

MA 520. Linear Algebra

Lecture details

T-Th 8:30 - 9:45, 461 Riddick Hall

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Office Hours: TW 2:00 - 3:00, or by appointment

Moodle page: <http://moodle.wolfware.ncsu.edu/>

Course text

P.J. Olver and C. Shakiban: *Applied Linear Algebra*, 2nd Ed. ISBN: 978-0131473829

Available through NCSU libraries: <https://catalog.lib.ncsu.edu/record/NCSU4441965>

A more elementary treatment of linear algebra:

Linear Algebra, by Jim Hefferon - A free text for a standard US undergraduate course.

http://joshua.smcvt.edu/linearalgebra/#current_version

Catalog Description

Prerequisite: MA 405

Vector spaces. Bases and dimension. Changes of basis. Linear transformations and their matrices. Linear functionals. Simultaneous triangularization and diagonalization. Rational and Jordan canonical forms. Bilinear forms.

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 graduate level course is to give a second course on linear algebra to cover the most important concepts in linear mathematics in depth, 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 LU decomposition, vector spaces, linear independence, bases, dimension, linear transformations, eigenvalues, diagonalization and Jordan forms, bilinear forms, orthogonality, norms, positive definite matrices. 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, and the student should be prepared to invest considerable amount of time in understanding the class material and doing homework.

At the end of the class, students will choose topics related to the applications of linear algebra, and will conduct independent research on the chosen topic as part of their final project.

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 inde-

pendence of vectors, spanning sets, basis, similarity, eigenvalues and eigenvectors, positive definite matrices.

- 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 various factorizations of matrices, apply the Gram-Schmidt process, calculate and analyze the characteristic equation of a matrix to determine its eigenvalues and eigenvectors, and complete the squares. 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.

Grading Policy

Letter grade is according to the following: A+ = 99-100, A = 92-98+, A- = 90-91+ , B+ = 88-89+, B = 82-87+, B- = 80-81+, C+ = 78-79+, C = 72-77+, C- = 70-71+, D+ = 68-69+, D = 62-67+, D- = 60-61+

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

Homework & Quizzes = 25 %
Three term tests = 60 % (20 % each)
Final Project = 10 %
Class Participation = 5 %

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.

Term Tests 60%

There will be three closed book, closed notes in-class term tests on *Thursday, February 14, Thursday, March 21, and Thursday, April 18*. *No re-tests* will be given. If you miss a test because of an undocumented or unexcused absence, a zero will be entered for that test grade. Students who are unable to take the test at those times (with a documented excuse) will schedule an alternate time to take the exam.

Homework and Quizzes There will be a quiz at the beginning of the semester to bring everyone

up to level with the pre-requisite material from MA 405. The grade of the quiz is counted towards the homework grade. There might be other quizzes during the semester.

Most of the homework assignment will be completed on-line using an Internet-based homework service called WeBWorK. Some of the homework assignment will be given separately and graded by the instructor. You can find the link to the login page at

<http://webwork.math.ncsu.edu/webwork2/>

For your username enter the NCSU unity id and your NCSU email password. If you are unable to get into WeBWorK for any reason, email me.

I will assign homework sets weekly or bi-weekly, and the due date is always on Thursdays before class. Any change from this will be announced by an email to all students.

Final Project

The project will involve giving a written essay and a poster presentation of a recent paper or chapter from a book, which will be selected by the student subject to the approval of the instructor. Poster presentations of the projects will take place during the last week of classes. More information, together with important dates, can be found under "Projects" at the Moodle website.

Corrections to the grading

If you believe an error has been made in grading on a test write a statement making your case and bring it to your instructor. 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. Do not alter the original work!

Test Make-Up Policy

All *anticipated absences* must be excused in advance of the test date. 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). *Emergency absences* must be reported as soon as possible once returning to class and must be appropriately documented (illness by an attending physician or family emergencies by Parent and Family Services). If you are sick on a test day and decide not to come to class, go to the health center or other medical facility. Students who miss a test and have a university-approved excuse must submit appropriate documentation.

Attendance is expected every day 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 missed work so that you do not fall behind. Office hours will not be utilized to re-teach material presented in class. Your class attendance and class participation is worth 5 % of the total grade.

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 they are traveling or sick; and to grade uniformly and consistently according to the posted guidelines.

The Math Multimedia Center is a tutorial center for undergraduate students that need help

in their mathematics courses (100- through 300-level), and is staffed by math graduate students familiar with the material taught in these courses.

Location: SAS Hall 2103/2105

Hours: Monday - Friday 8:00 am - 5:00 pm

You can also get help with your courses (not only math) at the NCSU Undergraduate Tutorial Center.

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 Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 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 (REG02.20.1)”

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.

Academic Integrity Statement and Academic Dishonesty

Both faculty and students at North Carolina State University have a responsibility to maintain academic integrity. An informational brochure about academic integrity is available from the university and students are encouraged to obtain a copy.

”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. Both situations will involve the Office of Student Conduct.

Other Remarks

- You are more than welcome to visit me during my official office hours, but I am available at many other times. Please make an appointment.
- A good way to contact your instructor is by email. Please make sure that you include your name and the course number 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 grades will be recorded in the gradebook in Moodle. Please notify me immediately if you notice any discrepancies in your grades. Keep all your quizzes and tests for future reference.
- 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. All cell phones should be turned off during class and no eating, drinking, or any tobacco products are allowed in the classroom. Please leave your laptop in your bag during class time. Students who do not follow these guidelines may be asked to leave class.

MA520 Tentative Schedule

- January 8, 10: Review: linear systems, matrix arithmetic, symmetric matrices, determinants; Short Quiz;
Sections 1.1, 1.2, 1.6, 1.9
- January 15, 17, 22: Gaussian elimination and LU factorization: regular and permuted; Gauss-Jordan elimination and Cramer's rule; General linear systems;
Sections 1.3, 1.4, 1.5, 1.8
- January 24, 29, 31, February 2: Real vector spaces, subspaces; Span, linear independence; Bases and dimension;
Chapter 2.1-2.4
- February 5, 7, 12: Fundamental matrix subspaces; The fundamental theorem of linear algebra;
Section 2.5
- February 14: Test 1
- February 19, 21, 26: Linear functions; Change of bases;
Sections 7.1, 7.2
- Feb 28, March 5, 7, 19: Eigenvalues and eigenvectors; Eigenvector bases and diagonalization;
Sections 8.2, 8.3
- March 21: Test 2
- March 26, 28: Bilinear functions, inner products; Inequalities, orthogonality; Norms;
Sections 3.1, 3.2, 3.3,
- April 2, 4: Orthogonal bases; Gram-Schmidt process; Orthogonal matrices;
Sections 4.1, 4.2. 4.3
- April 9, 11, 16: Positive definite matrices; Completing the square;
Sections 3.4, 3.5
- April 18: Test 3
- April 23, 25: Project presentations.

Good Luck!