THE OHIO STATE UNIVERSITY

College of Arts and Sciences
Department of Mathematics

SYLLABUS: MATHEMATICS 2568 Linear Algebra

Course Overview

Instructor

Lecturer Prof. Crichton Ogle

Email ogle@math.osu.edu

Phone (614) 292-8609

Office hours By appointment (via email)

For technical support for the online platform, contact ximera@math.osu.edu Please send all technical questions (e.g., broken document or video links, etc.) to ximera@math.osu.edu to guarantee to reach all those involved in designing the online course.

Course Description

Through linear algebra, seeming different "linear" things in algebra, geometry, and calculus—things like systems of certain equations, rigid motions in geometry, certain differential equations—can be placed in a common framework of vectors, matrices, and linear transformations. Viewing different things as somehow analogous provides not only insight, but also a common toolkit of surprisingly powerful algorithms. Topics include matrix algebra, vector spaces and linear maps, bases and dimension, eigenvalues and eigenvectors, and applications thereof.

Course Learning Outcomes

By the end of this course, successful linear algebra students should be able to:

- Understand algebraic and geometric representations of vectors in $\mathbb{R}^n$ and their operations, including addition, scalar multiplication and dot product. understand how to determine the angle between vectors and the orthogonality of vectors.

- Solve systems of linear equations using Gauss-Jordan elimination to reduce to echelon form. Solve systems of linear equations using the inverse of the coefficient matrix when possible. Interpret existence and uniqueness of solutions geometrically.
- Perform common matrix operations such as addition, scalar multiplication, multiplication, and transposition. Discuss associativity and noncommutativity of matrix multiplication.
- Discuss spanning sets and linear independence for vectors in $\mathbb{R}^n$. For a subspace of $\mathbb{R}^n$, prove all bases have the same number of elements and define the dimension. Prove elementary theorems concerning rank of a matrix and the relationship between rank and nullity.
- Interpret a matrix as a linear transformation from $\mathbb{R}^n$ to $\mathbb{R}^m$. Discuss the transformation's kernel and image in terms of nullity and rank of the matrix. Understand the relationship between a linear transformation and its matrix representation, and explore some geometric transformations in the plane. Interpret a matrix product as a composition of linear transformations.
- Use determinants and their interpretation as volumes. Describe how row operations affect the determinant. Analyze the determinant of a product algebraically and geometrically.
- Define eigenvalues and eigenvectors geometrically. Use characteristic polynomials to compute eigenvalues and eigenvectors. Use eigenspaces of matrices, when possible, to diagonalize a matrix.
- Use axioms for abstract vector spaces (over the real or complex fields) to discuss examples (and non-examples) of abstract vector spaces such as subspaces of the space of all polynomials.

The aforementioned learning outcomes are from OMT019 (Elementary Linear Algebra) and necessary to qualify for TAG equivalency.

Course Structure

This is a fully online, three credit hour course with a face-to-face in-person midterm exam and final exam.

Each week, there will be three hours of video lectures (available synchronously with an opportunity for immediate feedback—but also recorded and available for review later in a hyflex model).

The assigned textbook readings and online homework are completed asynchronously, following the Course Schedule at the end of this syllabus. Students are encouraged to keep up-to-date with the readings and assigned homework.

This course, like many courses, can be understood as a combination of

content that the student studies,

homework that the student does to guide those studies,

summative assessment that the student does to demonstrate his/her understanding

Content

The content for the course is provided through an online, interactive textbook and also through video lectures. Each lecture is provided synchronously, with the cohort of students in a chat room and able to ask questions of the live instructor. These videos are recorded for future review in a hylex model. To encourage students to follow the lectures, the textbook includes some questions for the students to respond to.

Homework

In addition to questions related to the videos, the textbook includes other homework questions interwoven with the text.

Students will input answers into the online textbook to earn points; the first module will include a introductory section to help students learn how to input answers into the website for validation.

Students have opportunities to discuss homework and the ideas of the course with their peers and the instructor in the online discussion forum.

Assessments

A closed-book, closed-notes proctored in-person midterm exam and a similar final exam comprise the majority of the possible points in the course. These exams must be taken at the assigned time. To complement the computer-graded homework, the assessments are primarily short answer and provide opportunities for students to not only demonstrate their skill in performing computation, but also in communicating the ideas and proofs of linear algebra.

Other Requirements

Students are expected to come to Columbus, Ohio to take the in-person midterm and final exam. If this is not possible and with the permission of the instructor, there may be opportunities provided to take the exams in a securely proctored environment at the same time/date as the rest of the students.

