



MATH 415 - Applied Linear Algebra

Lectures & Instructors.

Section AL1: MWF 9:00–9:50AM, 103 Mumford Hall (Now online format)

Section AL2: MWF 11:00–11:50AM, 101 Armory (Now online format)

Section AL3: MWF 1:00–1:50PM, 100 Materials Science & Eng Bld (Now online format)

Instructor: Jer-Chin Chuang

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Office hours: the above listed class times, MWF 9-9:50AM, 11-11:50AM, 1-1:50PM

Format. *This course will be conducted entirely online.* As such, each student will be assumed throughout the semester to have the necessary technical equipment to fulfill course activities. For example, to complete course activities you will need a computer/laptop/table with webcam and microphone as well as stable internet access, sufficient bandwidth, and data allowance for using a webcam on Zoom. Please contact Student Assistance Center (helpdean@illinois.edu) if you are missing any requisite items.

TAs.

- Mingyan Lin (mlyn39@illinois.edu)
- Tsutomu Okano (okano2@illinois.edu)
- Hadrian Quan (hquan4@illinois.edu)
- Elizabeth Tatum (etatum2@illinois.edu)

Textbook. We will post extensive lecture notes for all lectures and practice problems online at the course Moodle site. For many students these notes are enough. The course textbook is *completely optional*: Gilbert Strang, *Linear Algebra and its Applications*, fourth edition, Cengage. Cheaper alternatives include a used version, a previous edition (2nd edition available electronically through the library), another linear algebra text, or ~~using the physical copies of the textbook in the math library~~ (temporarily unavailable).

Content. This is an introductory course on Linear Algebra. It covers not only the basic definitions and algorithms of the subject needed in the higher level (engineering, science and economics) courses, but also more sophisticated mathematical techniques such as Fourier transformations and the Singular Value Decomposition. Throughout we will make an effort to motivate linear algebra by applications to real life problems (for example Google's PageRank algorithm and JPEG image compression). 3 credit hours. Prerequisite: MATH 241 or consent of instructor.

Other Linear Algebra courses. Be aware that credit is not given for both MATH 415 and any of MATH 125, MATH 225, MATH 410, or MATH 416.

If you are unsure whether to enroll in MATH 415 or MATH 416, please consult the mathematics undergraduate advising office: mathadvising@illinois.edu

Two disclaimers.

- (1) This is not a course that only teaches you how to compute stuff, and we know your computer will always be quicker. Modern applications of Linear Algebra require a sophisticated understanding of theory and methods, and learning these is the purpose of this course. Some of it might look like “abstract” Linear Algebra, but through the applications we present you will see that this is indeed “applied” Linear Algebra.
- (2) If you already know some Linear Algebra, this course might look very easy at the beginning. Don’t be fooled into thinking it will stay easy. It is likely that even the material familiar to you will be covered in more depth here. It is also likely that the exams will require a deeper understanding of the concepts you already know something about. *So it is a good idea to take this course seriously from the beginning.*

Four credit hours. Unfortunately, we can not offer a four credit hour version of MATH 415. The class is too big to offer it to every interested student. We simply do not have the necessary resources.

Learn@Illinois. This course has a page on Learn@Illinois:

<https://learn.illinois.edu/course/view.php?id=51474>

This site will be the primary source for course information. *All material will be available there.* You can check all your grades on this website. Please note that if you have just registered for the course, it will take 48 hours for you to get access to the Learn@Illinois website. If you do not have access to the course site 48 hours after registering, please contact your instructor.

Weekly Assessment Schedule. In addition to worksheets completed during recitation, each week will have the following assignment due dates:

Assignment	Deadline
Lecture Exercises (from previous Friday lecture)	Monday 11:50PM
Lecture Exercises (from Monday lecture)	Tuesday 11:50PM
PrairieLearn Homework (@ 100%, see below)	Wednesday 11:50PM
Lecture Exercises (from Wednesday lecture)	Thursday 11:50PM

Course Expectations and Suggestions.

