Course Syllabus: Matrices and Linear Transformations (21-241)

Carnegie Mellon University Spring 2024, Lectures 2 and 3

Syllabus Information: This syllabus serves as a contract between you the student, myself the instructor, and the course TAs. This document includes:

1. General Course Information
2. Course Content and Learning Outcomes
3. Assessment and Grading Information
4. Weekly Schedule and Dates
5. Course Policies
6. Additional Information

Please be sure to review the information in this document carefully. If you have any questions about the course, please **first** review this syllabus. If anything is unclear, you may then send an email asking for clarification.

General Course Information

Instructor: Dr. Elisa Bellah
Lecture 2: MWF 2-2:50pm in Doherty Hall 1212
Lecture 3: MWF 3-3:50pm in Doherty Hall 2302
Recitations: Please note that you must attend the recitation section you are registered for.

Recitation D: Tuesday and Thursday 9-9:50am in Wean Hall 8220

Recitation E: Tuesday and Thursday 12-12:50pm in Margaret Morrison 103

Recitation F: Tuesday and Thursday 1-1:50pm in Wean 8220

Recitation G: Tuesday and Thursday 12-12:50pm in Wean 5302

Recitation H: Tuesday and Thursday 1-1:50pm in Wean 4623

Recitation I: Tuesday and Thursday 4-4:50pm in Wean 4623

Office Hours and Contact Information: Office hours are available each week for you to ask questions about the course and to get more personalized help with course assignments. All questions are welcome and encouraged. Note that you may attend any of the office hours listed below. Please keep an eye out on Canvas for announcements of schedule changes.

Name (Role)	**Email**	**Office**	**Office Hours**
Dr. Elisa Bellah (Instructor)	ebellah@andrew.cmu.edu	WH 8119	MW 12-1pm
Jiaming Zhang (Rec D & E TA)	jiaming5@andrew.cmu.edu	WH 6207	R 4-5pm, F 5-6pm
Theo Waitkus (Rec F TA)	wwaitkus@andrew.cmu.edu	WH 8215	Sat & Sun 12-1pm
Pedro Marun (Rec G TA)	pmarun@andrew.cmu.edu	WH 7213	M 4-5pm, R 3-4pm
David Rotunno (Rec H TA)	drotunno@andrew.cmu.edu	WH 8215	R 11am-1pm
Rick Sun (Rec I TA)	ricks@andrew.cmu.edu	WH 8215	M 6-7pm, T 5-6pm

Textbook: There is no required course textbook. Instead, we will follow a set of lecture notes designed specifically for this course, which will be updated and posted on our course webpage weekly. The following list of resources may be used to supplement the course lecture notes. I do not expect you to reference any of these texts, but you might find them useful for alternate presentations of material:

- Alayont and Schlicker, Linear Algebra and Applications: An Inquiry-Based Approach
- Margalit and Rabinoff, Interactive Linear Algebra
- David Poole, Linear Algebra: A Modern Introduction (any edition)

Required Course Sites: There are four sites in this course you will need to access regularly.

1. **Course Webpage**: Course documents and information can all be found on the course webpage, which is housed on my website (andrew.cmu.edu/user/ebellah).
2. **Canvas**: Canvas will be used for announcements, to post grades, and for recitation pre-work assignments. Lecture recordings and a tentative schedule of material will also be stored in the "Pages" tab on Canvas. I suggest you change your notification settings on Canvas to receive emails when course announcements are posted.
3. **Gradescope**: Every other week, you will have a problem set to submit on Gradescope. This site will also be used to give feedback on Problem Sets and Exam Prep Assessment scores.
4. **Webwork**: You will have a Webwork assignment to complete each Thursday. Note that Webwork is a free online platform. Your username and password are both given by your Andrew ID. I suggest you change your password on Webwork after your initial login by going to the "User Settings" section on the sidebar.
5. **iClicker**: We will use iClicker each day in lecture, and your participation will be counted toward your total course grade. Please make sure to bring your phone with the iClicker app downloaded or a computer to class with you to participate in iClicker activities each lecture day.

Optional Course Sites: The following sites are meant to serve as resources for the course. I suggest you become familiar with each of these sites, but it is not required that you interact with them.

