poor learning strategy.

LATE/UNREADABLE ASSIGNMENTS: Late homework and worksheets will receive half credit if received by the next class period after they were due, after that none.

ACADEMIC INTEGRITY: Please make sure you are familiar with and abide by The Student Code governing Academic Integrity in Undergraduate Education and Research. For quizzes and exams you may not discuss the material with anyone other than the instructor or offical proctor, and no calculators, phones, slide rules or other devices designed to aid communication or computation may be used unless otherwise specifically indicated on the exam.

CONTENT: Linear Algebra is a beautiful and important subject, rich in applications within mathematics and to many other disciplines. For many of you this is the first course to begin bridging the gap between concrete computations and abstract reasoning. Understanding the notions of vector spaces, linear (in)dependence, dimension, and linear transformations will help you make sense of matrix manipulations at a deeper level, clarifying the underlying structure.

APPLICATIONS: This class may be your only chance to understand the theory of linear algebra, i.e., **why** things work the way they do. In the future, this deeper understanding will be your key to harnessing the power of this subject to solve problems and shed light on your projects. We need all the time we have to get to the most important tools, e.g., the *Singular Value Decomposition (SCD)*,

leaving unfortunately little time to focus on applications. The text has a sections on applications sprinkled throughout, and I encourage you to read them as you have time, during or after the term, particularly ones relevant to your current career path.

ACCESSIBILITY & DISABILITY ISSUES: Please contact me and UConn's Center for Students with Disabilities as soon as possible if you have any accessibility issues, have a (documented) disability and wish to discuss academic accommodations, or if you would need assistance in the event of an emergency.

LEARNING: **The only way to learn mathematics is by doing it!** Complete each assignment to the best of your ability, and get help when you are confused. Take advantage of the online discussions and office hours and the wealth of information on the web.

2210Q LECTURE AND ASSIGNMENT SCHEDULE

Section	Due Date	Topics	Videos	Ximera	HW (due following Tues.)
§1.1	8/27 T	Intro to Linear Alg & Systems of Eqns.	E1, E1pdf, E2, E2pdf,	XA1.1	**Mand: 3, 12, 21, 24, 25, 31.** Rec: 1, 2, 10, 13, 15, 16, 32.
§1.2	8/27 T	Row Reduction & Echelon Forms	E3, E3pdf, E4, E4pdf,	XA1.2	**Mand: 2, 13, 19, 21, 24.** Rec: 10, 14, 29, 31.
§1.3	8/29 R	Vector Equations	E5, E5pdf, Ov, Ovpdf,	XA1.3	**Mand: 6, 7, 15, 21, 23, 25.** Rec: 3, 9, 12, 14, 22.
§1.4	9/3 T	Matrix Equations	E7, E7pdf, E8, E8pdf,	XA1.4	**Mand: 1, 13, 17, 19, 22, 23, 25.** Rec: 4, 7, 9, 11, 31.
§1.5	9/3 T	Solution Sets of Linear Systems	E9, E9pdf, E10, E10pdf,	XA1.5	**Mand: 11, 15, 19, 23, 30, 32.** Rec: 2, 6, 18, 22, 27.
§1.7	9/5 R	Linear Independence	E11, E11pdf, E12, E12pdf,	XA1.7	**Mand: 1, 7, 15, 16, 20, 21.** Rec: 2, 5, 9, 32, 34, 35.
§1.8	9/10 T	Linear Transformations	M2, M2pdf,	XA1.8	**Mand: 2, 8, 9, 21, 31.**

					Rec: 4, 13, 15, 17.
§1.9	9/10 T	Matrix of Linear Transformations	M3, M3pdf, M4, M4pdf,	XA1.9	**Mand: 1, 8, 13, 19, 23, 26, 34.** Rec: 2, 7, 9, 15, 20, 32, 36.
§2.1	9/12 R	Matrix Operations and Inverses	M5, M5pdf, M6, M6pdf,	XA2.1	**Mand: 5, 7, 10, 15.** Rec: 2, 18, 20, 22, 27, 28.
§2.2	9/17 T	Inverse of a Matrix	M7, M7pdf, M8, M8pdf,	XA2.2	**Mand: 9, 11, 15, 16, 29.** Rec: 3, 6, 7, 13, 23, 24, 32, 37.
§2.3	9/17 T	Characterizations of Invertible Matrices	M9, M9pdf,	XA2.3	**Mand: 11, 13, 15, 28.** Rec: 1, 3, 5, 8, 17, 26, 35.
§3.1	9/19 R	Intro to Determinants	D1, D1pdf,	XA3.1	**Mand: 13, 20, 21, 37, 39.** Rec: 4, 8, 11, 31, 32.
§3.2	9/19 R	Properties of Determinants	D2, D2pdf, D3, D3pdf,	XA3.2	**Mand: 8, 10, 16, 19, 27, 34.** Rec: 2, 3, 18, 20, 26, 32, 36, 40.
§1.1–2.5	9/24 T	Catchup & Review Day			**Do Practice Midterm by today!**

THURSDAY 26 September: FIRST MIDTERM EXAM (through §2.3)

HW 3.1–3.2 due on Tues 10/1

§3.3	10/1 T	Cramer's Rule and Volumes	D4, D4pdf, D5, D5pdf,	XA3.3	**Mand: 6, 22, 23, 26.** Rec: 4, 5, 29, 30.
§4.1	10/1 T	Vector Spaces & Subspaces	B1, B1pdf, B2, B2pdf,	XA4.1	**Mand: 3, 8, 13, 23, 31.** Rec: 1, 12, 15, 17, 22, 32.
§4.2	10/3 R	Null Spaces, Columns Spaces and Linear Transf.	B3, B3pdf, B4, B4pdf,	XA4.2	**Mand: 11, 17, 25, 33, 34.** Rec: 3, 6, 14, 19, 21, 24, 32, 36.
§4.3	10/8	Bases and Linearly	B5, B5pdf, B6,	XA4.3	**Mand: 14, 21, 23,**

