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**Meetings:** MTWF 9:40 - 10:30 AM in AEB 320

**Instructor:** Dr. Alexander Rasmussen

**Email address:** rasmussen@math.utah.edu

**Office hours:** Monday 4-5, Thursday 4-5 on Zoom (see Canvas for details) or by appointment

**Text:** *Linear Algebra and Its Applications*, Lay, Lay, and McDonald (5th edition).

For information about purchasing the textbook, visit [math.utah.edu/resources/bookinfo.php](http://math.utah.edu/resources/bookinfo.php)

**Course information:** Math 2270, Linear Algebra, is a 4 credit course.

**Prerequisite information:**

- C or better in ((MATH 1260 OR MATH 1320 OR MATH 1321 OR MATH 2210) OR (MATH 1220 AND Full Major status in Computer Science OR Computer Engineering OR Data Science))
- OR B or better in MATH 1220

**Course description:** Euclidean space, linear systems, Gaussian elimination, determinants, inverses, vector spaces, linear transformations, quadratic forms, least squares and linear programming, eigenvalues and eigenvectors, diagonalization. Includes theoretical and computer lab components.

**Canvas and Zoom:** All homework will be posted and collected on Canvas. All student grades will be stored and calculated on Canvas. In addition, I will frequently post additional information and announcements on Canvas. Please check frequently for this information. You are welcome to use the Canvas discussion board to discuss problems and concepts from class.

If social distancing guidelines change, we may change to a Zoom lecture format.

**Online submission:** *Solutions to all homework assignments will be submitted online via Canvas.* You will be required to upload a pdf of your solutions. I recommend writing your solutions on paper and scanning your written homework with the (free) app “Genius scan” for Android or the (free) app “Scannable” for iOS devices. However, you are free to use any device and any program to capture your solutions and upload them. For ease of reading, I recommend that you:

- (1) use plain (non-ruled) paper,
- (2) write your homework solutions in pen,
- (3) lay your page flat on a surface and capture it from above.

Your solutions should be written in plain English with mathematical notation and must be neatly presented and easy to read. You will be graded on the mathematical and logical coherence of your arguments. *Please check your pdf file after uploading it* to make sure that it is readable. While I will make efforts to accommodate you, unreadable pdfs may not be graded in extreme cases.

**Grading:** The following are the grade components and the percentage each contributes to a student’s final grade:

- **Homework assignments (25%):** Assignments will be posted on Canvas and will be due by Thursday night at 11:59 pm most weeks of the semester. There will be a grader for the class. The grader will grade five problems each week, to be graded out of 10 possible points.
- **Midterms (48%, 16% each):** Each midterm will be approximately 50 minutes, held in class. A practice exam will be posted a week prior to the midterm that will cover the same material. The dates for the exams will be:
  - Midterm 1: Friday, October 1
  - Midterm 2: Friday, November 5

– Midterm 3: Friday, December 3

- **Final exam (27%):** There will be a 2 hour final exam. It will be held on Monday, December 13 at 8 am. The final will be cumulative.

Final letter grades will be determined by the following ranges:

	A: 93% – 100%	A-: 90% – 93%
B+: 87% – 90%	B: 83% – 87%	B-: 80% – 83%
C+: 77% – 80%	C: 73% – 77%	C-: 70% – 73%
D+: 67% – 70%	D: 63% – 67%	D-: 60% – 63%
E: 0% – 60%		

If necessary, the instructor may revise the grade ranges *downward* so that a *lower numerical* grade will result in a *higher letter* grade. Students will be notified of any such changes to the grading scheme.

### Resources:

- **Office hours:** Office hours are a great chance for students to get help with homework problems and to deepen their understanding of concepts from class. I encourage you to attend them. See Canvas for the meeting times and meeting IDs.
- **Tutoring center and computer lab:** There is free tutoring in the T. Benny Rushing Mathematics Student Center (room 155C), as well as a computer lab. Presently, tutoring is being conducted in person. They may offer online options as well in the near future. See their website, [math.utah.edu/undergraduate/mathcenter.php](http://math.utah.edu/undergraduate/mathcenter.php) for updates and further information.
- **The Learning Center:** The Learning Center offers private tutoring sessions. The first three sessions are free, while further sessions will incur a small fee. See [learningcenter.utah.edu](http://learningcenter.utah.edu) for more information.

**Expected learning outcomes:** Upon successful completion of this course, a student should be able to complete tasks in the following areas:

1. Row reduction — use row reduction to solve linear systems of equations; apply this to compute bases of vector spaces, kernels of linear transformations, and inverses of matrices.
2. Matrices — compute matrix representatives of linear transformations; perform computations with matrices including products, determinants, eigenvalues, eigenvectors, and inverses; understand and apply changes of bases; understand the geometry of matrices as linear transformations.
3. Abstract vector spaces — prove basic facts about abstract vector spaces and linear transformations; compute bases and dimensions of vector spaces; understand intersections of subspaces and their dimensions.
4. Geometry of Euclidean space — compute inner products and orthogonal projections; construct orthonormal bases using the Gram-Schmidt process.
5. Quadratic forms — understand the spectral theorem and diagonalization for symmetric matrices; compute quadratic forms and their properties.