- This course assumes a workload of two hours outside of class per hour of scheduled class time plus an hour for discussion section. Thus, expect to spend around $3 \times 3 + 1 = 10$ hours per week for this course.
- Students are expected to have read through the lecture notes (or watched the lecture videos) before the instructor Q&A sessions at the originally scheduled class times.
- This course is a transition from largely computational calculus classes to concept-heavy intermediate math courses. As such, *be prepared to be challenged: success will require both computational facility and sound conceptual understanding.*
- Even more than calculus, linear algebra is cumulative in its organization: concepts layer upon concepts to present a towering edifice. *To build well, do not slack!*

- Much like learning a foreign language, learning linear algebra well requires frequent practice. Thus, there are numerous assessments throughout the semester. To learn concepts well, make sure to know their definitions, key examples, and their interconnections (summarized in propositions, theorems, etc.).

Lecture Notes and Videos. Lecture notes for every lecture are available on Learn@Illinois. Two versions are provided:

- A version with fill-in boxes to complete as one follows the lecture videos
- A regular version with all boxed material already included.

Lecture videos for each lecture are available on Learn@Illinois. Some of the lecture notes will contain links to additional optional videos you might find helpful. Another great resource are the video of lectures given by Gilbert Strang available at

<https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures>

Recitations and Worksheets. Students are required to attend their registered discussion section via Zoom. Each section has its own Zoom meeting link, available through the course site on Learn@Illinois. Students will be assigned to small groups to complete collaboratively the designated worksheet available on Learn@Illinois for that week.

Attendance will be taken. You will be given a password at the beginning of each discussion section and you will have 15 minutes to mark yourself present on Learn@Illinois. Note that *it is not enough to just be present. You have to be actively working with your group, and the worksheet submitted by your group must show that your group put in the necessary effort.* If this is not the case, we will not consider you present and will not receive points for participation.

Unless there are special circumstances or you are told otherwise by the TA, we expect you to have your video and your audio active through the whole Zoom meeting.

Complete solutions to the worksheet will be posted afterwards on Learn@Illinois.

RESOURCES

Getting Help. There are numerous ways to get help, and assignment deadlines have been arranged so that students may utilize all of them:

- **Instructor Office Hours:** Every MWF at the originally scheduled class times, 9-9:50AM, 11-11:50AM, and 1-1:50PM Central Time via Zoom, link at course site on Learn@Illinois.
- **TA Help Session:** Every Monday-Thursday from (tentative) 7-9 PM Central Time via Zoom, link at course site on Learn@Illinois.

At least one TA will be present during this time to answer your questions. You don't have to come to the room only if you already have a question. You can just go there and listen to questions posed by other students or find other students to work or study together. We highly recommend that you form study groups and make use of this opportunity!

- **Weekly Discussion Section:** Feel free to ask your TAs for help during these sessions. This is also an opportunity to learn from your peers.
- **Online Discussion Forum:** Questions can be posted at the course forum on CampusWire (more below). This will be monitored regularly by the teaching staff. However, we encourage students to try answering the questions of their peers. In fact, explaining an idea is a good way to check whether you understand that idea well.

- **Email Teaching Staff:** You may also email the teaching staff (instructor or TAs) directly. However, please use the above means first unless there is a private matter. Please see the Communication section below for where and how to direct your inquiry.

These total 18 hours/week of online help in addition to the moderated online discussion forum, so please avail yourself of these many opportunities!

CampusWire. CampusWire is an online discussion forum designed to facilitate peer learning and manage question-response among a large number of participants. *Any question about course content and organization of potential interest to everyone in the class should be posted on CampusWire.* Private questions should be directed via email to the appropriate teaching staff (see Communication section below). Though the course site on Learn@Illinois will be the main site for announcements, major announcements will also be duplicated on the forum.

<https://campuswire.com/p/G895A2BEF>

Please make sure you are signed up for CampusWire. Unlike Learn@Illinois, students are not automatically enrolled in CampusWire upon course registration. Once the semester starts, teaching staff will regularly monitor the forum.