Course Technology

Carmen

Canvas powers Carmen, Ohio State's learning management system, and can be accessed at https://carmen.osu.edu/ Course modules are posted on Carmen.

General Technical Support

For help with your password, university e-mail, Carmen, or other technology issues, questions, or requests not related to Ximera, contact the OSU IT Service Desk. Support hours are available at https://ocio.osu.edu/help/hours and urgent issue support is available anytime.

Self-Service and Chat support http://ocio.osu.edu/selfservice

Phone 614-688-HELP (4357)

Email 8help@osu.edu

TDD 614-688-8743

Baseline Technical Skills

Success in this—and any—online course requires basic computer and basic web-browsing skills.

Technology Skills Necessary for this Specific Course

Students are expected to view the online lecture via twitch.tv and to join a text chat room if they wish to provide feedback to the lecturer in real-time. Instead of twitch.tv, students can use YouTube to watch recorded lectures. Help with YouTube can be found at https://support.google.com/youtube/?hl=en#topic=4355266 and assistance with twitch.tv can be fond at https://help.twitch.tv/ but questions about accessing video can also be addressed to the Ximera team.

Necessary Equipment

A successful student requiers a computer, which could be a Mac (running a recent version of OS X) or a PC (running a recent version of Windows), or a linux workstation. A high-speed internet connection is also needed. It is possible for a student to participate via mobile phone or tablet, but this would be less optimal.

Necessary Software

Students are expected to use a modern, standards-compliant browser (e.g., Google Chrome) capable of viewing video streams.

Privacy issues

YouTube's privacy policy is available at `https://www.google.com/policies/privacy/`.

Twitch.tv's privacy policy is available at `https://www.twitch.tv/p/privacy-policy`.

Grading and Faculty Response

Grades

Grades are assigned in this course based on earning a fraction of 800 points, broken down as

Online homework worth 200 points

Midterm exam worth 200 points

Final exam worth 400 points

Late Assignments

No make-up exams will be offered. Students may complete the computer-graded homework at their own rate, but students who fall behind should expect to receive reminders to catch up.

Students who miss the final exam will be given an incomplete (I) with an alternative grade equal to getting a zero on the final, and have to make it up the following Semester to avoid the alternative grade.

As per University policy, early finals are not be available for those persons who wish to depart early for spring break.

Grading Scale

Grades are earned

A student who earns 90% of the points will earn at least an A; a student who earns 80% of the points will earn at least a B; a student who earns 70% of the points will earn at least a C. Students who earn fewer than 70% of the possible points are in danger of earning a D or a lower grade.

Feedback and Response Time

If you have a technical problem with the online platform, you should email `ximera@math.osu.edu` For other questions, you should expect feedback on the schedule below.

Grading and Feedback

For questions on the online grading (e.g., quiz grades), you can expect feedback within four days.

E-mail

The instructor or a TA will reply to e-mails within two days.

Discussion Board

One of the instructional staff will check and reply to messages in the discussion boards within two days while discussion boards are open.

Attendance, Participation, and Discussions

Student Participation Requirements

Success in a distance course requires a great degree of self-regulated learning on the part of the students. To encourage student motivation, expectations include:

for lectures Students should participate in lecture during the assigned time, or watch the recorded video within a day. Participation includes completely the assigned questions related to the lecture.

for homework Students should read the the textbook and complete the homework in a timely matter; each lecture will include assigned readings and homework problems, and students should keep up to date on such problems. The platform monitors student progress, and students who are not logging in to complete homework will receive reminders and warnings.

The synchronous course experiences (like the real-time lectures and any real-time office hours) are optional; students who do not or cannot participate in the real-time components of the course will not be penalized. These synchronous components are recorded and provided for students to experience later; in place of asking questions in real-time in

the chat room, students may ask questions on the course discussion forum and sould expect a prompt response from course staff. Students should consult the discussion forum at least a few times each week.

Discussion and Communication Guidelines

The following are my expectations for how we should communicate as a class. Above all, please remember to be respectful and thoughtful.

Writing style While there is no need to participate in class discussions as if you were writing a research paper, you should remember to write using good grammar, spelling, and punctuation. Informality (including an occasional emoticon) is fine for non-academic topics only.

Tone and civility We seek to maintain a supportive learning community where everyone feels safe and where people can disagree amicably. Remember that sarcasm or ironic statements that are often accompanied by facial expressions or gestures do not always come across online.

Citing your sources When we have academic discussions, please cite your sources to support what you say. (For the textbook or other course materials, list at least the title and page numbers. For online sources, include a link.)

