

MA 405. Introduction to Linear Algebra and Matrices

Instructor:	A. Duca (preferred pronouns: she/her/hers)
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Video Lectures:	Asynchronous; available on the course Moodle page
Problem sessions:	Thursdays 11:45 - 1:00, zoom link: https://go.ncsu.edu/ma405_problem_session
Office Hours:	Tuesdays 3:00 - 4:00(or by appt), zoom link: https://go.ncsu.edu/ma405_office_hours

Course text

There is no required textbook for this course. However, several textbooks available through the NC State Libraries are good resources and specific chapters will be recommended for each course unit:

1. Nair M.T., Singh A. (2018) *Linear Algebra*. Springer
2. Olver P.J., Shakiban C. (2018) *Applied Linear Algebra*. Undergraduate Texts in Mathematics. Springer
3. Said-Houari B. (2017) *Linear Algebra*. Compact Textbooks in Mathematics. Birkhäuser
4. Axler S. (2015) *Linear Algebra Done Right*. Undergraduate Texts in Mathematics. Springer
5. Chahal, J. (2019). *Fundamentals of Linear Algebra*. New York: Chapman and Hall/CRC

Catalog Description

Prerequisite: MA 241 (Co-requisite MA 242)

This course offers a rigorous treatment of linear algebra, including systems of linear equations, matrices, determinants, abstract vector spaces, bases, linear independence, spanning sets, linear transformations, eigenvalues and eigenvectors, similarity, inner product spaces, orthogonality and orthogonal bases, factorization of matrices. Compared with MA 305 Introductory Linear Algebra, more emphasis is placed on theory and proofs. MA 225 is recommended as a prerequisite. Credit is not allowed for both MA 305 and MA 405.

Course overview

Linear Algebra provides one of the cornerstones for much of modern Mathematics, and has important applications in Physics, Engineering, and Economics. The main purpose of this course is to introduce the basic concepts from linear algebra, explain the underlying theory, the computational techniques, and study how these concepts and results can be productively used in other areas of mathematics and physical sciences, especially in applied mathematics where multivariable models are involved. Among the topics covered in this course will be: solving systems of linear equations using Gauss elimination, row echelon form, determinants, vector spaces, linear independence, bases, dimension, linear transformations, orthogonality, eigenvalues, and reduction of matrices to diagonal forms. If time permits, we will discuss applications of linear algebra to differential equations and/or quadratic forms and/or Fibonacci sequences. The subject involves a mixture of both the practical and the theoretical, and will provide in particular a good introduction to mathematical proofs. For this reason, the course is considered to be a difficult one in undergraduate mathematics, and the student should be prepared to invest considerable amount of time in understanding the class material and doing homework. Credit is not allowed for both MA 305 and MA 405.

Learning Objectives

Upon successful completion of this course, students will be able to:

1. **Use Mathematical Notation and Terminology.** The students will demonstrate mastery in using the mathematical notation and terminology of linear algebra. Students will read, interpret, and use the vocabulary, symbolism and basic definitions.
2. **Understand and Describe the Fundamental Concepts of Linear Algebra.** Students will identify and apply the theorems about abstract vector spaces and linear transformations; will gain a clear understanding of the basic concepts of linear algebra, such as linear independence of vectors, spanning sets, basis, similarity, eigenvalues and eigenvectors.
3. **Identify and Utilize Linear Algebra Tools.** The students will be able to apply course material along with techniques and procedures covered in this course to solve problems. Students will master techniques for solving linear systems by various matrix methods, compute the determinant and the inverse of a square matrix, compute various factorizations of matrices, apply the Gram-Schmidt process, calculate and analyze the characteristic equation of a matrix to determine its eigenvalues and eigenvectors. Moreover, students will apply properties and theorems about vector spaces to specific mathematical structures that satisfy the vector space axioms, will analyze the differences and similarities between spanning sets, bases, and orthogonal

bases and will use the knowledge gained in this course to determine appropriate methods of proof for specific problems.

