Math 502 Advanced Linear Algebra

College of Charleston
Department of Mathematics
Fall 2017 Syllabus

Instructor Information

Ben Cox — Office Hours: MW 11:00-12:00.
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Course Meetings

Mondays and Wednesdays in Maybank Hall 103 from 4:00 pm - 5:15 pm.

Course Description

This course provides the linear algebra background necessary for a variety of applied fields as well as advanced work in algebra and analysis. Topics include vector spaces, linear transformations, dual spaces, matrices, matrix factorizations, matrix norms, determinants, eigenvalues and diagonalization, bilinear forms, projections, orthogonal and unitary transformations, Jordan canonical form, and infinite dimensional linear spaces. Applications such as approximation theory, positive matrices, computation, multilinear algebra, and spectral theory will be selected by the instructor.

Prerequisites

Students must have a working knowledge of undergraduate Linear Algebra and proof techniques of Abstract Algebra and Analysis.

Textbook

Linear Algebra by W.H. Greub (4th edition), Springer. 2006.

Student Learning Outcomes:

After completing this course, students will be able to:

1. Analyze and solve theoretical and applied problems in the advanced areas of Linear Algebra using appropriate terminology, concepts, and methods developed in this course.
2. Prove and explain important theoretical results and concepts underpinning the development of Linear Algebra.
3. Use results and tools from Advanced Linear Algebra to discuss the properties of linear transformations and the underlying linear spaces in both finite- and infinite-dimensional settings.
4. Present theorems and results in reports that include a precise statement of hypotheses and thesis, employment of appropriate proof methods, and a discussion and interpretation of the results.

These outcomes will be assessed by means of homework assignments and in-class exams. This course is cross-listed with Math 402 and as such students enrolled in Math 502 will have some problems assigned that are more of an abstract nature than those assigned to Math 402 students. Similarly students in Math 502 will have a limited number problems that test their theoretical understanding on the exams than those seen on an exam for Math 502.

Graded Assignments

In this course, we will have two **midterm exams**, a **final** examination, and **weekly homework**. Graduate students will also be required to complete extra more abstract

problems on exams and also extra more abstract problems on homework assignments. Graduate students are expected to have a deeper understanding of the material, assessed by means of work of a more theoretical nature and requiring a higher-level of proof skills.

Important Dates

Midterm I:	Wednesday, September 20
Midterm II:	Monday, October 30
Final Exam:	Friday, December 8, 4:00-7:00 p.m.

Course Grades

Midterms and Final Exam. Two midterm exams will each account for 20% of the course grade. The Final Exam is comprehensive and is worth 40% of the final grade. The homework is worth 20% of the total score.

Midterms:	40%
Final Exam:	40%
Homework:	20%

Homework. I will assign homework problems for each topic, and you should complete and understand all the assigned problems. I will grade selected homework problems and give unannounced quizzes. Feel free to work in groups on the homework. However: Copying someone's writeup without participating in the solution and allowing your solution to be so copied are both considered a violation of the Honor Code. The best way to learn to think mathematically is to do lots of practice problems

Grading Scale. Grades will be based on the percentage of points earned in the categories listed above according to the following:

A (85-100), B+ (80-84), B (75-79), C+ (70-74), C (65-69), D (55-64), F (below 55).

Attendance Policy

You are expected to attend class every day. If you miss class, you will need to obtain notes from one of your classmates and talk with me about material that you do not understand. If for some reason you are not able to attend class the day that an assignment is due, you should email me your assignment that day. Make-up exams are only possible with proper documentation from the Absence Memo Office.

Disability Policy

If there is a student in this class who has a documented disability and has been approved to receive accommodations through the Center for Disability Services/SNAP (Students Needing Access Parity), please come and discuss this with me during my office hours. The College will make reasonable accommodations for persons with documented disabilities. Students should apply at the Center for Disability Services/SNAP, located on the first floor of the Lightsey Center, Suite 104. Students approved for accommodations are responsible for notifying me as soon as possible and for contacting me one week before accommodation is needed. See also http://disabilityservices.cofc.edu/accommodations/

Honor Code

Any violation of the College's Honor Code will be reported to the Honor Board. For more details, see http://studentaffairs.cofc.edu/honor-system/ and the Student Handbook at http://studentaffairs.cofc.edu/honor-system/studenthandbook/

Lying, cheating, attempted cheating, and plagiarism are violations of our Honor Code that, when identified, are investigated. Each instance is examined to determine the degree of deception involved. Incidents where the professor believes the student's actions are clearly related more to ignorance, miscommunication, or uncertainty, can be

addressed by consultation with the student. We will craft a written resolution designed to help prevent the student from repeating the error in the future. The resolution, submittd by form and signed by both the professor and the student, is forwarded to the Dean of Students and remains on file.

Cases of suspected academic dishonesty will be reported directly to the Dean of Students.A A student found responsible for academic dishonesty will receive a XF in the course, indicating failure of the course due to academic dishonesty. This grade will appear on the student's transcript for two years after which the student may petition for the X to be expunged. The student may also be placed on disciplinary probation, suspended (temporary removal) or expelled (permanent removal) from the College by the Honor Board. It is important for students to remember that unauthorized collaboration -working together without permission - is a form of cheating. Unless a professor specifies that students can work together on an assignment and/or test, no collaboration is permitted. Other forms of cheating include possessing or using an unauthorized study aid (such as a PDA), copying from another's exam, fabricating data, and giving unauthorized assistance. Remember, research conducted and/or papers written for other classes cannot be used in whole or in part for any assignment in this class without obtaining prior permission from the professor. Students can find a complete version of the Honor Code and all related processes in the Student Handbook.

ADDITIONAL HELP When you have questions and you are unable come to the instructor's office for help during his office hours, you should (1) discuss with and get help from your peers (but no copying each other's homework), or (2) make an appointment with the instructor.

SUPPLEMENTARY MATERIALS Homework assignments, solutions to some homework problems, and solutions to practice exams and exams will be posted on OAKS regularly.

TOPICS The following topics will be discussed:

1. Fundamentals: Groups, fields, rings, linear spaces, subspaces, linear independence, basis, dimension. Free vector space over a set.

2. Quotient spaces and Duality. Isomorphism Theorems. Direct sums of vector spaces.

3. Linear Mappings: range and nullspace, transposition, similarity, projections. The space of linear mappings.

4. Tensor products of vector spaces. Exterior product of vector spaces.

5. Matrix Representation of Linear Transformations. Change of basis.

6. The symmetric group. Determinant and Trace. (Application/Motivation: computing volumes in n-dimensions.)

7. Spectral Theory of square matrices: eigenvalues, eigenvectors and the Jordan canonical form. Young diagrams. The Cayley-Hamilton formula.

8. Lie algebras and the Baker-Campbell-Hausdorff formula.

9. Euclidean Structure: scalar product, Gram-Schmidt orthogonalization, matrix adjoint, isometries. (Application: the QR matrix factorization.)