Communication. Since there are more than five hundred students in this online course, please respect the following guidelines when posting questions to the discussion forum or emailing teaching staff. This will facilitate response times and students' search for relevant answers to their questions on the forum.

First, check whether your question is already answered in the syllabus, on Moodle, or in the discussion forum.

Second, please route your inquiries as follows:

- Content (including homework) and general administrative questions: discussion forum
- Personal questions:
 - Requests regarding discussion section or worksheets: discussion TA
 - Other administrative requests: instructor

Third, please format email/question headers as follows:

- **For the discussion forum:** please choose the appropriate category (Lecture, Homework, Worksheet, Quiz, etc.) and format your header to indicate the assignment: "Worksheet 5.3(a)" for Worksheet 5 question 3 part (a) or "Lecture Exercises 13.5" for Lecture 13 Exercises question 5, etc.
- **For emails:** indicate your discussion section as well as the topic, for example "[Math415 ADA] Missing score for Worksheet 5"

Again, please post content questions to the discussion forum so that the answer will benefit the entire class.

Given the volume of communication, the teaching staff will endeavor to respond to most inquiries by the next business day, but sometimes up to two business days may be needed. This applies to both emails and forum questions. We appreciate your cooperation and patience with this matter.

Suggestions for Learning. Below are some suggestions for improving your learning in this course:

- **Develop a weekly routine:** set specific recurring goals for each day.

- **Seek help early and often:** you are not in this alone, but the effectiveness of our help depends on your initiative! (See the many avenues for getting help in the Getting Help section above.)
- **Review frequently:** this course is like learning a foreign language—there is no substitute for sustained, hard work.
- **“Study smart”:**
 - *Memorize definitions of concepts and illustrate with examples (and non-examples)*
 - *Memorize key theorems and illustrate their content with examples*
 - *Ask questions as you read and make up examples:* A foreign language cannot be learned passively; neither can linear algebra.
 - Remember that *linear algebra prioritizes concepts:* Understanding the concepts makes the computations natural. Trying to remember the computations without understanding the concepts is both confusing and hard.

Netiquette. Since this is an online course, please be respectful of your fellow classmates and teaching staff in all online communications. *Fostering a helpful learning environment requires everyone’s cooperation.* Remember that forum posts are visible to all students and staff in the course (over 500 people) so please double-check your posts before submitting them.

Mathematica (Optional). Throughout this course we will cover some interesting (computer science) applications of linear algebra; for example, JPEG image compression and the PageRank algorithm behind Google. In order for you to try out these algorithms, we will Mathematica notebooks with implementations of these algorithms on the Learn@Illinois website. This is optional, but in previous years students really enjoyed seeing this part of linear algebra in action and playing around with the worksheets. You can get access to an online version of Mathematica for free through the University of Illinois webstore:

<https://webstore.illinois.edu/shop/product.aspx?zpid=3508>

ASSESSMENTS

Syllabus Quiz. Because of the online format for this course, familiarity with course policies will be essential. All students will be required to complete by 5PM Central Time Friday, September 11th a syllabus quiz on Learn@Illinois. This quiz covers basic course policies. It is open-notes and unlimited attempts are allowed.

Lecture Exercises. Whereas the PrairieLearn homework (see below) assesses computational proficiency, the lecture exercises largely assess conceptual understanding. Each consists of five questions altogether to be completed in 15 minutes. Most are true/false questions based on the lecture notes. These exercises are open-book and open-notes. They serve as a diagnostic for students to identify conceptual misunderstandings. Answers are provided after the submission deadline has expired. They are open for submission from 2PM of the lecture day and due 11:50PM the following day (all times Central Time Zone). For example, the lecture exercises for the material of Monday’s lecture is open for submission 2PM Monday and due 11:50pm Tuesday. Because of weekends, those for Friday’s lectures are due Monday 11:50pm.

Lecture exercises for lectures in the first two weeks of the semester will not count towards the final grade due to changing enrollments during that period.

