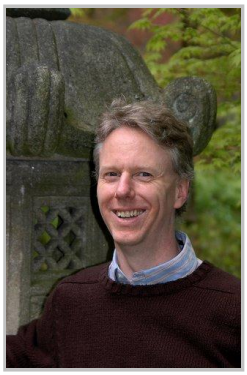
# Tom Roby's Math 2210Q Home Page (Summer 2023)
# Applied Linear Algebra

## *See UPDATED ONLINE EXAM and COURSE PACE notes (in Red) below!*

### Questions or Comments?



- *For questions about the **course material** or **structure/logistics**:* Please ask in the approriate discussion forum in Zulip.
- *For questions about using HuskyCT:* Once you are logged in to HuskyCT, look for **Tech Help** under **Resources** in the left menu bar.
- *For questions about assignment grades:* Please email the TA managing grades for the course (listed in HuskyCT).
- *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://www2.math.uconn.edu/~troby
- *Problem Solving Sessions and Office hours*: will be held online over Zoom at times to be determined during the first week. We are also happy to respond to questions and comments within the Zulip discussion forum, which we check regularly.

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## Class Information

*INSTRUCTIONAL TEAM:*

- *Lead Instructor:* Tom Roby;

*COORDINATES:* Classes meet online, and you can find everything you need linked within Husky CT.

*PREREQUISITES:* MATH 1132 (Calculus 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's textbook *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. **You do not need any special access code** (despite what the UConn bookstore may say). 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:* **(1)** For overall course information, this website (that you are on): http://www2.math.uconn.edu/~troby/math2210sum23 has static information about the course, with links to many of the course materials.
**(2)** A version of the schedule on the HuskyCT site will be updated with homework and worksheet solutions.
**(3)** The class discussion board (Zulip) will include announcements, practice exams, and other information.
**(4)** Links to additional web resources are posted below the schedule.

*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 Beezer's textbook (linked above) 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 | Worksheets | Homework | Participation |
|---|---|---|---|---|
| 20% each | 30% | 10% | 8% | 12% |

*EXAMS:* Exams will be administered **online,** probably over the Zoom platform. You must take your exams with a **webcam** and **decent internet connectivity** that allows us to see you continuously during the exam administration. We also plan to do some short follow-up oral examinations to check your understanding in case there are any concerns (e.g., your internet goes out during the exam administration, you have problems uploading files, etc.).

The dates are already scheduled (see below), so please mark your calendars now. 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 early September.

*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 ACTIVITIES as a self check;
- DO the WORKSHEET problems and SUBMIT them by the deadline on the schedule;
- USE the ZULIP message board or ask in **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, and SUBMIT them the day AFTER the worksheet is due;
- CHECK your HW against the solutions (posted the morning after the due date);

Note that many days have multiple sections due. This course will be **fast-paced** and cover the *full semester's worth of material*. Please make sure you clear your calendar to allow adequate time for all the activities and for the material to sink in. If you have a full-time job, plan to have no social life. I strongly encourage you to **work ahead whenever possible**, since you never know when circumstances beyond your control may conspire to set you behind. Catch-up time is much more limited than during a regular term.

*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 towards your participation grade since they are meant to be formative rather than summative.

*ZULIP:* The Zulip discussion board is what makes this class a community since we do not meet in person. We use Zulip because of its excellent ability to include math notation using LaTeX/MathJax. The quality and quantity of your posts in Zulip count towards your participation grade. If you don't have questions, please try to help out your fellow students who might be confused.

*DISCUSSION SECTIONS:*We will survey student availability on the first day and try to create *discussion sections* for small groups to meet via videoconferencing. Attending these **will count towards your participation grade**. Here you can get your questions answered, or watch the instructors go over problems.

*PARTICIPATION:* Your participation grade will be a linear combination (with positive coefficients) of your: **(1)** completed Ximera activities, **(2)** responding to class surveys, AND your **(3)** attendance at discussion sections or **(4)** posts on Zulip (at least a couple each week if you aren't attending discussions).

*WORKSHEETS:* Every section has a worksheet of basic problems. Attempt these as soon as you're ready, and upload your written solutions in HuskyCT (as a readable PDF file) by 11:59PM on the due date. (Generally if a

submission arrives no more than 2 hours late, we will count it as "on time".) Solutions to these will be released shortly afterwards. These will be graded for completion rather than accuracy.

***IMPORTANT:*** *HuskyCT does not handle other image formats as well as PDF, so please make sure you upload a* ***SINGLE PDF*** *file for each assignment. There are free apps (e.g., "CamScanner") that allow you to take a picture with a smart phone that is immediately converted to PDF.*

*HOMEWORK:* Homework is assigned for each section, and is due one day AFTER the corresponding worksheet (again uploaded as a **SINGLE PDF** by 11:59PM, with a 2-hour grace period). The problems are grouped as *Mandatory (Mand.)* and *Recommended (Rec.)*. As with the worksheets, solutions to these will be released shortly afterwards, and they will be graded for completion rather than accuracy. In order to be well-prepared for exams you should be able to do all the homework problems.