**Class attendance:** Given the nature of this course, attendance is required and adjustments cannot be granted to allow non-attendance. However, if you need to seek an ADA accommodation to request an exception to this attendance policy due to a disability, please contact the *Center for Disability and Access (CDA)*. CDA will work with us to determine what, if any, ADA accommodations are reasonable and appropriate.

**Student responsibilities:** All students are expected to maintain professional behavior in the classroom setting, according to the Student Code, spelled out in the Student Handbook. Students have specific rights

in the classroom as detailed in Article III of the Code. The Code also specifies proscribed conduct (Article XI) that involves cheating on tests, plagiarism, and/or collusion, as well as fraud, theft, etc. Students should read the Code carefully and know they are responsible for the content. According to Faculty Rules and Regulations, it is the faculty responsibility to enforce responsible classroom behaviors, and I will do so, beginning with verbal warnings and progressing to dismissal from class and a failing grade. Students have the right to appeal such actions to the Student Behavior Committee. See [regulations.utah.edu/academics/6-400.php](http://regulations.utah.edu/academics/6-400.php)

**ADA statement:** The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability & Access, 162 Olpin Union Building, 801-581-5020. CDA will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the Center for Disability & Access.

**Addressing sexual misconduct:** Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted on the basis of your sex, including sexual orientation or gender identity/expression, you are encouraged to report it to the University's Title IX Coordinator, Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, [oeo.utah.edu/contact-us/index.php](http://oeo.utah.edu/contact-us/index.php) or to the Office of the Dean of Students, 270 Union Building, 801-581-7066, [deanofstudents.utah.edu/](http://deanofstudents.utah.edu/). For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to police, contact the Department of Public Safety, 801-585-2677(COPS), [police.utah.edu/](http://police.utah.edu/).

**Campus safety:** The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit [safeu.utah.edu](http://safeu.utah.edu).

**Student names and personal pronouns:** Class rosters are provided to the instructor with the student's legal name as well as preferred first name (if previously entered by you in the Student Profile section of your CIS account). While CIS refers to this as merely a preference, I will honor you by referring to you with the name and pronoun that feels best for you in class and on exams, homework, etc. Please advise me of any name or pronoun changes (and update CIS) so I can help create a learning environment in which you, your name, and your pronoun will be respected. If you need assistance getting your preferred name on your UID card, please visit the LGBT Resource Center Room 409 in the Olpin Union Building, or email [bpeacock@sa.utah.edu](mailto:bpeacock@sa.utah.edu) to schedule a time to drop by. The LGBT Resource Center hours are M-F 8am-5pm, and 8am-6pm on Tuesdays.

**University counseling center:** The UCC staff is committed to supporting the mental health needs of our campus community. Their phone number is 801-581-6826. Their hours are Monday-Friday, 8:00am-5:00pm. For after-hours emergencies, contact the 24/7 Crisis Line: 801-587-3000. More information is at [counselingcenter.utah.edu/](http://counselingcenter.utah.edu/).

**Office of the Dean of Students:** The Office of the Dean of Students is dedicated to being a resource to students through support, advocacy, involvement, and accountability. It serves as a support for students facing challenges to their success as students, and assists with the interpretation of University policy and regulations. To contact the Office of the Dean of Students, please email [deanofstudents@utah.edu](mailto:deanofstudents@utah.edu) or call 801-581-7066. There is more information at [deanofstudents.utah.edu/](http://deanofstudents.utah.edu/).

**COVID-19 Considerations:** Students must self-report if they test positive for COVID-19 via [coronavirus.utah.edu](https://coronavirus.utah.edu)

University leadership has urged all faculty, students, and staff to model the vaccination, testing, and masking behaviors we want to see in our campus community. These include:

