Math 221: Linear Algebra and Applications

Math 221.003 (P), Math 221.04 (O), Fall 2020
Location: 128 Physics Building (003) and Zoom (004)
Lecture Time: WF 8:30 AM - 9:45 AM
Discussion Time: M 8:30-9:20 AM, M 10:15-11:05 AM, M 12-12:50 PM (003), TBD (004)
Sakai Homepage: https://sakai.duke.edu/portal/site/linalgebra003 (003)
Sakai Homepage: https://sakai.duke.edu/portal/site/linalgebra004 (004)

Lecturer: Prof. Veronica Ciocanel
Discussion Section Instructor: Prof. Curtis Porter

Contact info:

- **Office:** Room 213, Physics Building

- **Email:** ciocanel@math.duke.edu

- **Office hours (Zoom):** Tuesdays 2-3:30 pm, Fridays 9:50 am - 11:20 am, and by appointment. Zoom meeting links will be provided in Sakai.

Email Policy:
The best way to reach me is by email. I will only respond to class-related emails from your "duke.edu" address. In the subject line of your email, include the words "Math 221" so that I know to respond in an appropriate time frame. All emails should begin with the greeting "Dear Prof. Ciocanel" or "Dear Dr. Ciocanel". Please identify yourself in your email.

I **Course Description:** Students will learn the concepts and theory of linear algebra, and will learn how to write rigorous mathematical arguments as a gateway to more advanced mathematics courses. Topics will include systems of linear equations and elementary row operations, Euclidean n-space and subspaces, linear transformations and matrix representations, Gram-Schmidt orthogonalization process, determinants, eigenvectors and eigenvalues; applications.

II **Course Goals and Learning Outcomes:**
By the end of the course, students will be able to:

- Identify theorems and results on vector/matrix properties needed for solving linear algebra problems.

- Interpret and represent linear algebra techniques and results as geometric operations in multi-dimensional space.

- Develop rigorous proofs of true mathematical statements and construct counterexamples for false statements.

- Recognize situations where linear algebra techniques are applicable to answer questions in different mathematical fields and other disciplines.

III **Course Prerequisites:**
Second-semester calculus (Mathematics 122, 112L, or 122L, or equivalent). Not open to students who have taken Mathematics 216 or 218.

IV **Course Materials:**
Linear Algebra: A Geometric Approach (second edition), by Theodore Shifrin and Malcolm R. Adams. The text book will be available for 3-hour checkouts at the Duke Libraries through the Top Textbooks program.

V **Course Requirements:**

Class Sessions:

- Attendance is mandatory (for section 003, this is the case if you do not show COVID-19 symptoms).
- Lectures and discussion sections will be live-streamed via Zoom.
- Lectures will be recorded and posted on the Sakai class website. This is required for students participating in the class asynchronously.
- It is recommended to read the relevant portions of the textbook before and after attending lectures; the textbook will be a vital study-aid throughout the semester.
- No one is permitted to share any video of anybody else from any portion of the class, including the discussion sections, with parties outside of the class.
- No digital devices may be used during class sessions. (Certain exceptions will be made in coordination with the Duke Student Disability Access Office.)

Homework (15%)

- Problem sets will be assigned every week and graded via Gradescope. They will be posted on Sakai, so check the course site regularly for updates. They will typically be due on Wednesdays at 5 pm and they will cover the previous week's material. **Late problem sets will not be accepted.** Your two lowest homework grades will be dropped.
- You may (and are *encouraged* to) discuss the homework problems with your classmates and both offer and receive advice. However, submitted homework must be written up in your own words without consulting anyone else's written solution. You may also consult sources other than the text to clarify the material, but it is not acceptable to seek out solutions to problems on the homework from other texts, online sources, or previous semesters' materials. On the front page of your homework, please put your name and the section numbers of the problems. Please also clearly indicate the names of other students or individuals (other than your instructor) with whom you had significant discussions of the problems. Cite any books or online sources other than the textbook that contributed significantly to your understanding of the problem.
- Unless otherwise noted on a particular assignment, it is acceptable to verify your work on problem sets with a computational aid, but it is **not recommended**, since no computational aids will be allowed on in-class quizzes, midterms, or final exam.

- We will use Gradescope for grading: the completed problem sets must be written on paper and scanned according to the instructions available here: https://help.gradescope.com/article/0chl25eed3-student-scan-mobile-device. Use a separate page for each problem in the assignment. The front page must include your full name and the number of the problem set. Each problem must be labeled precisely as on the assignment sheet (e.g. Exercise 1.6.3). Handwritten homework must be entirely legible. All usage of language must be phrased in complete sentences. Written work not meeting these standards will not be graded.