PrairieLearn. We will use PrairieLearn for homework. Please access the homework by clicking on the relevant link in the weekly tabs on Learn@Illinois. Homework will be due on Wednesdays at 11:50PM. The first homework is due on Wednesday, September 2th. The PraireLearn homework will focus on computations, while the lecture exercises and weekly worksheets in the discussion section will focus more on conceptual problems.

How points are given on PrairieLearn. PrairieLearn places emphasis on mastery. The idea is to keep doing questions until you master the underlying concept or method. Once you do, you should be able to answer these questions very quickly.

The way this works in PrairieLearn is that each question has a value, a point total, and a point maximum. If you answer a question correctly, two things happen:

- The point total increases by the value, until you reach the point maximum.
- The value increases.

If you answer a question incorrectly, one thing happens:

- The value goes back to what it was originally.

This system rewards repeated correct answers, which tend to demonstrate mastery. There is no penalty (other than resetting the value) for answering a question incorrectly, so don't be afraid to submit an answer. Similarly, don't be afraid to keep doing a question after you reach the point maximum - your point total with never go down!

Credit. There is no need to "submit" your homework. The system will record whatever your score is at that time. *Starting with the third homework*, you'll note the following line at the top of your screen:

Available credit: 110% until 11:50PM, Monday, September 14th

What this means is that if you reach 100% prior to 11:50PM on that Monday - i.e., complete the homework early - you will receive an extra 10% bonus. You will see this reflected in your score (the instant you reach 100%, it will jump to 110%).

If you click on the "?" just to the right of the line about available credit, you'll see all the dates associated with this homework. In particular, it says:

- you can receive 110% until 11:50PM, Monday, September 14th,
- you can receive 100% until 11:50PM, Wednesday, September 16th,
- you can receive 75% until 11:50PM, Wednesday, September 23 (one week later),
- you can receive 0%, but can keep doing problems as practice for the rest of the semester.

Note that your score will never go down. For example, if you achieve 90% by 11:50PM on Wednesday, September 16th, you won't be able to increase your score after that time, but you won't be penalized for not reaching 100% - your score will remain 90% forever. On the other hand, if you achieve only 70% by 11:50PM on Wednesday, September 16th, you will still be able to increase your score after that time, up to a maximum of 75% before Wednesday, September 23.

The extra 10% policy begins with the third homework since course enrollment is fluid during the first two weeks. Please note that the total available points for homework is capped. Receiving 110% on each homework will not give your extra points beyond the fixed total.

Typos/Errors. If you believe there is a typo or an error in a question, or if you believe your answer was graded incorrectly, please take a screenshot and let the teaching staff know with a private CampusWire post. We have access to all of your submissions and can easily check to see what, if anything, went wrong.

Exams.

Dates. There will be three midterm exams, each about 50 minutes long from 7-7:50PM Central Time on the following Thursdays:

- **Exam 1: Thursday, September 17, 2020**
- **Exam 2: Thursday, October 15, 2020**
- **Exam 3: Thursday, November 12, 2020.**

Final: TBA

Please note that we (the instructors) don't choose the date for the final exam. The university assigns us a date for the final exam at some point later in the semester (probably in October). We will let you know the date as soon as we know it. Please be aware that the final exam could be as late as the last day of the exam period. Keep that in mind when making travel arrangements for the winter break.

We are required to cancel three classes because of the evening exams. The canceled classes are:

- (1) Friday, September 18, 2020
- (2) Friday, October 16, 2020
- (3) Friday, November 13, 2020

Conflict exams are available for each of the midterms. For a list of permissible reasons, see the CBTF website. Students must register directly with CBTF to request a conflict exam. Students are advised to contact their office at least a week before the exam date to ensure availability.

There will be no make-up exams. Instead, if you miss an exam and have a valid excuse, we will mark the exam as 'excused'. An 'excused' exam means that this exam will not be taken into account in the computation of your grade. **Valid excuses must be documented** and must be reported to your instructor before the regularly scheduled exam times listed above.