1. **Piazza**. Piazza will be used as a platform for you to engage with your classmates and course TAs about course content. Additionally, we will use the live Q&A feature during lecture as an optional method for you to ask questions during lecture. Please note that Dr. Bellah will not be monitoring these discussions outside of the in-class Live Q&A. Questions about course policies should be sent directly to ebellah@andrew.cmu.edu.
2. **3Blue1Brown** This site holds beautifully created visualizations of core concepts in the course. I recommend using this as a resource to build intuition on course topics.
3. **WolframAlpha**. A computational tool which can do just about everything we need in the course. Documentation on using this tool with topics in our course can be found here.
4. **Desmos**. A free online graphing calculator.

Supplemental Instruction: The Student Academic Success Center will be providing supplemental instruction for our course. Supplemental Instruction (SI) is a learning support model provided through the university that utilizes peer-assisted study sessions. The SI program provides weekly sessions that provide students practice with course content outside the classroom. See the supplemental instruction page for details.

Research to Improve the Course. For this class, I am conducting research on student outcomes. This research will involve your work in this course. You will not be asked to do anything above and beyond the normal learning activities and assignments that are part of this course. You are free not to participate in this research, and your participation will have no influence on your grade for this course or your academic career at CMU. If you do not wish to participate or if you are under 18 years of age, please send an email to Chad Hershock (hershock@andrew.cmu.edu) with your name and course number. Participants will not receive any compensation. The data collected as part of this research may include student grades. All analyses of data from participants' coursework will be conducted after the course is over and final grades are submitted. The Eberly Center may provide support on this research project regarding data analysis and interpretation. The Eberly Center for Teaching Excellence & Educational Innovation is located on the CMU-Pittsburgh Campus and its mission is to support the professional development of all CMU instructors

regarding teaching and learning. To minimize the risk of breach of confidentiality, the Eberly Center will never have access to data from this course containing your personal identifiers. All data will be analyzed in de-identified form and presented in the aggregate, without any personal identifiers. If you have questions pertaining to your rights as a research participant, or to report concerns to this study, please contact Chad Hershock (hershock@andrew.cmu.edu).

Course Content and Learning Outcomes

Catalog Course Description: A first course in linear algebra intended for scientists, engineers, mathematicians and computer scientists. Students will be required to write some straightforward proofs. Topics to be covered: complex numbers, real and complex vectors and matrices, rowspace and columnspace of a matrix, rank and nullity, solving linear systems by row reduction of a matrix, inverse matrices and determinants, change of basis, linear transformations, inner product of vectors, orthonormal bases and the Gram-Schmidt process, eigenvectors and eigenvalues, diagonalization of a matrix, symmetric and orthogonal matrices.

Prerequisite: There are no prerequisites, but 21-127 (Concepts of Mathematics) is strongly recommended.

Learning Outcomes: By the end of the course, a successful student will be able to do the following:

1. Identify which systems of linear equations are consistent. Determine the number of solutions to systems of equations, and find a complete solution sets to systems of equation.
2. Identify when a square matrices is invertible, and find the inverse of an invertible square matrix.
3. Interpret matrices as linear transformations on vector spaces.
4. Demonstrate proficiency with the language of vector spaces, including span, linear independence, bases, and dimension.
5. Find the rank of an $m \times n$ matrix, and describe the four fundamental subspaces corresponding to the matrix, including their dimensions.
6. Find the determinant and eigenvalues of a square matrix and interpret them geometrically.
7. Determine when matrices are similar, diagonalizable, and orthogonally diagonalizable. Demonstrate geometric understanding of each of these concepts.

Assessment and Grading Information

There are six types of graded work you will be doing throughout the course, which are weighted accordingly: Recitation Assignments (5%), iClicker Questions (5%), Webwork (10%), Problem Sets (20%), Exam Prep Assessments (30%), and the Final Exam (30%). Details and policies for each of these components are given below.

Recitation Assignments (5%): Recitations will take place each Tuesday and Thursday of the semester. Each recitation day, except for odd numbered Tuesdays, you will complete one or more of the following assignments: Problem Set Peer Review, Exam Wrapper, Worksheet, or Course Survey/Reflection.

Details and Policies:

- Some of these assignments will have associated pre-work to complete on Canvas before recitation. Details about pre-work will be provided on Canvas a few days before each Recitation Assignment.
- Recitation assignments will be graded on participation only.
- I will drop your **lowest three** recitation assignment scores.
- Recitation assignments cannot be made up in the case of absence.

iClicker Questions (5%): Lectures will take place each Monday, Wednesday and Friday of the semester. Each lecture day, you will be expected to login to iClicker and answer questions when prompted.