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. 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 (up to 24 hours beyond the 2-hour grace period) will receive half credit, after that none. Homework and worksheets that are not easily readable (e.g., because of bad image quality) will not be graded and will receive no credit.

*ACADEMIC INTEGRITY:* Please make sure you are familiar with and abide by The Student Code governing Academic Integrity in Undergraduate Education and Research. For 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.

*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 | Worksheet | Homework (due next day) |
|---|---|---|---|---|---|---|
| | | | **WEEK 1** | | | |
| §1.1 | 5/30 Tu | Intro to Linear Alg & Systems of Eqns. | E1, E1pdf, E2, E2pdf, | XA1.1 | W1.1 | **Mand: 3, 12, 21, 24, 25, 31.** Rec: 1, 2, 10, 13, 15, 16, 32. |
| §1.2 | 5/30 Tu | Row Reduction & Echelon Forms | E3, E3pdf, E4, E4pdf, | XA1.2 | W1.2 | **Mand: 2, 13, 19, 21, 24.** Rec: 10, 14, 29, 31. |
| §1.3 | 5/31 We | Vector Equations | E5, E5pdf, Ov, Ovpdf, | XA1.3 | W1.3 | **Mand: 6, 7, 15, 21, 23, 25.** Rec: 3, 9, 12, 14, 22. |

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| §1.4 | 6/1 Th | Matrix Equations | E7, E7pdf, E8, E8pdf, | XA1.4 | W1.4 | **Mand: 1, 13, 17, 19, 22, 23, 25.** Rec: 4, 7, 9, 11, 31. |
| §1.5 | 6/1 Th | Solution Sets of Linear Systems | E9, E9pdf, E10, E10pdf, | XA1.5 | W1.5 | **Mand: 11, 15, 19, 23, 30, 32.** Rec: 2, 6, 18, 22, 27. |
| §1.7 | 6/3 Sa | Linear Independence | E11, E11pdf, E12, E12pdf, | XA1.7 | W1.7 | **Mand: 1, 7, 15, 16, 20, 21.** Rec: 2, 5, 9, 32, 34, 35. |
| §1.8 | 6/3 Sa | Linear Transformations | M2, M2pdf, | XA1.8 | W1.8 | **Mand: 2, 8, 9, 21, 31.** Rec: 4, 13, 15, 17. |
| | | **WEEK 2** | | | | |
| §1.9 | 6/5 Mo | Matrix of Linear Transformations | M3, M3pdf, M4, M4pdf, | XA1.9 | W1.9 | **Mand: 1, 8, 13, 19, 23, 26, 34.** Rec: 2, 7, 9, 15, 20, 32, 36. |
| §2.1 | 6/5 Mo | Matrix Operations and Inverses | M5, M5pdf, M6, M6pdf, | XA2.1 | W2.1 | **Mand: 5, 7, 10, 15.** Rec: 2, 18, 20, 22, 27, 28. |
| §2.2 | 6/6 Tu | Inverse of a Matrix | M7, M7pdf, M8, M8pdf, | XA2.2 | W2.2 | **Mand: 9, 11, 15, 16, 29.** Rec: 3, 6, 7, 13, 23, 24, 32, 37. |
| §2.3 | 6/6 Tu | Characterizations of Invertible Matrices | M9, M9pdf, | XA2.3 | W2.3 | **Mand: 11, 13, 15, 28.** Rec: 1, 3, 5, 8, 17, 26, 35. |
| §1.1–2.3 | 6/7 We | Catchup & Review Day | | | | **Do Practice Midterm by today!** |
| | | **THURSDAY 8 JUNE: FIRST MIDTERM EXAM (through §2.3)** **Tentatively 8:00PM–9:30PM** | | | | |
| §3.1 | 6/10 Sa | Intro to Determinants | D1, D1pdf, | XA3.1 | W3.1 | **Mand: 13, 20, 21, 37, 39.** Rec: 4, 8, 11, 31, 32. |
| §3.2 | 6/10 Sa | Properties of Determinants | D2, D2pdf, D3, D3pdf, | XA3.2 | W3.2 | **Mand: 8, 10, 16, 19, 27, 34.** Rec: 2, 3, 18, 20, 26, 32, 36, 40. |
| §3.3 | 6/10 Sa | Cramer's Rule and Volumes | D4, D4pdf, D5, D5pdf, | XA3.3 | W3.3 | **Mand: 6, 22, 23, 26.** Rec: 4, 5, 29, 30. |
| | | **WEEK 3** | | | | |
| §4.1 | 6/12 Mo | Vector Spaces & Subspaces | B1, B1pdf, B2, B2pdf, | XA4.1 | W4.1 | **Mand: 3, 8, 13, 23, 31.** Rec: 1, 12, 15, 17, 22, 32. |
| §4.2 | 6/12 Mo | Null Spaces, Columns Spaces and Linear Transf. | B3, B3pdf, B4, B4pdf, | XA4.2 | W4.2 | **Mand: 11, 17, 25, 33, 34.** |

