Math 3304 - Introduction to Linear Algebra (Spring 2021)

Instructor: Ross Parker (rhparker@smu.edu)
Course hours: MWF 8-8:50 am
Location: Dallas Hall 306
Website: Canvas
Office Hours (via Zoom): Mon, Tue, and Thu 3-4 pm

Course Description

Linear algebra is the mathematics of systems of linear equations. As an example, the system of two linear equations

$$ax + by = p$$
$$cx + dy = q$$

describes two lines in a two-dimensional plane. In high school algebra, you learned how to determine if these two lines intersect. Linear algebra generalizes this to higher dimensions. It has numerous applications, which include

- Machine learning: how can you reduce a high-dimensional object such as a 1000x1000 pixel color image to something simpler which captures key features of the object?
- Electrical engineering: in a complex analog circuit, how you determine the currents and voltages at any position and point in time?
- Computer graphics: how do you display three dimensional objects on a two-dimensional screen in a convincing way?

The course will cover the following topics: matrices and linear equations, Gaussian elimination, determinants, rank, geometrical notions, eigenvalue problems, coordinate transformations, norms, inner products, orthogonal projections, and Gram-Schmidt and least squares regression. The course will also include computation exercises related to these topics.

Learning goals

By the end of the course, you will be able to

- Write a system of linear equations in matrix form, and then solve that system using Gaussian elimination.
- Define linear independence, and determine if a set of vectors is linearly independent.
- Define a vector space, and solve problems involving subspaces, null spaces, column spaces, and bases.
- Determine the eigenvectors and eigenvalues of a matrix and use them in applications.
- Define the inner product of two vectors, use this to determine the length and orthogonality of vectors, and apply this to least squares regression problems.
- Use MATLAB to compute solutions to problems in linear algebra.

Nuts and Bolts

Class format: Courses will be taught in a hybrid format. Students will either participate in person or remotely via Zoom. I will incorporate class participation and in-class activities to the extent that I can while still maintaining social distancing. Please feel free to interrupt me at any time to ask me to repeat something, clarify a point, request I slow down, fix my handwriting, point out a mistake I have made, etc. Remote students will be audible via the classroom sound system, so please participate as well! I will keep the Zoom chat open during class, and you can ask questions and participate via Zoom chat. I will post surveys a few times throughout the course and welcome your feedback and suggestions for improvement.

- Although I will not formally take attendance, I *strongly* recommend attending class live in person or via Zoom. You will only be able to participate in class activities and ask questions if you attend class live.
- I request that during class you refrain from using electronic devices for non course-related purposes. I know that I cannot compete with TikTok and Snapchat for your attention, but I like to think that I am engaging and entertaining, and I will do the best I can to make the time we have together as useful as possible. I fully understand this is extra challenging for students participating remotely. (I have essentially tuned out many talks I have attended virtually.)
- All classes will be recorded and will be available for viewing via the Panopto tab on Canvas.
- I will use a "virtual whiteboard" (a.k.a. iPad) for class. Everything written during class will be posted on Canvas after class.
- All exams will be taken remotely and submitted electronically via Canvas. Exams will be given during regular class time. If you have accommodations for extra time and have class following this class, please contact me to make the necessary arrangements.
- All homework assignments will be submitted electronically via Canvas.
- All office hours will be conducted remotely via Zoom.

Prerequisites: C- or higher in MATH 1338 or MATH 1340.

Textbook: David C. Lay. *Linear Algebra and its Applications.* Fourth edition (2012) or fifth edition (2016). There is essentially no difference between the two editions except for price. I would highly recommend getting a used copy of the fourth edition and saving yourself more than $100.

For another take on the course material (same general approach, but following a different textbook), you can check out these `lectures` by Gilbert Strang.

Reading: Reading sections of the textbook is required for the course. Specific reading assignments for each class will be given on the main Canvas page for the course. Reading assignments will be posted at least a week in advance.

Warm-up quizzes: Prior to each class, you must complete a short quiz based on your reading for that topic. These will be completed on Canvas and can be found under the Quizzes tab. These

"warm-up" quizzes must be completed before the beginning of class. (Late quizzes will not be accepted). The goal of these problems is for you to think about each topic before class, so that it will be easier to learn during class. If all problems are attempted, the lowest possible grade you can attain on this is a 70.

