MATH 5330 (CRN 26550)

Computational Methods of Linear Algebra

Spring 2019
The University of Texas at El Paso

Xianyi Zeng, Instructor

This course focuses on several fundamental topics in computational methods of linear algebra: solutions to systems of linear equations, linear least squares problems, the eigenvalue problems, and linear programming.

Course number:	MATH 5330 (CRN 26550)
Course title:	Computational Methods of Linear Algebra
Credit hours:	3
Term:	Spring 2019
Time & location:	6:00–7:20pm MW, UGLC 338
Exam dates	Midterm exam: in class Monday, March 11, 2019 Final exam: 7:00pm–9:45pm Wednesday, May 15, 2019
Drop deadline	Friday, April 5, 2019
Prerequisites:	MATH 3323 (Matrix Algebra) or equivalent, and working knowledge of a high-level programming language.
Course fee:	None
Instructor:	Xianyi Zeng
	Office hour: 4:30pm–5:50pm MW, or by appointment Office location: Bell Hall 202 Office phone: 915-747-6759 Email: xzeng@utep.edu
Course website:	http://math.utep.edu/faculty/xzeng/2019spring_math5330
Textbook:	Lecture notes will be provided in each class. Main reference: Granville Sewell, *Computational Methods of Linear Algebra*, 3rd Edition.
Other references:	Gene H. Golub and Charles F. Van Loan, *Matrix Computations*. Yousef Saad, *Iterative Methods for Sparse Linear Systems*. David G. Luenberger and Yinyu Ye, *Linear and Nonlinear Programming*.

Important

The course website will be updated throughout the semester according to the progress in class. The instructor will send emails regarding class annoucements. It is your responsibility to check the emails and the course website frequently to keep up to date.

Course objectives

After a warm-up introduction to matrix analysis including linear spaces and vector/matrix norms, the students will learn the major numerical methods for four important problems: linear systems, least squares problems, eigenvalue problems, and linear programming. We will not only talk about the algorithms themselves, but also mathematical analysis of these methods including error analysis, proof of convergence, stability analysis, and discussion of scenarios when the methods may fail.

Upon successful completion of the course, the students are expected to understand why the computational methods work or fail in different situations, be able to implement the algorithms using a high-level language, and conduct basic error analysis for practical problems.

Grading

Your grade for the course will be based on the following:

- 40% homework.
- 20% midterm exam (linear systems and least squares problems).
- 40% final exam (comprehensive, but with emphasis on the eigenvalue problem and linear programming).

Late homework are **not** accepted under any circumstances. However, I will drop **two** lowest homework scores towards calculating your final grade. In general, missed exams **cannot** be made up, either. Exceptions can be given only in extraordinary and unavoidable circumstances with reasonable proofs, and with advance notice in written.

The letter grade will be guaranteed at the following levels: A $(90-100\%)$, B $(80-89\%)$, C $(70-79\%)$, D $(60-69\%)$. Depending on circumstances, the thresholds for each of the four letter grades could be lowered, but will be equal among all students. The letter grade F will be given if the final score does not reach the D threshold.

Attendance policy

Attendance to every class is strongly encouraged but not enforced. However, if you are absent from a lecture, it is your responsibility to check the course website and to find out the materials and homework that needs to be made up.

Accommodations for students with disabilities

If you have a disability and need classroom accommodations, please contact The Center for Accommodations and Support Services (CASS) at 747-5148, or by email to cass@utep.edu, or visit their office located in UTEP Union East, Room 106. For additional information, please visit the CASS website at `http://www.sa.utep.edu/cass`.

Academic honesty policy

Make sure you understand the UTEP academic honesty policy. Students are encouraged to share ideas, but you must do your own homework and you must write your own code for the projects (you may copy code that is on the course website). If homework or program code is suspected of being duplicated or copied, you will receive an incomplete for the assignment, and your case will be referred to the Dean of Students for adjudication. If the instructor has reason to believe that you have cheated on a quiz or exam, your case will be referred to the Dean of Students for adjudication.

Military statement

If you are a military student with the potential of being called to military service and/or training during the course of the semester, you are encouraged to contact as soon as possible.

Course drop deadline

April 5 is the university spring drop/withdrawal deadline. After the deadline, student-initiated drops will not garantee a grade of W; and the instructor will issue a grade of either W or F.

Course format and participation

The course is composed of lectures and after-lecture office hours. Topic-wise, we will follow the structure of the main reference book; but the lecture materials are provided in the lecture notes, which will be made available online and distributed in each class.

Course schedule

Below is a tentative schedule for this course.

Week 01 (01/23)	Preliminaries.
Week 02 (01/28, 01/30)	Gaussian elimination, LU decomposition, and error analysis.
Week 03 (02/04, 02/06)	Iterative methods for sparse systems and the conjugate gradient method.
Week 04 (02/11, 02/13)	The Krylov-subspace methods, GMRES.
Week 05 (02/18, 02/20)	BiCGSTAB and preconditioners.
Week 06 (02/25, 02/27)	Least squares problems and orthogonal reduction.
Week 07 (03/04, 03/06)	Householder transformation and GMRES revisited.
Week 08 (03/11, 03/13)	Midterm exam, the eigenvalue problems.
Week 09 Spring Break	No class
Week 10 (03/25, 03/27)	The Jacobi method and the Rayleigh quotient iterative method.
Week 11 (04/01, 04/03)	Schur decomposition and the QM method.
Week 12 (04/08, 04/10)	The singular value decomposition.
Week 13 (04/15, 04/17)	Introduction to linear programming.
Week 14 (04/22, 04/24)	The simplex method.
Week 15 (04/29, 05/01)	The method of duality.
Week 16 (05/06, 05/08)	Flexible, and comprehensive review
Week 17 (05/15)	Final exam