MATH 203
Fall 2021
Linear Algebra

MW1:30-2:45pm, Horizon Hall 1014

Instructor: Rebecca R.G. **Email:** rrebhuhn@gmu.edu

Call me: Dr. R.G. **Office:** Exploratory 4406

Learning Assistants: Lujain Nsair, she/her (lnsair@gmu.edu) and Aidan Donahue, he/him (adonahu2@gmu.edu).

Office Hours: Dr. R.G.: in person and virtual, time TBD. LA review sessions: online, time TBD.

Course Description: This course is an introduction to linear algebra. The students will learn about systems of linear equations, linear independence, linear transformations, inverse of a matrix, determinants, vector spaces, eigenvalues and eigenvectors, and orthogonality. Linear algebra plays an essential role in mathematics and in other fields like computer science, engineering, physics, economics, and statistics. Students will also gain experience in problem solving techniques and mathematical collaboration.

Prerequisites: A C or better in Math 114.

Textbook: Linear Algebra for Team-Based Inquiry Learning by Steven Clontz and Drew Lewis, available for free at `https://teambasedinquirylearning.github.io/linear-algebra/frontmatter.html`

Practice quiz problems can be found in the problem bank at `https://teambasedinquirylearning.github.io/checkit-tbil-la/#/bank/`.

Optional additional textbook (good for extra practice problems, and we'll cover one or two topics here that are not in the above book): *Linear Algebra and its Applications* by David C. Lay, Steven R. Lay, and Judi J. McDonald, 6th edition, Pearson 2020.

Other supplies: If you are taking class in person, you will need whiteboard markers in 4 colors and a whiteboard eraser. I will have some I can loan out, but not enough for the whole class.

Covid safety: All students taking courses with a face-to-face component are required to follow the university's public health and safety precautions and procedures outlined on the university Safe Return to Campus webpage (`https://www2.gmu.edu/safe-return-campus`). Similarly, all students in face-to-face and hybrid courses must also complete the Mason COVID Health Check daily, seven days a week. The COVID Health Check system uses a color code system and students will receive either a Green, Yellow, or Red email response. Only students who receive a "green" notification are permitted to attend courses with a face-to-face component. If you suspect that you are sick or have been directed to self-isolate, please quarantine or get testing. Faculty are allowed to ask you to show them that you have received a Green email and are thereby permitted to be in class.

Students are required to follow Mason's current policy about facemask-wearing. As of August 11, 2021, all community members are required to wear a facemask in all indoor settings, including classrooms. An appropriate facemask must cover your nose and mouth at all times in our classroom. If this policy changes, you will be informed; however, students who prefer to wear masks either temporarily or consistently will always be welcome in the classroom.

As a covid precaution, I will allow students to attend class virtually through Zoom (except for the midterm and final, which must be taken in person). If you are at a higher risk from covid, live with someone at a higher risk, are sick (even if it's not covid), or simply feel safer taking class virtually, please do.

Course technology: Class will take place simultaneously in person and through Zoom. During class, you will be working on problems solo and in groups, and will use a shared whiteboard (a Jamboard if you are attending virtually) to collaborate. If you are taking class virtually, you will need a computer that can access Zoom, including a speaker and microphone so you can talk to other students during class. If you are taking class in person, you will need to bring a device to class that can access the online textbook, preferably one that can also run a second browser tab so you can do Octave computations during class.

You will turn in work by submitting a single pdf of each assignment or quiz through Gradescope. There are various phone apps that will allow you to scan handwritten work and turn it into a single pdf–a quick Google search should find one. When submitting work, please make sure all pages are contained in the file, your writing is legible and not blurry, and all pages are in order and right side up. Once you have uploaded the file to Gradescope, you will need to label which pages contain which problems.

Note that even if you are attending class virtually, you will need to take the midterm and final exam in person.