Homework: There will be problem sets due every **Wednesday**, starting the second week of class. These will be posted at least one week in advance. Homework will involve both standard written problems and computational problems in MATLAB. (See below for information about the computational problems). Homework will be submitted on Canvas and will be due by the end of the day (11:59 pm) on Wednesday. **Please submit the written problems in your homework as a single PDF file**. If you write your problems on paper, I recommend the CamScanner app to scan them to PDF.

Learning mathematics, like getting to Carnegie Hall, is all about practice, practice, practice. For all assigned problems, you must show all of your work. This means you should display the process used, not just state a final result. Your goal is to convince me you know how to do the problem, not just what the answer is.

You are encouraged to discuss assignments with other students, but you must write up your own solution independently. When you have collaborated with other students, please acknowledge this by adding a note such as "I discussed question X with A and B." If you use any electronic resources, please indicate that as well. Identical or clearly copied assignments will be treated as violations of the honor code.

Do not postpone the problem sets until the last minute, as some answers may not come to you immediately, but then become clear a day later. If you are stuck on a problem, seek help from office hours or discussing with other students. Finally if you are not able to complete a question, write a short note to describe what you tried and what you think may be important. Credit on assignments will come from a serious effort as much as anything else.

Computational problems: Each homework assignment will contain problems which you will complete using the industry standard software package MATLAB. (MATLAB stands for "matrix laboratory", and was developed specifically for linear algebra). SMU has a site license for MATLAB, which means you can install it for free on your computer using the instructions at `https://www.smu.edu/OIT/Services/Info/Matlab`. Please install MATLAB during the first week of class. If you are having trouble getting MATLAB up and running, do not hesitate to contact me. Instructions for how to submit MATLAB problems on Canvas will be given with the first problem set.

Homework grading: Homework will be graded on a holistic scale.

- Excellent (100): assignment shows good effort and understanding, all problems essentially correct (except perhaps for typos), all relevant work shown.
- Good (90): assignment shows good effort, there are some mistakes but no significant gaps in understanding.
- Satisfactory (80): assignment shows good effort, but at least one significant gap in understanding.

- Fair (70): assignment was submitted, but minimal effort shown.
- No credit (0): assignment was not submitted.

There will be separate grades for the written portion and the MATLAB portion of each homework.

Homework policy: Late assignments will in general not be accepted. If you turn in every assignment, your lowest homework grade will be dropped.

Midterm exams: There will be two midterm exams, which will be 50 minutes in duration and will be taken during regular class time. The dates of the midterm exams are

- Friday, March 5
- Friday, April 9

These will be done remotely and submitted via Canvas. Exams will be released on Canvas a few minutes before 8:00 am. Unless you have an accommodation for extra time, your exam must be submitted on Canvas by 9:00 am. Please contact me if you have an accommodation for extra time to make the appropriate arrangements. The exams will not be cumulative, although you may need to use techniques which were tested on the first exam on the second exam. All students are expected to take exams as scheduled, except as noted below. If you must miss an exam for one of these reasons, or for serious illness or injury, please contact me as soon as possible.

Final exam: The final exam has been scheduled by the university for Tuesday, May 11 from 8-10 am. It will be 2 hours in duration. (If you have accommodations for extra time, make the necessary adjustments.) By university policy, the final exam must be taken during this block of time. The final exam is cumulative, although it will emphasize material taught since the second midterm.

Exam policy: The following policies will be in effect for the midterm and the final exams.

- You may use a calculator if you wish.
- No other electronic devices may be used, except to physically write the exam.
- You may use a study sheet, which you must make yourself. Study sheets must be one standard 8.5x11 sheet of paper. You may use both sides of the paper and may write whatever you want on it.
- You will be asked to turn in your study sheet on Canvas along with the exam.
- You may not use the textbook, class notes, or any other paper references.

Grades: The grade for this class is computed as follows:

Warmup quizzes	10%
Homework	30% (15% written and 15% MATLAB)
Midterm Exams	30% (15% each)
Final Exam	30 %

If your final exam grade is higher than your lowest midterm exam grade, that midterm grade will be replaced with the final exam grade.

Communication: Email is the best way to reach me. During the week, I will try to respond within 24 hours. Email responses may be slower on the weekends, but I will try to reply by Sunday evening. For complex questions, I may ask you to talk with me during office hours.