- Full work must be shown on each problem, in order to receive full credit. The logic of a proof must be complete in order to receive full credit.

- Read and study the text carefully before attempting the assignments. You should work on the homework for each section after the class in which that section is covered. It is extremely unlikely that you will do well on the exams if you do not carefully and thoughtfully work on the assigned homework problems (at a minimum); problems from the homework may reappear on quizzes and exams.

Discussion meetings and quizzes (15%)

- Discussion meetings will be opportunities for smaller-group learning (8-12 students) and will allow you to focus on oral and written mathematical exposition as well as on further understanding course concepts. These sessions will be run by Dr. Curtis Porter online and will involve small groups of students presenting the solution to chosen problems (from the homework or otherwise).

- The times of the three discussion meetings for section 004 will be selected during the first week of class by Dr. Porter and the students enrolled in the online section.

- There may also be one or more quizzes during the course of the semester, if homework performance lags. All quizzes will be closed book (no books or electronic resources allowed) and must be completed independently, with no collaboration or consultation with others.

Midterm exams (40%: 20% each)

- There will be two midterms during the semester, as scheduled on the Tentative Course Calendar below: **September 30th** and **October 28th** (tentative). The midterms will be closed book (no books or electronic resources allowed) and must be completed entirely independently, with no collaboration or consultation with others.

Final exam (30%)

- The final exam will be held in our classroom at the time dictated by the University Registrar (**November 22nd, 9am-12pm**, see Tentative Calendar below). The final exam will be closed book (no books or electronic resources allowed) and must be completed entirely independently, with no collaboration or consultation with others.

Missed work

- Missed in-class or online quizzes, discussion meetings, homework, group work, midterms or final exam, may not be made up unless an accommodation may be allowed because the situation qualifies for one of four strictly-defined types of University-sanctioned exceptions:

personal emergencies or tragedies, an incapacitating illness, a religious holiday, or varsity athletic participation. In these instances it is the student's responsibility to be aware of and follow all relevant University-wide policies, including appropriate notification of the instructor.

VI Grading Policy

The final letter grade for the course will be based, tentatively and at the discretion of the instructor, on the following:

Graded work	Weight
Homework	15%
Discussion meetings, quizzes	15%
Midterm 1	20%
Midterm 2	20%
Final exam	30%

Participation in class discussion can contribute to your discussion meeting score.
Attendance of office hours can contribute to your homework score.

VII Tentative Course Schedule

Disclaimer: The schedule listed below is tentative, and topics covered on a given week may change depending on the pace set for the course.

Week	Textbook sections	Topics	Assignments
1	1.1 - 1 .3	Vectors; n-dimensional geometry	
2	1.4	Matrix multiplication; Gaussian elimination	Homework
3	1.5, 1.6.1	Linear systems; Solving linear systems	Homework
4	2.1 - 2.3	Linear transformations; Matrix algebra	Homework
5	2.4 - 2.5, 3.1 - 3.2	Elementary matrices; Transpose; Linear subspaces	Homework
6	3.2	Linear subspaces; Linear independence	Homework
7	3.3 - 3.4	Bases, dimension	**Midterm 1**
8	3.4, 3.6	Bases, dimension; Abstract vector spaces	Homework
9	3.6 - 4.2	Inner products; Projections; Orthonormal bases; Gram-Schmidt	Homework
10	4.3 - 4.4	Abstract linear transformations; Change of basis	Homework
11	4.3 - 4.4	Review of change of basis	**Midterm 2**
12	5.1 - 5.2	Determinants; Formulas for determinants	Homework
13	6.1, 6.2, 6.4	Eigenvalues and eigenvectors; Diagonalizability; Spectral thm	Homework
14		Review of material	**Final exam**

VIII Academic Support

The Math Help Room is a great resource for extra assistance on assignments and other course topics. I also recommend checking out resources from the Academic Resource Center at arc.duke.edu.

IX Accessibility and technology accommodations

In addition to accessibility issues experienced during the typical academic year, I recognize that remote learning may present additional challenges. Students may be experiencing unreliable wi-fi, lack of access to quiet study spaces, varied

time-zones, or additional responsibilities while studying at home. If you are experiencing these or other difficulties, please contact me to discuss possible accommodations.

Students who may have limited access to computers and stable internet may request assistance in the form of loaner laptops and WIFI hotspots. For new Fall 2020 technology assistance requests, please go here. For returning students who wish to request an extension of a laptop or hotspot loan for Fall 2020 semester, please go here. For updates, please visit https://keeplearning.duke.edu/undergraduate-students/.