4. **Develop Cognitive Skills.** Students will demonstrate the ability to reason with abstract linear algebra concepts, to read and comprehend mathematical arguments utilizing direct and indirect proof, case analysis, and mathematical induction. Students will develop familiarity with axiomatic approach in mathematics through the study of vector spaces and linear transformations. They will acquire a level of proficiency in manipulating linear algebra concepts, in analyzing and evaluating their applicability in their future studies, including graduate work, in academic areas requiring linear algebra as a prerequisite for work in occupational fields requiring a background in linear algebra.

Course Delivery Changes Related to COVID-19:

Please be aware that the situation regarding COVID-19 is frequently changing, and the delivery mode of this course may need to change accordingly, including possibly moving our synchronous sessions to an asynchronous format. Regardless of the delivery method, we (instructor and students) should all strive to provide a high-quality learning experience.

Course Structure and Rules of Engagement

All course learning materials and resources are housed in Moodle: <http://moodle.wolfware.ncsu.edu/>. The video lectures are pre-recorded and made available in Moodle, along with the pdf course notes.

We will also have synchronous problem sessions via Zoom (https://go.ncsu.edu/ma405_problem_session) on Thursdays during the scheduled class time, 11:45am -1:00pm when the students can experience small group activities. These sessions will be recorded and posted in Moodle as well. The goal for these sessions is for students to work with their peers, generate questions, ideas, and experience opportunities for in-depth learning. We will share ideas and learn from each other. It will be important for each of you to communicate, interact and “try” on new ideas and to make conjectures even if you are not sure that you are correct. You will also be asked to critique the ideas and arguments of others. While it is OK to disagree with those ideas and arguments, it is not OK to make personal attacks.

Grading Policy

Your final grade in this course will be determined by grades earned on the final exam, three term tests, and online homework assignments. The weighting of these components are as follows:

- Homework 25%
- Three hourly term tests 45 %

September 15

October 6

October 27

- Final Exam 30%

November 19

$B+ < 90, 83 \leq B < 87, 80 \leq B- < 83 \dots$

Grading Scale: $97 \leq A+ \leq 100, 93 \leq A < 97, 90 \leq A- < 93, 87 \leq$

Note: I do NOT curve grades in this course. It is theoretically possible for everyone in the class to get an A (or an F). Your performance depends only on how you do, not on how everyone else in the class does. It is therefore in your best interests to help your classmates, while keeping the academic integrity policy in mind.

Testing

Procedural details about the tests will be made available in Moodle. The term tests will be hour-long exams that you will be able to take during a prescribed time window (the dates above are *tentative*). The final exam is two hour long and will be set up in a similar way. The Moodle site will have guidance regarding the material covered in each tests. The final exam is mandatory, cumulative.

Homework Assignments will be submitted using an Internet-based homework service called WeBWorK. The lowest 3 homework grades will be dropped. Use these drops wisely. The links to the homework assignments are available in Moodle.

Corrections to the grading

If you believe an error has been made in grading on a test write a statement making your case and email it to me. I will give partial credit to partial correct solution that was neatly presented. You have *1 week after the test is returned* to request re-grading.

Make-Up Policy

Late assignments and make-up work will only be allowed for excused absences. These include university duties or trips (certified by an appropriate faculty or staff member), required court attendance (certified by the Clerk of Court), or religious observances (certified by the Department of Parent and Family Services 515-2441). You should contact me by email before any anticipated excused absence. If you have an unanticipated excused absence (for example, a medical emergency), you should contact me within one week of returning to class. For complete attendance and excused absence policies, please see: <https://policies.ncsu.edu/regulation/reg-02-20-03-attendance-regulations/>.

Attendance is expected for every problem session as it is critical for the understanding of the material and not attending class serves as its own penalty because this material takes much longer to learn independently. You are responsible for keeping up with your work so that you do not fall behind. Office hours will not be utilized to re-teach material presented in class.