Grading: Grades will be a combination of demonstrated mastery of the learning objectives through weekly quizzes, and demonstrated understanding of the concepts through regular assigned problems. The following are the approximate grading criteria, with plus and minus grades being assigned for in-between scores:

Letter grade	Number of learning objectives met (out of 26)	Number of problems solved
A	24	10, at least 5 of which are from exams
B	22	8, at least 3 of which are from exams
C	20	6, at least 1 of which is from an exam
D	10	4
F	< 10	0

Quizzes: To demonstrate your knowledge of each learning objective in the course (see next item on syllabus), you will need to correctly solve a quiz problem. Quiz problems will be graded successful/unsuccessful. Each topic will appear on multiple quizzes (for all but the last couple of learning objectives, at least 3 quizzes), so if you are not successful the first time a topic appears, you can try again. Quizzes will be offered weekly on Fridays, and on a given quiz, you only need to answer questions for learning objectives you have not yet met. Problems will be labelled with the corresponding topic, and I will maintain a list of topics you have already mastered on Blackboard.

For example, a quiz might include 5 problems from 5 learning objectives, but you will choose 1-3 topics you have not yet successfully answered a quiz question for and answer only those problems.

Note that in order to get a problem correct, your answer must include enough detail for me to see how you solved it. This can be informal, but must be understandable.

Quizzes will be offered through Gradescope, and can be taken any time from 6am to 11:59pm on Fridays. You will have 25 minutes for the quiz, plus another 10 minutes to upload your solutions.

List of learning objectives for the course:

- E1: I can translate back and forth between a system of linear equations, a vector equation, and the corresponding augmented matrix.
- E2: I can explain why a matrix isn't in reduced row echelon form, and put a matrix in reduced row echelon form.

- E3: I can compute the solution set for a system of linear equations or a vector equation.
- V1: I can explain why a given set with defined addition and scalar multiplication does satisfy a given vector space property, but nonetheless isn't a vector space.
- V2: I can determine if a Euclidean vector can be written as a linear combination of a given set of Euclidean vectors by solving an appropriate vector equation.
- V3: I can determine if a set of Euclidean vectors spans $\mathbb{R}^n$ by solving appropriate vector equations.
- V4: I can determine if a subset of $\mathbb{R}^n$ is a subspace or not.
- V5: I can determine if a set of Euclidean vectors is linearly dependent or independent by solving an appropriate vector equation.
- V6: I can explain why a set of Euclidean vectors is or is not a basis of $\mathbb{R}^n$.
- V7: I can compute a basis for the subspace spanned by a given set of Euclidean vectors, and determine the dimension of the subspace.
- V8: I can answer questions about vector spaces of polynomials or matrices.
- V9: I can find a basis for the solution set of a homogeneous system of equations.
- A1: I can determine if a map between vector spaces of polynomials is linear or not.
- A2: I can translate back and forth between a linear transformation of Euclidean spaces and its standard matrix, and perform related computations.
- A3: I can compute a basis for the kernel and a basis for the image of a linear map, and verify that the rank-nullity theorem holds for a given linear map.
- A4: I can determine if a given linear map is injective and/or surjective.
- A5: I can compute a change of coordinates matrix between two bases of the same vector space, and I can use it to write a vector with respect to a new basis.
- M1: I can multiply matrices.
- M2: I can express row operations through matrix multiplication.
- M3: I can determine if a square matrix is invertible or not.
- M4: I can compute the inverse matrix of an invertible matrix.
- G1: I can describe how a row operation affects the determinant of a matrix.
- G2: I can compute the determinant of a 4×4 matrix.
- G3: I can find the eigenvalues of a 2×2 matrix.
- G4: I can find a basis for the eigenspace of a 4×4 matrix associated with a given eigenvalue.
- O1: I can determine whether a set of vectors forms an orthogonal basis, and express a vector as a linear combination of the vectors in an orthogonal basis.

Exams: These must be taken in person. The midterm exam will take place during class on **Tuesday, 10/12 (note day of week)**, and will consist of 5 conceptual problems, which will count towards the "Number of problems solved" component of your grade. Each problem will be graded sufficient/insufficient. The final exam will take place on **Wednesday, 12/8 from 1:30-4:15pm** and will have 2 pieces. The first piece will be a final attempt at some of the learning objectives from the course, including objectives that have not been tested 3 times yet and other objectives that a number of students still need to pass. These will count towards the learning objective part of your grade. The second piece will consist of 5 conceptual problems, like the midterm, and will count towards the "Number of problems solved" part of your grade. Unlike the quizzes, which will directly test the skills from the class, the conceptual questions on the midterm and final will ask you to explain in words why you are choosing particular methods to solve the problems, compare techniques from multiple sections, or otherwise analyze your solutions. To prepare for these questions, attempt the homework and participate in class.

