MATH 203
Fall 2020
Linear Algebra

TTh5:55-7:10pm online

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

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

Office Hours: Dr. R.G.: online, time TBD. LA review sessions: online, time TBD.

Course Description: This course is an introduction to linear algebra. The student will learn about systems of linear equations, linear independence, linear transformations, inverse of a matrix, determinants, vector spaces, eigenvalues, eigenvectors, and orthogonalization. Linear algebra plays an essential role in mathematics and in other fields like computer science, engineering, physics, economics, and statistics.

Prerequisites: A C or better in Math 114.

Textbook: *Linear Algebra and its Applications* by David C. Lay, Steven R. Lay, and Judi J. McDonald, 6th edition, Pearson 2020.

Course technology: This class will take place online. Videos or readings on course material will be posted for you to watch before class, and class will take place on Blackboard Collaborate Ultra. During class, you will be working on problems solo and in groups, and will use a shared whiteboard to display your work. You will also need to use either the chat or a microphone to communicate with others in the class.

You will turn in work by submitting a single pdf of each assignment or test problem on Blackboad. 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.

Grading: Grades will be a combination of your points from the homework and exams, and demonstrated mastery of the learning objectives through weekly quizzes. 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 27)	Points from exams and homework
A	25	220
B	22	180
C	20	120
D	10	60
F	< 10	0

Quizzes: To demonstrate your knowledge of each topic 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, 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.

List of learning objectives for the course:

1. Solve a system of linear equations using elementary row operations. (1.1-1.2)
2. Determine whether a system of linear equations is consistent or inconsistent. (1.1-1.2)
3. Determine whether a given vector is in the span of a given set of vectors. Describe the span of a given set of vectors. (1.3)
4. Interpret a system of equations as a vector equation and solve it. The same for a matrix equation. (1.3-1.4)
5. Compute the solution set of a linear system (either homogeneous or inhomogeneous) and express it in parametric vector form. (1.5)
6. Determine whether a set of vectors is linearly independent or dependent. (1.7)
7. Identify properties of a linear transformation. Find a matrix representing a linear transformation. (1.8-1.9)
8. Multiply matrices, compute the transpose of a matrix. (2.1)
9. Determine whether a matrix is invertible. (2.2-2.3, 3.2)
10. Compute the inverse of a matrix (2.2, 3.3)
11. Compute the determinant of a matrix using the definition and/or properties of determinants. (3.1-3.3)
12. Use Cramer's rule to solve a system of linear equations. (3.3)
13. Determine whether given examples are or are not vector spaces or subspaces using the definitions of vector space and subspace. Determine whether a given element of a vector space is contained in a given subspace. (4.1)
14. Compute null and column spaces of a matrix. Relate these subspaces to entries of the matrix, matrix equations, and linear transformations. (4.2)
15. Given a set of vectors, find a basis for its span. Find bases for the null and column space of a matrix. (4.3)
16. Given a vector, find its coordinate vector with respect to a basis $\mathcal{B}$. (4.4)
17. Determine the dimension of a given subspace or the null or column space of a matrix. (4.5)
18. Find the change of coordinates matrix between two bases of the same vector space. (4.6)
19. Given a matrix and an eigenvalue, find the corresponding eigenvectors and a basis for the corresponding eigenspace. (5.1)
20. Compute the eigenvalues of a matrix using the characteristic equation. (5.2)
21. Determine whether a matrix is diagonalizable, and if it is, find a diagonalization. (5.3)
22. Compute dot products, lengths of vectors, distance between vectors, and unit vectors in the direction of a given vector. Use the dot product to determine whether vectors are orthogonal. (6.1)
23. Determine whether a set of vectors forms an orthogonal or orthonormal set or basis. Express a vector as a linear combination of the vectors in an orthogonal basis. (6.2)
24. Compute the orthogonal projection of a vector y onto another vector u and the component of the vector y orthogonal to the vector u. Given a vector u, write a vector y as the sum of a multiple of u and a vector orthogonal to u. (6.2)

25. Given an orthogonal basis for a subspace of $\mathbb{R}^n$, compute and use the orthogonal projection of a vector onto the subspace and decompose a vector into the sum of a vector in a given subspace and a vector orthogonal to the subspace. (6.3)
26. Given a basis for a nonzero subpsace of $\mathbb{R}^n$, use the Gram-Schmidt process to construct an orthogonal or orthonormal basis for the subspace. (6.4)

Exams: There will be a midterm exam and a final exam, each worth 100 points. Unlike the quizzes, which will directly test the skills from the class, 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, do the homework and participate in class.

The final exam period will also include a final attempt at the learning objectives from the last few weeks of the course. These problems will be graded like the weekly quizzes.

Homework: There will be weekly homework, based on the material from class. The homework problems will ask you to explain your reasoning, similar to the exams. 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: Before each class, you will be expected to prepare by doing assigned reading or watching videos on Blackboad. 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 exams through Blackboard as well. Please check Blackboard 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. Due to the number of students in the class, late homework will not be accepted.

Getting help: Dr. R.G. and the two LA's will hold office hours 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 MasonLive email account to receive important University information, including communications related to this class. 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	Topic
8/25	Introduction and setting of class norms, Section 1.1
8/27	Section 1.1
9/1	Section 1.2
9/3	Section 1.3
9/8	Sections 1.4, 1.5
9/10	Section 1.7
9/15	Section 1.8
9/17	Section 1.9
9/22	Section 2.1
9/24	Section 2.2
9/29	Section 2.3
10/1	Section 3.1, 3.2
10/6	Section 3.3
10/8	Section 4.1
10/13	Catch-up and Review for midterm
10/15	Midterm exam during class time
10/20	Section 4.2
10/22	Section 4.3
10/27	Section 4.4
10/29	Section 4.5
11/3	No class–election day. Go vote!
11/5	Section 4.6
11/10	Sections 5.1, 5.2
11/12	Section 5.3
11/17	Section 6.1
11/19	Section 6.2
11/24	Section 6.3
11/26	No class–Thanksgiving
12/1	Section 6.4
12/3	Wrap-up and Review
12/10	Final exam 4:30 pm - 7:15 pm