Instructor's commitment

You can expect your instructor to be courteous, punctual, well organized, and prepared for lecture and other class activities; to answer questions clearly and in a non-negative fashion; to be available during office hours or to notify you beforehand if they are unable to keep them; to provide a suitable guest lecturer when if they can't teach; and to grade uniformly and consistently according to the posted guidelines.

Grading/Scheduling Changing Options Related to COVID-19

Undergraduates have the option to make changes to their enrollment status for this course. In particular, if the delivery mode has a negative impact on your academic performance in this course, the university has provided options to potentially reduce the impact:

Please consult the Enhanced Satisfactory/ Unsatisfactory Grading policy and Enhanced Late Drop Option. The late drop date for the Fall 2020 semester is September 30, 2020 .

Please be aware that if you decide to use the enhanced S/U grading option, you will still need to complete the course and receive at least a C- to pass the course. In some cases, another option may be to request an incomplete in the course. Before using any of these tools, please discuss the options with your course instructor and with your academic advisor.

Auditing the Course

To audit the course, you must have the approval of your advisor and the Mathematics Department. In order to receive an AU, you must attend the majority of the sessions, and you must hand in all of the homework and take all of the tests. See: <https://policies.ncsu.edu/regulation/reg-02-20-04/>.

Incomplete Grades will be handled on an individual basis. Note, however, that if an extended deadline is not authorized by an instructor or department, an unfinished incomplete grade will automatically change to an F after either (a) the end of the next regular semester in which the student is enrolled (not including summer sessions), or (b) the end of 12 months if the student is not enrolled, whichever is shorter. See: <https://policies.ncsu.edu/regulation/reg-02-50-03/>.

COVID-19 Related Absences

If you need to miss class or coursework because you have been advised that you may have been exposed to COVID-19 or you have a personal or family situation related to COVID-19 that prevents you from attending our sessions, please contact me. Together we will develop a plan to help you keep up with your coursework during any such absences. COVID 19-related absences will be considered excused. You do not need any additional documentation.

Academic Integrity Statement and Academic Dishonesty

Both faculty and students at North Carolina State University have a responsibility to maintain academic integrity. Students are required to comply with the university policy on academic integrity/honesty found in the Code of Student Conduct: <https://policies.ncsu.edu/policy/pol-11-35-01/>. It is my understanding and expectation that your signature on any test or assignment means that you have adhered to the Pack Pledge:

"Academic dishonesty is the giving, taking, or presenting of information or material by a student that unethically or fraudulently aids oneself or another on any work which is to be considered in the determination of a grade or the completion of academic requirements or the enhancement of that student's record or academic career." (NCSU Code of Student Conduct)

Scholarly activity is marked by honesty, fairness and rigor. A scholar does not take credit for the work of others,

does not take unfair advantage of others, and does not perform acts that frustrate the scholarly efforts of others. The violation of any of these principles is academic dishonesty. Penalties for a violation: For the first violation, you will receive a zero for your work and be put on academic integrity probation for the remainder of your stay at NCSU. The second violation may result in your suspension from NCSU. Violations of academic integrity will be handled in accordance with the Student Discipline Procedures (NCSU REG 11.35.02).

Electronically-hosted Components

Please be advised that this course is being recorded for current (and potential future) educational purposes. By your continued participation in this recorded course, you are providing your permission to be recorded. Please see the relevant technology requirements (Zoom, WeBWorK) provided in Moodle. Please be advised that students may disclose personally identifiable information to other students in the course, via electronic tools like email or web-postings. Examples include online discussions of class topics and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.

Accommodations for Students with Disabilities

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Resource Office at Holmes Hall, Suite 304, 2751 Cates Avenue, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (REG02.20.01).

Non-Discrimination Policy

NC State prohibits discrimination, harassment, and retaliation based on a person's age (40 years or older), color, disability, genetic information, gender identity, national origin, race, religion, sex (including pregnancy), sexual orientation or veteran status. If you feel that you have been the subject of prohibited discrimination, harassment, or retaliation, you should contact the Office for Institutional Equity and Diversity (OIED) at 919-513-0574. NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at <http://policies.ncsu.edu/policy/pol-04-25-05> or <http://oied.ncsu.edu/divweb>.