- Vaccination
- Masking indoors
- If unvaccinated, getting weekly asymptomatic coronavirus testing
- Vaccination
  - Get a COVID-19 vaccination if you have not already done so. Vaccination is proving highly effective in preventing severe COVID-19 symptoms, hospitalization and death from coronavirus. Vaccination is the single best way to stop this COVID resurgence in its tracks.
  - Many in the campus community already have gotten vaccinated:
    - \* More than 80% of U. employees
    - \* Over 70% of U. students
  - Visit [mychart.med.utah.edu/](https://mychart.med.utah.edu/), [alert.utah.edu/covid/vaccine](https://alert.utah.edu/covid/vaccine), or [vaccines.gov/](https://vaccines.gov/) to schedule your vaccination.
- Masking
  - While masks are no longer required outside of Health Sciences facilities, UTA buses and campus shuttles, CDC guidelines now call for everyone to wear face masks indoors.
    - \* Check the CDC website periodically for masking updates — [cdc.gov/coronavirus/2019-ncov/vaccines/fully-vaccinated-guidance.html](https://cdc.gov/coronavirus/2019-ncov/vaccines/fully-vaccinated-guidance.html)
    - \* Treat masks like seasonal clothing (i.e. during community surges in COVID transmission, masks are strongly encouraged indoors and in close groups outside).
- Testing
  - If you are not yet vaccinated, get weekly asymptomatic coronavirus tests. This is a helpful way to protect yourself and those around you because asymptomatic individuals can unknowingly spread the coronavirus to others.
  - Asymptomatic testing centers are open and convenient:
    - \* Online scheduling Saliva test (no nasal swabs)
    - \* Free to all students returning to campus (required for students in University housing)
    - \* Results often within 24 hours
    - \* Visit [alert.utah.edu/covid/testing](https://alert.utah.edu/covid/testing)
  - Remember: Students must self-report if they test positive for COVID-19 via this website: [coronavirus.utah.edu/](https://coronavirus.utah.edu/).
- Student Mental Health Resources
  - Rates of burnout, anxiety, depression, isolation, and loneliness have noticeably increased during the pandemic. If you need help, reach out for campus mental health resources, including counseling, trainings and other support.
  - Consider participating in a Mental Health First Aid or other wellness-themed training provided by our Center for Student Wellness and sharing these opportunities with your peers, teaching assistants and department colleagues.

**Approximate calendar:** On the following page I include an *approximate* schedule of lectures and exams. The dates of the exams are definite. However, I will likely *deviate* frequently from the lecture schedule. Thus it should be used as a rough guide for when in the semester various topics will be taught.

## Approximate calendar

Week	Day	Monday	Tuesday	Wednesday	Friday
1	<b>August 23</b>	<b>Intro</b>	1.1 - Systems of Linear Eqs	1.1 - Systems of Linear Eqs	1.2 - Row Reduction and Echelon Forms
2	<b>August 30</b>	1.2 - Row Reduction and Echelon Forms	1.3 - Vector Eqs	1.4 - The Matrix Eq $A\mathbf{x} = \mathbf{b}$	1.5 - Solution Sets of Linear Systems
3	<b>September 6</b>	<b>Labor day</b>	1.6 - Applications of Linear Systems	1.7 - Linear Independence	1.8 - Intro to Linear Transformations
4	<b>September 13</b>	1.9 - The Matrix of a Linear Transformation	2.1 - Matrix Operations	2.1 - Matrix Operations	2.2 - The Inverse of a Matrix
5	<b>September 20</b>	2.2 - The Inverse of a Matrix	2.3 - Characterizations of Invertible Matrices 2.4 - Partitioned Matrices	2.5 - Matrix Factorizations	2.8 - Subspaces of $\mathbb{R}^n$
6	<b>September 27</b>	2.9 - Dimension and Rank	3.1 - Intro to Determinants	3.2 - Properties of Determinants	<b>50 Minute Test</b> Sections 1.1 — 2.2
7	<b>October 4</b>	3.2 - Properties of Determinants	3.3 - Cramer's Rule, Volume, and Linear Transformations	4.1 - Vector Spaces and Subspaces	4.1 - Vector Spaces and Subspaces
8	<b>October 11</b>	<b>Fall Break</b>	<b>Fall Break</b>	<b>Fall Break</b>	<b>Fall Break</b>
9	<b>October 18</b>	4.2 - Null Spaces and Column Spaces	4.2 - Null Spaces and Column Spaces 4.3 - Lin Independent Sets	4.3 - Linearly Independent Sets	4.4 - Coordinate Systems
10	<b>October 25</b>	4.5 - The Dimension of a Vector Space	4.6 - Rank	4.7 - Change of Basis	4.7 - Change of Basis
11	<b>November 1</b>	4.8 - Applications to Difference Eqs	5.1 - Eigenvectors and Eigenvalues	5.2 - The Characteristic Equation	<b>50 Minute Test</b> Sections 2.3 — 4.3
12	<b>November 8</b>	5.2 - The Characteristic Equation 5.3 - Diagonalization	5.3 - Diagonalization	5.4 - Eigenvectors and Linear Transformations	5.5 - Complex Eigenvalues
13	<b>November 15</b>	6.1 - Inner Product, Length, and Orthogonality	6.1 - Inner Product, Length, and Orthogonality	6.2 - Orthogonal Sets	6.3 - Orthogonal Projections
14	<b>November 22</b>	6.3 - Orthogonal Projections	6.4 - The Gram-Schmidt Process	6.5 - Least Squares Problems	<b>Thanksgiving</b>
15	<b>November 29</b>	7.1 - Diagonalization of Symmetric Matrices	7.2 - Quadratic forms	7.3 - Constrained Optimization	<b>50 Minute Test</b> Sections 4.4 — 6.2
16	<b>December 6</b>	7.4 - The Singular Value Decomposition	Review	Review	<b>Reading Day</b>