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| | | | | | | Rec: 3, 6, 14, 19, 21, 24, 32, 36. |
| §4.3 | 6/13 Tu | Bases and Linearly Independent Sets | B5, B5pdf, B6, B6pdf, | XA4.3 | W4.3 | **Mand: 14, 21, 23, 29, 30.** Rec: 3, 4, 8, 10, 15, 24, 31. |
| §4.4 | 6/14 We | Coordinate Systems | B7, B7pdf, B8, B8pdf, | XA4.4 | W4.4 | **Mand: 13, 15, 17, 21, 32.** Rec: 2, 3, 5, 7, 10, 11, 23. |
| §4.5 | 6/14 We | Dimension of a Vector Space | B9, B9pdf, B10, B10pdf | XA4.5 | W4.5 | **Mand: 8, 21, 23, 26, 29.** Rec: 1, 4, 11, 14, 28. |
| §4.6 | 6/15 Th | Rank | B11, B11pdf, | XA4.6 | W4.6 | **Mand: 7, 17, 24, 27, 28.** Rec: 2, 5, 10, 13, 19. |
| §4.7 | 6/17 Sa | Change of Basis | B12, B12pdf, | XA4.7 | W4.7 | **Mand: 3, 11, 13, 15.** Rec: 1, 5, 7, 9. |
| §5.1 | 6/17 Sa | Eigenvectors & Eigenvalues | F1, F1pdf, F2, F2pdf, | XA5.1 | W5.1 | **Mand: 2, 6, 13, 21, 23, 31.** Rec: 7, 11, 15, 19, 24, 25, 27. |
| | | **WEEK 4** | | | | |
| §5.2 | 6/19 Mo | Characteristic Equation | F3, F3pdf, F4, F4pdf, | XA5.2 | W5.2 | **Mand: 9, 19, 21.** Rec: 2, 5, 12, 15, 20. |
| §5.3 | 6/19 Mo | Diagonalization | F5, F5pdf, | XA5.3 | W5.3 | **Mand: 11, 21, 24, 26.** Rec: 1, 4, 5, 9, 15, 17. |
| §1.1–5.3 | 6/20 Tu | Catchup & Review Day | | | | **Do Practice Midterm by today!** |
| | | **WEDNESDAY 21 JUNE: SECOND MIDTERM EXAM (through §5.3)** **Tentatively 8:00PM–09:30PM** | | | | |
| §5.4 | 6/23 Fr | Eigenvectors & Linear Transformations | F6, F6pdf, | XA5.4 | W5.4 | **Mand: 6, 7, 10, 15, 25.** Rec: 1, 3, 16, 23. |
| §6.1 | 6/23 Fr | Inner Product & Orthogonality | G1, G1pdf, | XA6.1 | W6.1 | **Mand: 3, 5, 19, 25, 27, 29.** Rec: 10, 16, 18, 23. |
| §6.2 | 6/24 Sa | Orthogonal Sets | G2, G2pdf, G3, G3pdf, G4, G4pdf, | XA6.2 | W6.2 | **Mand: 8, 14, 23, 27, 28, 29.** Rec: 3, 6, 9, 11, 20, 21, 26. |
| §6.3 | 6/24 Sa | Orthogonal Projections | G5, G5pdf, | XA6.3 | W6.3 | **Mand: 1, 7, 17, 21, 24.** Rec: 6, 9, 11, 13, 23. |
| | | **WEEK 5** | | | | |

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| §6.4 | 6/26 Mo | Gram-Schmidt | G6, G6pdf, F7, F7pdf, | XA6.4 | W6.4 | **Mand: 17, 19.** Rec: 1, 3, 7, 9, 11. |
| §6.5 | 6/26 Mo | Least-Squares Problems | G7, G7pdf, | XA6.5 | W6.5 | **Mand: 3, 17, 19, 21.** Rec: 5, 7, 9, 11. |
| §7.1 | 6/27 Tu | Diagonalization of Symmetric Matrices | F8, F8pdf, | XA7.1 | W7.1 | **Mand: 1, 3, 5, 8, 13, 25.** Rec: 10, 17, 19, 29. |
| §7.2 | 6/28 We | Quadratic Forms | F9, F9pdf, F10, F10pdf, | XA7.2 | W7.2 | **Mand: 8, 11, 21, 27.** Rec: 1, 5, 13, 19. |
| §7.3 | 6/28 We | Constrained Optimization | F11, F11pdf, | XA7.3 | W7.3 | **Mand: 1, 3, 7, 11.** Rec: 5. |
| §1.1–7.4 | 6/29 Th | Catchup & Review Day | | | | **Do Practice Final by today!** |

**FRIDAY 30 JUNE: FINAL EXAM (through §7.1)**
**Tentatively in the MORNING!!, 10:00AM–12:00 Noon**

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## Additional 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.)
- A free textbook by Jim Hefferon
- Another free textbook with a more abstract focus by Anne Schilling and her students
- Our text's useful site with review sheets and downloadable data
- 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.
- The *3Blue1Brown* Essence of Linear Algebra video animations
- 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?