

## M 340L. Matrices and Matrix Calculations–CS.

Unique #54160, Fall 2018

### Instructor:

Prof. Todd Arbogast

Office: RLM 11.162, Phone: 512-471-0166

E-mail: [arbogast@ices.utexas.edu](mailto:arbogast@ices.utexas.edu)

Office hours: W 1:00–1:50 p.m. and Th 8:40–10:00 a.m.

### Teaching Assistant:

Ms. Beatriz Tapia Oregui (OH by Mr. Sebastian Schulz until Nov.) Office: RLM 10.104

E-mail: [btapiaoregui@utexas.edu](mailto:btapiaoregui@utexas.edu) ([s.schulz@math.utexas.edu](mailto:s.schulz@math.utexas.edu))

Office hours: TTh 1–3:00 p.m.

**Prerequisite:** Mathematics 408C, 408K, or 408N with a grade of at least C-. Restricted to computer science majors. Mathematics 340L and 341 may not both be counted.

**Meeting:** MWF 12:00–1:00 p.m. in PAI 2.48. Attendance is required at all class meetings.

**Textbook:** Gilbert Strang, *Introduction to Linear Algebra*, Fifth Edition, Wellesley-Cambridge Press, 2016, ISBN: 978-09802327-7-6, <http://math.mit.edu/~gs/linearalgebra> (Required).

**Web Pages:** We use the University's Canvas (<http://canvas.utexas.edu>) web site. Please check that your scores are recorded correctly in Canvas. You can access Canvas from [my.utexas.edu](http://my.utexas.edu).

**Course Outline:** The numbers refer to Strang's textbook.

1. Introduction to Vectors (3 lectures)
  - 1.1. Vectors and Linear Combinations
  - 1.2. Lengths and Dot Products
  - 1.3. Matrices
2. Solving Linear Equations (7 lectures)
  - 2.1. Vectors and Linear Equations
  - 2.2. The Idea of Elimination
  - 2.3. Elimination Using Matrices
  - 2.4. Rules for Matrix Operations
  - 2.5. Inverse Matrices
  - 2.6. Elimination = Factorization:  $A = LU$
  - 2.7. Transposes and Permutations
3. Vector Spaces and Subspaces (6 lectures)
  - 3.1. Spaces of Vectors
  - 3.2. The Nullspace of  $A$ : Solving  $Ax = 0$  and  $Rx = 0$
  - 3.3. The Complete Solution to  $Ax = b$
  - 3.4. Independence, Basis and Dimension
  - 3.5. Dimensions of the Four Subspaces
4. Orthogonality (5 lectures)
  - 4.1. Orthogonality of the Four Subspaces
  - 4.2. Projections
  - 4.3. Least Squares Approximations
    - Alternate norms
  - 4.4. Orthogonal Bases and Gram-Schmidt
5. Determinants (2 lectures)
  - 5.1. The Properties of Determinants
  - 5.2. Permutations and Cofactors
  - 5.3. Cramers Rule, Inverses, and Volumes
6. Eigenvalues and Eigenvectors (7 lectures)
  - 6.1. Introduction to Eigenvalues
  - 6.2. Diagonalizing a Matrix
  - 10.3. Markov Matrices, Population, and Economics (from Chapter 10)
  - 6.3. Systems of Differential Equations

- 6.4. Symmetric Matrices
- 6.5. Positive Definite Matrices
- 7. The Singular Value Decomposition (SVD) (4 lectures)
  - 7.1 Image Processing by Linear Algebra
  - 7.2 Bases and Matrices in the SVD
  - 7.3 Principal Component Analysis (PCA by the SVD)
  - 7.4 The Geometry of the SVD
- 8. Linear Transformations (3 lectures)
  - 8.1. The Idea of a Linear Transformation
  - 8.2. The Matrix of a Linear Transformation
  - 8.3. The Search for a Good Basis
- 10. Applications (2 lectures, as time permits)
  - 10.1 Graphs and Networks
  - 10.6. Computer Graphics

**Computer Accounts:** A computer account on the Mathematics Department network can be obtained in the Undergraduate Computer Lab, RLM 7.122.

**Homework and Quizzes:** Homework and quizzes will be assigned regularly, with only a portion fully graded. Quizzes must be completed solely by the individual. For the homework, however, it is acceptable for groups of students to help each other; however, each student must write up his or her own work. Late homework will not be accepted for credit (unless there is a valid health issue), and homework must be turned in during class. The textbook web site has answers to the exercises.

**Exams:** Three in-class exams will be given on Fridays, Sept. 28, Oct. 26, and Nov. 16. A comprehensive final exam will be given Saturday, December 15, 2–5:00 p.m.

**Final Grade:** Grades on the three midterm exams will be scaled to count 20 points each. For the homework and quizzes, the lowest score will be dropped, and the result will count as 20 points. The final exam will count 40 points. The final grade on the letter plus/minus scale will be determined out of 100 points by dropping the lowest midterm test grade, or by weighting the final test grade by 1/2 (i.e., count it as 20 points). The homework score *will* count in the final grade.

**Student Honor Code:** “As a student of The University of Texas at Austin, I shall abide by the core values of the University and uphold academic integrity.”

**Code of Conduct:** The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the university is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.

**Students with Disabilities:** Students with disabilities may request appropriate academic accommodations from the Division of Diversity and Community Engagement, <http://diversity.utexas.edu/disability/>. Notify your instructor early in the semester if accommodation is required.

**Religious Holidays:** Academic accommodation is made for major religious holidays upon request.

**Emergency Classroom Evacuation:** Occupants of University of Texas buildings are required to evacuate when a fire alarm is activated. Alarm activation or announcement requires exiting and assembling outside. Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building. Do not re-enter a building unless given instructions by the Austin Fire Department, the University Police Department, or the Fire Prevention Services office.

**Counseling and Mental Health Services:** Available at the Counseling and Mental Health Center, Student Services Building (SSB), 5th floor, M-F 8:00 a.m. to 5:00 p.m., phone 512-471-3515, web site [www.cmhc.utexas.edu](http://www.cmhc.utexas.edu).