X **Health and safety measures to prevent COVID-19 spread**

As members of the Duke community, we are all responsible for adhering to new norms and standards as mandated by local law and university policy. These include wearing masks or cloth face coverings in classroom and public settings; practicing physical distancing; washing and sanitizing hands frequently; and monitoring symptoms daily. Additional resources for students are available at https://coronavirus.duke.edu/updates/for-students/. In particular, here are some health resources if you are feeling sick: https://coronavirus.duke.edu/if-you-feel-sick/ or if you need support: https://coronavirus.duke.edu/support/.

The Duke Compact recognizes our shared responsibility for our collective health and wellbeing. Please be reminded that by signing your name to this pledge, you have acknowledged that you understand the conditions for being on campus.

XI **Statement on Academic Misconduct**

All students, whether residing on campus or learning remotely, must adhere to the Duke Community Standard (DCS): are expected to adhere to the Duke Community Standard. Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, and accountability. Citizens of this community commit to reflect upon these principles in all academic and nonacademic endeavors, and to protect and promote a culture of integrity.

To uphold the Duke Community Standard:

Students affirm their commitment to uphold the values of the Duke University community by signing a pledge that states:

- I will not lie, cheat, or steal in my academic endeavors;
- I will conduct myself honorably in all my endeavors;
- I will act if the Standard is compromised.

You must reaffirm your commitment to these standards by writing out and signing the following statement on every in-class quiz, midterm, and final exam: *I confirm my commitment to the Duke Community Standard.*

XII **Statement about disability services**

Duke University is committed to providing equal access to students with documented disabilities. Students with disabilities may contact the Student Disability Access Office (SDAO) to ensure your access to this course and to the program. There you can engage in a confidential conversation about the process for requesting reasonable accommodations both in the classroom and in clinical settings. Students are encouraged to register with the SDAO as soon as they begin the program. Please note that accommodations are not provided retroactively. More information can be found online at access.duke.edu or by contacting SDAO at 919-668-1267, SDAO@duke.edu.

XIII **Commitment to Diversity and Inclusion**

Duke aspires to create a community built on collaboration, innovation, creativity, and belonging. Our collective success depends on the robust exchange of ideas—an exchange that is best when the rich diversity of our perspectives, backgrounds, and experiences flourishes. To achieve this exchange, it is essential that all members of the community feel secure and welcome, that the contributions of all individuals are respected, and that all voices are heard. All members of our community have a responsibility to uphold these values.

I intend to support an inclusive classroom environment where diverse perspectives are recognized, respected, and seen as a source of strength. I encourage you to learn from your fellow students, who may be interested in applying mathematical techniques in different fields, as this will allow you to appreciate your new knowledge even more. I also recommend that you ask many questions, whether in the classroom or during office hours, to ensure that you understand the material throughout the semester.

XIV **Mental health statement**

As a student, you may experience personal or academic stress at any point throughout the semester. Duke offers several resources for students to both seek assistance on coursework and improve overall wellness, including, but not limited to:

- The Academic Resource Center at (919) 684-5917, theARC@duke.edu, or arc.duke.edu. Offers free services to all students during their undergraduate careers at Duke, including learning consultations, peer tutoring and study groups, ADHD/LD Coaching, Outreach Workshops, Test Prep and more.

- DuWell at (919) 681-8421 or duwell@studentaffairs.duke.edu Purpose is to provide students an understanding of what wellness is and how it applies to their lives. Moments of Mindfulness programs teach practical steps that students can use, in order to facilitate the growth of their personal wellness.

- WellTrack at https://app.welltrack.com/ Offers a suite of online tools and courses that help you identify, understand and address issues that you are having. Using the variety of tracking and assessment tools and practicing mindfulness can be essential in maintaining your mental health.

The purpose of the above programming is to assist students in having a daily practice of wellness management. If your mental health concerns and/or stressful events negatively affect your daily emotional state, academic performance, or ability to participate in your daily activities, additional resources are available, including:

- DukeReach at http://studentaffairs.duke.edu/dukereach DukeReach provides comprehensive outreach services to identify and support students in managing all aspects of their wellbeing. If you have concerns about a student's behavior or health visit the website above for resources and assistance.

- Counseling and Psychological Services (CAPS) at (919) 660-1000 and https://studentaffairs.duke.edu/caps CAPS services include: individual, group, and couples counseling services, health coaching, psychiatric services, and workshops and discussions

- Blue Devils Care at bluedevilscare.duke.edu
  Blue Devils Care is a convenient and cost-effective way for Duke students to receive 24/7 mental health support through TalkNow.

Personal Mental Health Day

Due to the absence of official breaks in the academic calendar this semester, I offer the option for students to take a "mental health day" this term. You may schedule this day in advance or elect to take it at a time when it will afford the most relief. Please note that you will be responsible for making up missed course material and assignments.