Diversity Statement

Mathematics, in its idealized form, is objective. (Important exception: mathematics applied to fields such as the social sciences.) The field of mathematics, however, has long been dominated by white males. Pop culture and the media have not made this any better, from Teen Talk Barbie telling us that "math class is tough" to the stereotypical "nerdy male" mathematicians in movies and television. It is my intent that students from all diverse backgrounds and perspectives be well-served by this course. To that end,

- If you feel like your performance in the class is being impacted by your experiences outside of class, please do not hesitate to come and talk with me.
- If you have a name and/or set of pronouns that differ from those that appear in your official records, please let me know.
- If something was said in class (by me or anyone else) that made you feel uncomfortable, please talk to me about it.
- I will provide a web address at which you can submit anonymous feedback.

Honor Code

The SMU Honor Code applies to all homework and exams in this course. Work submitted for evaluation must represent your own individual effort. Any giving or receiving of aid without my express consent on academic work submitted for evaluation shall constitute a breach of the SMU Honor Code.

I take honor code violations very seriously, and will report all violations to the SMU Honor Council. The minimum penalty for a violation is a grade of 0 on the assignment, and the maximum penalty is immediate failure of the course. These penalties are in addition to those imposed by the SMU Honor Council. Examples of honor code violations include:

- Copying homework solutions from any source: online, another student, or a tutor.
- Allowing another student to copy your homework for another student to copy.
- Submitting a Matlab assignment produced by another student as your own.
- Cheating on an exam.

See the SMU Honor Code website for more information.

Disability Accommodations

Students needing academic accommodations for a disability must first register with Disability Accommodations and Success Strategies (DASS). Students can call 214-768-1470 or visit `http://www.smu.edu/Provost/ALEC/DASS` to begin the process. Once registered, students should then schedule an appointment with the professor as early in the semester as possible, present a DASS Accommodation Letter, and make appropriate arrangements. Please note that accommodations are not retroactive and require advance notice to implement.

Religious Observance

Religiously observant students wishing to be absent on holidays that require missing class should notify their professors in writing at the beginning of the semester, and should discuss with them, in advance, acceptable ways of making up any work missed because of the absence. (See University Policy No. 1.9.)

Excused Absences for University Extracurricular Activities

Students participating in an officially sanctioned, scheduled University extracurricular activity should be given the opportunity to make up class assignments or other graded assignments missed as a result of their participation. It is the responsibility of the student to make arrangements with the instructor prior to any missed scheduled examination or other missed assignment for making up the work. (see University Undergraduate Catalogue.)

COVID-19 Information

Students experiencing COVID-19 symptoms or who have been notified through contact tracing of potential exposure and a need to self-quarantine or isolate should follow the protocols laid out by SMU CAN. To ensure academic continuity, students in these situations will not be penalized and will be provided appropriate modifications to assignments, deadlines, and testing. Please also note that your SMUFlex class might go remote for two-week periods to accommodate COVID-related issues. To ensure these necessary accommodations, affected students should:

- Provide as much advance notification as possible to the instructor about a change in circumstances. Students are not required to disclose health details, but should notify their instructor about a potential absence as well as plans for a return to class. For cases in which students test positive for COVID-19, they should fill out a CCC form (`https://www.smu.edu/Coronavirus/Contact-Tracing`). With the student's permission, a member of the contact tracing team could reach out to the student's instructors.

- Communicate promptly with the instructor to establish, as necessary, alternative assignments and/or changes to deadlines and exams. Students are then responsible for meeting the expectations laid out in these alternative arrangements.

- Continue participation in class via Zoom, as health circumstances permit. Attend class regularly, when not in a situation outlined above, in accordance with safety measures laid out by SMU CAN (including wearing masks, maintaining social distancing, and cleaning personal space after class).

- In-person participation in SMUFlex classes is required on students' assigned red/blue rotation days except in cases when students are experiencing COVID-19 symptoms, in self-quarantine or in isolation.
- Students facing multiple or extended COVID-19-related absences can work with the Office of Office of the Dean of Students to consider options such as fully remote learning or medical withdrawal.

This policy, aligned with the SMU Honor Code and the SMU Pledge to Protect, relies on mutual trust and respect between students and faculty to ensure safety, academic integrity, and instructional continuity.