Delivery. This course uses the College of Engineering Computer-Based Testing Facility (CBTF) for its quizzes and exams: <https://cbtf.engr.illinois.edu>.

The policies of the CBTF are the policies of this course, and academic integrity infractions related to the CBTF are infractions in this course.

If you have accommodations identified by the Division of Rehabilitation-Education Services (DRES) for exams, please email your Letter of Accommodation (LOA) to CBTF Manager Carleen Sacris at sacris1@illinois.edu before you make your first exam reservation.

Any problem with testing in the CBTF must be reported to CBTF staff at the time the problem occurs. If you do not inform a proctor of a problem during the test, then you forfeit all rights to redress.

Cheating. No books, notes, calculators, cheat sheets or electronic devices are allowed during the exams. We take cheating very seriously! A more detailed description of the University policy on cheating and plagiarism may be found in the following link:

<http://www.las.illinois.edu/students/integrity/>

Test taking accommodations/DRES. We ask students who received a Letter of Accommodation from DRES, to provide a copy of the accommodations letter to the course teaching staff (lecture instructor and discussion TA). Students will also need to contact CBTF directly to arrange their exams. See details under the Delivery subsection above. Please make arrangements with CBTF *at least one week in advance of the exam*. Students are responsible to make the arrangements sufficiently early to ensure availability of proper testing accommodations.

Grading. The course grade will be the average of your homework, worksheets, midterm exams, and final exam grades, weighted as follows:

- 2% syllabus quiz
- 13% online PrairieLearn homework (the two lowest scores %-wise will be dropped)
- 5% recitation worksheets (graded on effort) (the two lowest scores %-wisewill be dropped)
- 5% lecture exercises (the two lowest scores %-wise will be dropped)
- 17% per each of three midterm exams (total: $3 \times 17 = 51\%$)
- 24% final exam

In addition: If your final exam score is higher than one of your midterm scores, then we will replace your lowest midterm score by your final exam score.

If you miss one midterm (**and have a valid excuse**), we will use the average of the two other midterms and the final exam as the score for the midterm you missed. We then apply the above calculation (including the potential replacement of your lowest midterm score).

If you miss more than one midterm, please contact your instructor.

In accordance with departmental policy, letter grades will be assigned according to the historical grade distribution for the course. Usually around 30% of the students get an A letter grade (including +/-) and around 70% score a B letter grade or higher. That is, your final letter grade is assigned according to your relative class rank. The average GPA of this course over the last few years has been around 3.0. This will also be the case this semester. The median score is usually between 83% and 84%.

We will renormalize each of the midterms and final exam such that the distribution of letter grades coincides with this historic distribution of the letter grades for MATH 415. No further curve will be applied at the end of the course.

The following is a tentative scale (this is for the percentage, not for the absolute score!):

- 100.00 % - 98.00 % → A+
- 97.99 % - 93.00 % → A
- 92.99% - 90.00% → A-
- 89.99 % -87.00 % → B+
- 86.99 % - 83.00 % → B

- 82.99 % - 80.00 % → B-
- 79.99 % - 77.00 % → C+
- 76.99 % - 73.00 % → C
- 72.99 % - 70.00 % → C-
- 69.99 % - 67.00 % → D+
- 66.99 % - 55.00 % → D
- 54.99 % - 0.00 % → F

There will be **no extra credit**. With over 500 students there are always many cases where students are close (sometimes even very close) to the next letter grade, and at the end of the semester make the case that they should receive higher grades. Unfortunately, in almost all cases we can not grant the request without being unfair to other students—even if we would like to! So make sure to work hard for every midterm!

Please check each week that your score was entered correctly on Learn@Illinois. With so many students it can happen that your grade is entered incorrectly. If, after an exam or a quiz, you find an error in the scoring of your exam, please notify the teaching staff *immediately*. It can always happen that we made a mistake while grading your exam, so we always encourage you to see us if you think that happened. *Rescoring requests will only be considered within a week after an assessment is handed back*. So don't wait!