Homework: I will regularly assign conceptual problems, which will ask you to explain your reasoning like on the exams. These will count towards the "Number of problems solved" portion of your grade, and will be graded as correct/retry/insufficient. If you get a "retry", you may resubmit the problem.. You do not need to turn in every conceptual problem, but they will be difficult enough that you should not expect to answer all of them successfully. So if you want an A or a B in the course, I recommend trying most of them. Your write-ups of homework problems should be in full sentences, and should be written so that a classmate can follow your argument without prior knowledge of the problem. You may work together on the homework, but must write up your assignment separately and in your own words. **Please list everyone you worked with on the homework and all sources you consulted.**

Course Participation: During most of class time, you will be working alone or in groups on problems, with help from myself and the LA's. When working in groups, you will be expected to explain your reasoning to your peers, in particular why you are choosing a particular method to solve a problem.

On the first day of class we will set guidelines for participating effectively, and you will be expected to adhere to these guidelines.

Blackboard: All course materials and grades will be posted on Blackboard, and you will turn in assignments and quizzes through Gradescope. Please check Blackboard and Gradescope regularly to keep up to date with announcements and class material and to ensure your grades have been recorded correctly.

Late Policy: Quizzes cannot be taken late, but you will have multiple opportunities to demonstrate mastery of each topic. Late homework will be accepted until I have started grading the assignment. This usually means you have a day or two to turn in late work. If you will need more flexibility than this, talk to me as early as possible so we can find an accommodation that will work for both of us.

Getting help: Dr. R.G. and the two LA's will hold office hours both in person and virtually. In addition to coming to office hours to ask questions, you can use the space to meet other students from class and work on the homework together. You can also email questions to Dr. R.G.

Email Policy: Students must use their GMU email account to receive important University information, including communications related to this class. Please check your GMU email regularly, and only email me from that account. I will try to respond to all emails within 24 hours, or by Monday if questions are sent over the weekend. If 48 hours have passed and you have not received a response, send a follow-up email.

Students with Disabilities: If you have learning needs and have been evaluated or are in the process of being evaluated by Mason's Disability Services (http://ds.gmu.edu), please let me know so that I may make certain you are receiving the support you need.

Academic Integrity: By putting your name on your assignments, you are acknowledging the integrity of your work. If you have any questions about academic integrity, please either consult with us or go to https://oai.gmu.edu/mason-honor-code/

You are strongly encouraged to discuss the homework with your classmates and to work together. Please come to office hours to ask for help as well. However, everything you submit must be your own work, and should reflect your own understanding. Copying a problem solution from a classmate, the internet, or any other source is a violation of academic integrity. If you have any questions about the difference between working together and copying, or how to cite your sources, please come talk to me.

Mandatory Reporting: As a faculty member, I am designated as a "Responsible Employee," and must report all disclosures of sexual assault, interpersonal violence, and stalking to Mason's Title IX Coordinator per University Policy. If you wish to speak with someone confidentially, please contact one of Mason's confidential resources, such as Student Support and Advocacy Center (SSAC) at 703-993-3686 or Counseling and Psychology Services (CAPS) at 703-993-2380. The 24-hour Sexual and Intimate Partner Violence Crisis Line for Mason is 703-380-1434. You may also seek assistance from Mason's Title IX Coordinator by calling 703-993-8730 or email titleix@gmu.edu.

Tentative Class Calendar:

Date	**Learning objective**
8/23	Introduction and setting of class norms
8/25	E1
8/30	E2
9/1	E3
9/6	No class
9/8	V1
9/13	V2
9/15	V3
9/20	V4
9/22	V5
9/27	V6
9/29	V7
10/4	V8
10/6	V9
10/11	No class (class meets on Tuesday, 10/12)
10/12	Midterm exam during class time
10/13	A1
10/18	A2
10/20	A3
10/25	A4
10/27	A5
11/1	M1
11/3	M2
11/8	M3
11/10	M4
11/15	G1
11/17	G2
11/22	G3
11/24	No class–Thanksgiving break
11/29	G4
12/1	O1
12/8	Final exam 1:30-4:15pm