Details and Policies:

- You will be expected to bring a phone or computer with you to class each day to participate in iClicker activities. If you do not have access to a device, please speak with me and we will make other arrangements.
- You will need to purchase an iClicker subscription, which starts at $15.99 USD for 6 months.
- iClicker Questions will be graded on participation only. Your iClicker scores will be entered into the Canvas gradebook as a cumulative grade after each lecture day.
- I will drop your **lowest six days** of iClicker Question scores.
- In order to receive credit on iClicker Question assignments, you must attend the corresponding lecture. No exceptions will be made for absences past your six dropped iClicker Question scores.

Webwork (10%): Webwork assignments will be used to practice computation and check for understanding of core material in the course, and will be due online on our Webwork course site.

Details and Policies:

- Webwork will be due every Thursday no later than 11:59pm.
- You have unlimited attempts at every problem.
- I will drop your **lowest three** Webwork scores.

Problem Sets (20%): Problem Sets will be posted on the course webpage and collected on **Gradescope**, generally on Tuesdays of even numbered weeks of the semester. Problem Sets will contain the most challenging problem you'll see in the course and will help you dive deeper into the course material. I strongly suggest you start assignments well before the due date so that you have time to get stuck, attend office hours, and put together your final work professionally.

Details and Policies:

- On Thursday before each Problem Set is due you will be working with your classmates on a peer review assignment as part of your Recitation Assignment work. In order to earn full credit for peer review assignments, you must have attempted **at least half** of the corresponding problem set assignment.
- Work must be presented professionally and legibly. If we cannot read your work or struggle to follow your reasoning, we will not grade the problem. I suggest reviewing this resource on writing mathematics well.
- Assignments must be carefully scanned and uploaded to Gradescope no later than the indicated time. There will be no exceptions for technology issues, so I suggest you upload your homework at least one hour before the deadline.
- Problem Sets will generally be returned to you on Gradescope within one week of submission. Late work will not be accepted under any circumstance.
- Regrade requests will be due one week after grades are released (see the Course Policies section for details about regrade requests).
- I will drop your **lowest three** Problem Set scores.

Exam Prep Assessment (30%): During Tuesday's recitation in odd-numbered weeks of the semester, you will be given a problem set to complete on your own during recitation, which will be graded similar to an exam. The goal of these assessments is to keep you current with material throughout the course, and to give you practice solving new problems on your own under some time pressure in order to prepare you for the final exam.

Details and Policies:

- Each assessment will be written to take about 30 minutes, but you will be given the full 50 minutes of recitation to complete them.

- You are allowed a full page of notes (front and back) for all exam prep assessments. No calculators or other resources will be allowed.
- Each assessment will only cover new material from the previous two weeks of the semester. I suggest you review the previous week's worksheet, webwork, problem set, lecture activities, and lecture notes to prepare.
- Your assessments will be scanned and graded by the course TAs using Gradescope.
- Regrade requests will be due one week after grades are released (see the Course Policies section for details about regrade requests).
- I will drop your **lowest two** exam prep scores.

Final Exam (30%): The final exam will take place during the week of April 29th, and will cover all material from the semester. Details about the format and material for the final exam will be provided during the last week of classes. The final exam schedule will be released sometime in mid-semester. If you need to make travel arrangements before the exam schedule is released, I suggest you schedule your departure on or after May 6th. Note that **I will not provide makeup exams to accommodate your travel schedule**. If you cannot attend the final exam due to scheduling your departure before our scheduled exam date, you will receive a zero on the final exam.

University Grading Standards: Final grades will be assigned using a standard grading scheme. Grading in this course is designed to meet the CMU grading standards. Final grades, with the standard grading option for the course, will be awarded as follows:

Grade	Percentage	Standard
A	$\geq 90\%$	Excellent
B	$[80\%, 90\%)$	Good
C	$[70\%, 80\%)$	Satisfactory
D	$[60\%, 70\%)$	Passing
R	$< 60\%$	Retake

Unless otherwise stated, I will not be planning to adjust grades or curve the course.

