MA 405. Introduction to Linear Algebra and Matrices

Lecture Details
Section 002| MWF 10:40-11:30 AM, SAS 2225
Instructor: Suzanne Crifo | LAU 208| secrifo@ncsu.edu| https://secrifo.wordpress.ncsu.edu/
Office Hours: T 10:00-11:00 AM and F 11:30-12:30 AM, and by appointment
Class Website: https://secrifo.wordpress.ncsu.edu/teaching/ma-405/

Course Text
Linear Algebra Done Right, by Sheldon Axler, Springer International Publishing : Imprint: Springer, 2015
ISBN: 9783319110806 - available as a **free download** through NCSU libraries.
We may also use **Linear Algebra** by Jim Hefferon as a supplement. That link takes you to a page where you can download both the text and solutions.

Catalog Description
Prerequisite: MA 241 (MA 225 recommended) Co-requisite: MA 341 recommended
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 a considerable amount of time in understanding the class material and doing homework.

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 Tools from Linear Algebra to Solve a Given Problem.** 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, 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. **Apply Different Proof Techniques to Formulate and Formally Present Arguments.** 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 Grade: According to NCSU policies, we will use the following grading system:

Grading Scale

97-100	A+	93-96.99	A	90-92.99	A-
87-89.99	B+	83-86.99	B	80-82.99	B-
77-79.99	C+	73-76.99	C	70-72.99	C-
67-69.99	D+	63-66.99	D	60-62.99	D-

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

Participation = 3 %
WeBWorK and Quizzes = 5 %
Semester-Long Project= 10 %
Written Homework = 15 %
Three term tests = 45 %
Final Exam = 22 %

Participation 3% includes active engagement in class, completion of any Google form check-ins, and cooperation with other students when asked to work in groups. Please note that office hours will not be used to reiterate material covered in class. I appreciate if you come prepared with questions building on what we went over in class. I do not appreciate if you come hoping to learn the material because you were texting in class

WeBWorK and Quizzes 5%
WeBWorK is a free online service. I suggest working through each problem on WeBWorK as if it will be submitted to thoroughly understand the material. WeBWorK can be accessed through the Moodle page. "Pop" quizzes may occur if I find a WeBWorK problem particularly interesting. I'm very bad at keeping secrets, so you'll have a good idea if a "pop" quiz is coming in the next class period. They will not be more than five or ten minutes long.

Semester-Long Project 10% will consist of check-ins and drafts at various stages of the project. The project is designed to help you determine how you can use linear algebra in your own major and/or passion. The checks and updates throughout the semester will factor into the final grade for the project, in addition to a completed summary.

Written Homework 15%will always be announced at least one week before the due date. You should expect to have a written homework assignment due every two weeks. I encourage collaboration among classmates on homework as long as you maintain academic integrity as defined in the NCSU Code of Student Conduct. If you do work with another student on a written homework assignment, please each hand in your own assignment, written in your own words, with the statement "I worked with [student's name]" at the top of the paper.

Three Term Tests 45%will be closed-book, closed-notes. The target dates are*Friday, February 2, Friday, March 2,*and*Friday, April 13*. 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 cannot, not just that you don?t want to) will schedule an alternate time to take the exam.

Final Exam 22% is mandatory, cumulative and will be held in the usual classroom on Monday, May 7, 2018, 8:00-11:00am.

Corrections to 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 where appropriate. 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.

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.

Add/Drop Regulation
Undergraduate students are expected to complete all courses for which they are enrolled as of census date (the official enrollment date defined as the 10th day of fall and spring terms and the 3rd day of summer terms). Undergraduate course drops after census date will now be considered to be course withdrawals and will result in W grades on the transcript. Undergraduates will be limited to a maximum of 16 hours of course withdrawals after census date and before the drop date March 12, 2018 for their entire undergraduate career at NC State. These course withdrawals will count as attempted hours for course repeat, financial aid satisfactory academic progress, and tuition surcharge calculations.

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. We may also have mid-semester evaluations to determine if instruction should change in any way to meet students' needs. Completion of these mid-semester evaluations will be considered in the student's participation grade.

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.

MA405 Tentative Schedule

*Note: the online schedule will be kept up to date. Students should refer to the online schedule, as this provides only a topical outline.

- Lectures 1 & 2. Euclidean Vector Spaces (1.A)
- Lectures 3, 4, 5, & 6. Vector Spaces. Examples. Subspaces (1.B, 1.C)
- Lectures 7 & 8. Span (2.A)
- Lecture 9 & 10. Linear Independence (2B)
- Lectures 11 & 12. Basis & Dimension (2C)
- Lectures 13 & 14. Row space/Column space/Null Space/ Rank Theorem. (Instructor Notes)
- Lectures 15 & 16. Coordinates. Change of Basis. (Instructor Notes)
- Lectures 17 & 18. Linear Maps (3A)
- Lectures 19, 2,0 & 21. Kernel, Range of a Linear Map (3B)
- Lectures 22 & 23. Matrix Theory. Invertible matrices. (3C)
- Lecture 24, 25, 26, & 27. Isomorphisms. (3D)
- Lectures 28, 29, 30, 31 & 32. Eigenvalues & Eigenvectors (Instructor Notes)
- Lectures 33 & 34. Eigenspaces. Diagonalization. Similarity (Instructor Notes)
- Lectures 35 & 36. Inner Product Spaces. Orthonormal Bases. Gramm-Schmidt process. (6A, 6B)
- Lectures 37 & 38. Orthogonal Complements. Least squares approximation. (Instructor Notes)
- Lecture 39. Diagonalization of symmetric matrices. (Instructor Notes)
- Lecture 40. Singular Value Decomposition (Instructor Notes)