Health and Well-Being Resources

These are difficult times, and academic and personal stress are natural results. Everyone is encouraged to take care of themselves and their peers. If you need additional support, there are many resources on campus to help you:

- NCSU Counseling Center
- Student Health Center
- NC State CARES Team: As members of the NC State Wolfpack community, we each share a personal responsibility to express concern for one another and to ensure that our campus remains a healthy and safe environment for learning. Occasionally, you may come across a classmate whose personal behavior concerns or worries you, either for your classmate's well-being, for your well-being or for the well-being of others. When this is the case, I would encourage you to report the behavior to the NC State CARES team: Share a Concern.
- If you or someone you know are experiencing food, housing or financial insecurity, please see the Pack Essentials Program.

Additional COVID-19 Information

Due to the Coronavirus pandemic, public health measures have been implemented across campus. You should stay current with these practices and expectations listed on the Protect the Pack site <https://www.ncsu.edu/coronavirus/>.

We are most concerned about your health and the health of the students, faculty, and staff across campus. If you test positive for COVID-19, or are told by a healthcare provider that you are presumed positive for the virus, please follow university guidelines, including self-reporting: Coronavirus Self Reporting. Self-reporting is not only to help provide support to you, but also to assist in contact tracing for containing the spread of the virus.

Community Standards related to COVID-19

We are all responsible for protecting ourselves and our community. Please see the Community Standards and Rule 04.21.01 regarding Personal Safety Requirements Related to COVID-19.

NC State Rules and Regulations

Students are responsible for reviewing the NC State University Policies, Rules, and Regulations (PRRs) which pertain to their course rights and responsibilities, including those referenced both below and above in this syllabus:

- Equal Opportunity and Non-Discrimination Policy Statement with additional references at <https://oied.ncsu.edu/equity/>
- Code of Student Conduct

Student Evaluations

Online class evaluations will be available for students to complete during the last three weeks of classes. You will receive an email message directing you to a website where you can login using your Unity ID and complete the evaluation. All evaluations are confidential; instructors will not know how any one student responded to any question, and students will not know the ratings for any instructors.

Other Remarks

- All course communications will be sent via the Moodle announcement forum to your official ncsu.edu email address.
- You are more than welcome to email me to schedule a one-on-one meeting to discuss issues related to the course.
- I prefer to be contacted by email (not phone). Please make sure that you include your name and the course number and section in the subject line of your email.
- Your email address registered with the NCSU online directory will be used for announcements associated with this class. It is your responsibility to maintain a valid email address and check/empty your Inbox regularly.
- The test and homework grades will be recorded in the Moodle gradebook. Please notify me immediately if you notice any discrepancies in your grades.
- Please check the course webpage regularly, as it will be continuously updated with announcements, any changes in the schedule, homework problems, solutions, review sheets, and other additional course materials.
- Please mark the test dates on your calendar and do not set your dental/doctor/interview... appointments on top of the test dates.
- Be respectful to your peers and to your instructor.

MA405 Tentative Schedule

- Week of August 10: Vector Spaces
- Week of August 17: Vector Spaces
- Week of August 24: Matrices, Linear systems
- Week of August 31: Matrices, Linear systems. More Vector Spaces
- Week of September 7: More Vector Spaces
- Week of September 14: More Vector Spaces. Test 1 (September 15)
- Week of September 21: Linear Transformations
- Week of September 28: Linear Transformations
- Week of October 5: Test 2 (October 6). Eigenvalues & Eigenvectors
- Week of October 12: Eigenvalues & Eigenvectors
- Week of October 19: Eigenvalues & Eigenvectors
- Week of October 26: Test 3 (October 27). Inner Product Spaces..
- Week of November 2: Inner Product Spaces
- Week of November 9: Inner Product spaces
- Final Exam: **November 19, 12-2:30**

Good Luck!