Course Policies

Anonymous Grading: Problem Sets, Exam Preps, and the Final Exam will all be graded blindly (with the help of Gradescope) to help account for grader bias. Please do not put any identifying information on your Problem Sets, and please only write your name and Andrew ID on exams and exam prep assessments in the indicated area.

Absences and Late Work: Due to the size of our course, I WILL NOT BE ACCEPTING ANY LATE WORK OR ALLOWING FOR MAKEUPS IN THE COURSE. Note that I drop a number of assignments from each category of graded work for the course to account for any absences (see the Assesment and Grades section for details). Further flexibility will be granted only in exceptional circumstances such as major life or cultural events. Note that **most illnesses will not warrant further flexibility**. If you are sick, please stay home and use the flexibility built into the course. Accommodations for religious holidays and observances will be made. Please make sure to reach out via email ahead of time to make arrangements for these absences. If you are unsure whether your circumstance warrants further flexibility, please send me an email.

Lecture Recordings: I will attempt to record lectures each day and post them to Canvas each week. Keep in mind that the technology will likely fail some days, but I'll do my best. Lecture recordings and activities will be posted to the "Pages" tab of Canvas. I will aim to post material by the end of each week, but please allow a few days of flexibility.

Use of Resources: You are allowed to use whatever resources necessary to complete homework assignments and concept quizzes, but ultimately the work you submit must be your own. For example, if you lookup a homework solution, I expect you to rework the problem in your own words. **Any verbatim copying will be reported to the university as plagiarism**. If you are unsure if you've used a resource properly, please ask during office hour. Note that I strongly suggest you attempt every problem on your own first. Learning to consistently solve problems on your own is the most important thing you can do to prepare for exams, which are weighted much more heavily in this

course than homework. If you rely too much on external resources to help you solve homework problems, you will not be prepared to solve problems on your own during in-class exams.

Regrade Requests: You may submit regrade requests for any assignment given during the semester. When submitting your request, please clearly indicate a justification for the regrade (e.g. points have been added correctly, mark does not match the rubric, etc). All regrade requests must be made on Gradescope (here is a tutorial) **within one week** of the assignment being returned to you.

Email: The instructor and TAs will aim to respond to emails within three business days. If you do not receive a response within that time frame, please do follow back up (sometimes our inboxes get flooded and things get buried). Note that you should not expect responses to emails outside of normal working hours (around 9am to 5pm) or on weekends. All emails must be sent through your CMU email address.

Calculator Policy: Calculators will not be permitted on any of the exam prep assessments or on the final exam.

Weekly Schedule and Dates

Weekly Schedule: Unless otherwise specified, we will meet as a class on Monday, Wednesday and Fridays during the indicated time of your lecture sections. On Tuesdays and Thursdays, you will have assignments to complete during your recitation sections, often with some associated pre-work due on Canvas. Please review the Assessment and Grading Information section for details on each of these assignments.

Schedule of Assignments: Our weekly workflow is outlined below. Note that assignment due dates will also be posted on Canvas, and a schedule of all course assignments can be found on our course webpage.

Day	**Week**	**Agenda**
Tuesday	Odd numbered weeks	Exam Prep Assessment
Thursday	Odd numbered weeks	Problem Set Peer Review Activity Webwork due by 11:59pm
Tuesday	Even numbered weeks	Exam Wrapper Problem Set due on Gradescope by 11:59pm
Thursday	Even numbered weeks	Worksheet Webwork due by 11:59pm

Important Dates: Here are some dates you may want to keep in mind:

Tues Jan 16:	Classes begin
Mon Jan 29:	Add deadline
Mon Feb 26:	Drop deadline (W assigned after this date)
March 4-8:	Spring break (no classes)
April 11-13:	Spring carnival (no classes)
Mon April 3:	Withdraw deadline
April 17-21:	Fall registration week
Fri April 28:	Last day of classes

See the CMU academic calendar for a full list of dates.

Additional Information

Student Academic Success Center: The SASC provides various programs to support student learning. Checkout the SASC's site (cmu.edu/student-success) for a full list of programs. In particular, I encourage you to consider their peer tutoring. This is a tutoring service available to all CMU students at no additional cost.

Accommodations for Students with Disabilities: If you have a disability and have an accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources (cmu.edu/disability-resources), I encourage you to contact them at access@andrew.cmu.edu.

Respect for Diversity: It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you