	T	Independent Sets	B6pdf,		**29, 30.** Rec: 3, 4, 8, 10, 15, 24, 31.
§4.4	10/8 T	Coordinate Systems	B7, B7pdf, B8, B8pdf,	XA4.4	**Mand: 13, 15, 17, 21, 32.** Rec: 2, 3, 5, 7, 10, 11, 23.
§4.5	10/10 R	Dimension of a Vector Space	B9, B9pdf, B10, B10pdf,	XA4.5	**Mand: 8, 21, 23, 26, 29.** Rec: 1, 4, 11, 14, 28.
§4.6	10/15 T	Rank	B11, B11pdf,	XA4.6	**Mand: 7, 17, 24, 27, 28.** Rec: 2, 5, 10, 13, 19.
§4.7	10/15 T	Change of Basis	B12, B12pdf,	XA4.7	**Mand: 3, 11, 13, 15.** Rec: 1, 5, 7, 9.
§5.1	10/17 R	Eigenvectors & Eigenvalues	F1, F1pdf, F2, F2pdf,	XA5.1	**Mand: 2, 6, 13, 21, 23, 31.** Rec: 7, 11, 15, 19, 24, 25, 27.
§5.2	10/22 T	Characteristic Equation	F3, F3pdf, F4, F4pdf,	XA5.2	**Mand: 9, 19, 21.** Rec: 2, 5, 12, 15, 20.
§5.3	10/22 T	Diagonalization	F5, F5pdf,	XA5.3	**Mand: 11, 21, 24, 26.** Rec: 1, 4, 5, 9, 15, 17.
§5.4	10/24 R	Eigenvectors & Linear Transformations	F6, F6pdf,	XA5.4	**Mand: 6, 7, 10, 15, 25.** Rec: 1, 3, 16, 23.
§1.1–5.4	10/29 T	Catchup & Review Day			Do Practice Midterm 2 by today

THURSDAY 31 OCTOBER SECOND MIDTERM EXAM (through §5.4)

HW 5.2–4 due on TUES 11/5.

§6.1	11/5 T	Inner Product & Orthogonality	G1, G1pdf,	XA6.1	**Mand: 3, 5, 19, 25, 27, 29.** Rec: 10, 16, 18, 23.
§6.2	11/5 T	Orthogonal Sets	G2, G2pdf, G3, G3pdf, G4, G4pdf,	XA6.2	**Mand: 8, 14, 23, 27, 28, 29.**

					Rec: 3, 6, 9, 11, 20, 21, 26.
§6.3	11/7 R	Orthogonal Projections	G5, G5pdf,	XA6.3	**Mand: 1, 7, 17, 21, 24.** Rec: 6, 9, 11, 13, 23.
§6.4	11/12 T	Gram–Schmidt	G6, G6pdf, F7, F7pdf,	XA6.4	**Mand: 17, 19.** Rec: 1, 3, 7, 9, 11.
§6.5	11/12 T	Least-Squares Problems	G7, G7pdf,	XA6.5	**Mand: 3, 17, 19, 21.** Rec: 5, 7, 9, 11.
§7.1	11/14 R	Diagonalization of Symmetric Matrices	F8, F8pdf,	XA7.1	**Mand: 1, 3, 5, 8, 13, 25.** Rec: 10, 17, 19, 29.
§7.2	11/19 T	Quadratic Forms	F9, F9pdf, F10, F10pdf,	XA7.2	**Mand: 8, 11, 21, 27.** Rec: 1, 5, 13, 19.
§7.3	11/19 T	Constrained Optimization	F11, F11pdf,	XA7.3	**Mand: 1, 3, 7, 11.** Rec: 5.
§7.4	11/21 R	Singular Value Decomposition (SVD)	F12,F12pdf,	No XA7.4	**Mand: 3, 9, 17, 19.** Rec: 1, 11, 18.

25–30 NOVEMBER IS THANKSGIVING BREAK: NO CLASSES

§7.5	12/3 T	Principal Component Analysis (PCA)
§	12/5 R	Google PageRank and/or Review Day

WEEK OF 9–15 DEC (TBD by Registrar): FINAL EXAM (covers entire course)

Web Resources

- Rob Beezer has a free open-source textbook in linear algebra that uses the open-source software package Sage for computations. You can download a print edition, or view the online hyperlinked version. (This text is geared a bit more for those transitioning to theoretical math courses.)

- The MIT 18.06 (Linear Algebra) website has lots of resources, including Mathlets (small web-based teaching tools) (called "Demos" under the Extras link.). See also resources related to Strang's standard textbook *Introduction to Linear Algebra*, in its 5th edition as of 2016. (This text is more geared towards applications.) Strang's video lectures are available on YouTube, or cataloged at the MIT 18.06 Course Website for Fall 2011.

- A Linear Transformation Viewer by Lauren K. Williams.

- This is a brief blurb on how Google ranks pages when you give is a search query and a more detailed accessible exposition from the AMS math samplings website.

- An elementary exposition of the singular value decomposition from the AMS math samplings website.

- Here's an Online Mind Reader. Can you figure out how it works?

NEWS, NOTES, AND HANDOUTS

Handouts

- Practice Quiz #1
- Practice Midterm 1

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