Backing up your work Consider composing your academic posts in a word processor, where you can save your work, and then copying into the Carmen discussion.

Other Course Policies

Academic Integrity Policy

Policies for this Online Course

Exams You must complete the midterm and final exams yourself, without any external help or communication. Short pre/post-lecture assessment questions are self-checks without any points attached. End-of-week short quizzes are graded, as described above.

Written assignments Your written assignments, including discussion posts, should be your own original work. In formal assignments, you should follow a clear and consistent style to cite the ideas and words of your research sources. You are encouraged to ask a trusted person to proofread your assignments before you turn them in, but no one else should revise or rewrite your work.

Reusing past work In general, you are prohibited in university courses from turning in work from a past class to your current class, even if you modify it. If you want to build on past research or revisit a topic you've explored in previous courses, please discuss the situation with us first.

Fabricating research or results All work you will conduct in this course is intended to be a learning experience; you should never feel tempted to make your results or your library research look more successful than it was.

Collaboration and informal peer-review The course includes many opportunities for informal collaboration with your classmates. While study groups and peer-review of major written projects is encouraged, remember that comparing answers on a quiz or assignment is not permitted. If you're unsure about a particular situation, please ask ahead of time. In general, even if an answer to a group question is developed as a group, you must write the final answer down in your own words to represent your take on the group's answer.

Ohio State's Academic Integrity Policy

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the University's Code of Student Conduct, and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the University's *Code of Student Conduct* and this syllabus may constitute "Academic Misconduct."

The Ohio State University's *Code of Student Conduct* (Section 3335-23-04) defines academic misconduct as: "Any activity that tends to compromise the academic integrity of the University, or subvert the educational process." Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Ignorance of the University's Code of Student Conduct is never considered an "excuse" for academic misconduct, so I recommend that you review the Code of Student Conduct and, specifically, the sections dealing with academic misconduct.

If I suspect that a student has committed academic misconduct in this course, I am obligated by University Rules to report my suspicions to the Committee on Academic Misconduct (Faculty Rule 3335-5-487). If COAM determines that you have violated the University's Code of Student Conduct (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the University.

If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact us.

Other sources of information on academic misconduct (integrity) to which you can refer include:

- The Committee on Academic Misconduct web pages
- Ten Suggestions for Preserving Academic Integrity

Accessibility Accommodations for Students with Disabilities

Requesting Accommodations

If you would like to request academic accommodations based on the impact of a disability qualified under the Americans with Disabilities Act and Section 504 of the Rehabilitation Act of 1973, contact your instructor privately as soon as possible to discuss your specific needs. Discussions are confidential.

In addition to contacting the instructor, please contact the Student Life Disability Services at 614-292-3307, VRS: 429-1334, or `slds@osu.edu` to register for services and/or to coordinate any accommodations you might need in your courses at The Ohio State University.

Go to `http://slds.osu.edu/` for more information.

Accessibility of Course Technology

This online course requires use of Carmen (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations with your instructor.

Twitch.tv Twitch provides a selection of accessibility features (see `https://blog.twitch.tv/live-closed-captions-on-twitch-streams-2fded336287b`) but we expect most learners needing accessible video will utilize YouTube.

YouTube `https://support.google.com/youtube/answer/189278?hl=en`

Ximera is designed to address accessibility by using LaTeX input that can be converted to Braille via tools like Perky Duck (`http://www.duxburysystems.com/`) and screen-readers. Additional ARIA tags are being implemented with input from Peter Bossley. In particular, unlike MyMathLab, Ximera is designed to meet Ohio State's obligations under the ADA.

Carmen Information about accessibility and universal design for learning is available at `https://odee.osu.edu/universal-design-and-accessibility`

Other Ohio State Resources

To see your available options for academic support, visit `http://artsandsciences.osu.edu/current-students/university-resources`

For other student support, see the Student Service Center site at `http://ssc.osu.edu/`

Additionally, the Mathematics and Statistics Learning Center provides free tutoring. Walk-in hours are Monday–Thursday 10:20A.M.–4:00P.M. in Cockins Hall 137; there is also evening tutoring available Monday–Thursday 4:00P.M.–7:00P.M. in Science and Engineering Library 040.

Course Schedule

Week 1: Linear systems

Week 2: Matrices

Week 3: Sets of vectors

Week 4: Matrix algebra

Week 5: Nonsingular matrices

Week 6: Determinants

Week 7: Vector spaces

Week 8: Basis and dimension

Week 9: Coordinates

Week 10: Linear transformations

Week 11: Eigenvectors

Week 12: Inner product spaces

Week 13: Applications