Prereq: Any of the following courses or an equivalent: MATH 1242, MATH 1252, MATH 1342.

Course Description: MATH 2331, Linear Algebra, introduces basic concepts, algorithms, theory, and applications of linear algebra. It includes the following topics:

• Systems of linear equations, Gauss-Jordan elimination, vectors and matrices (Chapter 1)
• Linear transformations and their inverses, geometry of linear transformations (Chapter 2)
• Subspaces of \( \mathbb{R}^n \), image and kernel, linear independence and bases, dimension (Chapter 3)
• Projections, orthogonal bases, Gram-Schmidt process, QR-factorization, orthogonal transformations and matrices, least squares approximations and data fitting (Chapter 5)
• Determinants and their properties (Chapter 6)
• Computation of eigenvalues and eigenvectors (Chapter 7)
• Symmetric matrices, singular value decomposition (Chapter 8)

Text: Linear Algebra with Applications (5th ed.), O. Bretscher, Pearson Prentice Hall, 2013

Blackboard website: Sample problems and solutions, quiz solutions, supplementary notes and course materials

Grading: Six in-class quizzes will be given on the following dates: 9/19, 10/6, 10/27, 11/10, 11/21, 12/1. (These dates are tentative, and it is your responsibility to keep up with any changes.) Make-ups for missed quizzes are given solely at the discretion of the instructor. The five best quiz scores will count for 60% of the grade. The final exam will count for the remaining 40%. It is important to attend class regularly, and work on the exercises assigned in class and for homework. Occasionally these exercises will be collected. The exercises you submit and your attendance will be the basis of a grade for class participation. If your class participation grade is higher than your lowest quiz grade it will be used in place of the lowest quiz grade in computing your class average.

The final exam will be a common examination for all sections of this course. The letter grade will be determined from the numerical average using the scale:

A: 93-100; A-: 90-92; B+: 87-89; B: 83-86; B-: 80-82; C+: 77-79; C: 73-76; C-: 70-72; D+: 66-69; D: 58-65; D-: 50-57; F: 0-49; U: 0-72.

Borderline cases will be determined by the final exam score. Thus, a student whose course average is 89, but scores 90 or above on the final exam will receive an A-. Whereas a student whose course average is 89.5 but whose final exam score is 88 will receive a B+.

Suggested Homework Problems:

All references below are to the textbook: Linear Algebra with Applications (5th ed.), O. Bretscher, Pearson Prentice Hall, 2013

Topics and Homework Assignments (Tentative):
1. Linear Equations
   1.1 Introduction to Linear systems 1, 7, 10, 21, 24, 25, 36, 42
   1.2 Matrices, Vectors, and Gauss-Jordan Elimination 2, 4, 5, 7, 18, 21-24, 31-33, 36, 37
   1.3 On The Solution of Linear Systems 1-8, 11-15, 21-31, 34, 36, 47, 55

Quiz 1

2. Linear Transformations
   2.1 Intro. to Linear Transformations and their Inverses 1-3, 5, 6, 9, 47
   2.2 Linear Transformation in Geometry 1, 4, 6, 7, 8, 10, 17, 19, 21,26(a)(b)(c), 53
   2.3 Matrix Products 3, 5, 11, 13, 15-23, 25, 29, 47
   2.4 The Inverse of a Linear Transformation 1-3, 5, 6, 17, 19,29, 35-41 (odd), 42, 67-74

Quiz 2

3. Subspaces of \( \mathbb{R}^n \) and Their Dimensions
   3.1 Image and Kernel of a Linear Transformation 1, 3, 5, 7, 12, 15, 16, 23, 25, 33, 35, 42
   3.2 Subspaces of \( \mathbb{R}^n \), Bases and Linear Independence 1, 3, 4, 11-33(odd), 26, 37, 39, 46, 49, 52
   3.3 The Dimension of a Subspace of \( \mathbb{R}^n \) 1, 3, 5, 7, 11,13, 17, 21, 23, 27, 37, 39, 51
   3.4 Co-ordinates 1, 2, 6, 7, 19, 20, 28, 37—40, 47

Quiz 3
5. Orthogonality and Least Squares
   5.1 Orthogonal Projections and Orthonormal Bases 1, 3, 5, 15, 17, 27, 35
   5.2 Gram-Schmidt Process and QR Factorization 5, 7, 19, 21, 33, 35
   5.3 Orthogonal Transformations and Orthogonal Matrices 5-8, 13-17, 27, 29, 31, 37, 41
   Quiz 4
   5.4 Least Squares and Data Fitting 1, 5, 7, 17-25 (odd), 31-33

6. Determinants
   6.1 Introduction to Determinants 1-11(odd), 17, 27, 31, 43, 44
   6.2 Properties of Determinants 1, 6, 24-26, 30, 37-42
   Quiz 5

7. Eigenvalues and Eigenvectors
   7.1 Diagonalization, Eigenvalues 1-7, 9, 15-21 (odd), 34, 43, 44
   7.2 Finding the Eigenvalues of a Matrix 1-13(odd), 16
   7.3 Finding the Eigenvectors of a Matrix 1-13(odd), 21
   7.4 Dynamical Systems 1-7 (odd), 11, 17, 21, 25
   Quiz 6

8. Symmetric Matrices
   8.1 Symmetric Matrices 1, 3, 7, 22
   8.2 Quadratic Forms 1—11, 27, 28, 37
   8.3 Singular Value Decomposition 1, 2, 4, 6, 12, 13, 14

**ISSUES WITH THE COURSE/INSTRUCTOR:** If you have issues with this course and/or instructor which you are not comfortable discussing with your instructor or can’t resolve to your satisfaction, you should contact the teaching director of the mathematics department, Prof. David Massey, d.massey@neu.edu.

**Academic Honesty:** Cheating will not be tolerated. All incidents of cheating will be reported to the Office of Judicial Affairs. The University's policy on cheating and related disciplinary actions is detailed in the Student Handbook and at the following web site [http://www.northeastern.edu/osccr/academicintegrity](http://www.northeastern.edu/osccr/academicintegrity).

**Computers, calculators and cell-phones:** You will need a calculator such as the TI-84 which computes matrix products and matrix inverses later in the semester. Computers and calculators may be referenced during class only with the explicit permission of your instructor. Cell phones must be turned off during the class, especially during exams.

**Your travel plans:** It will not be possible to change the scheduled time for the final exam. So, do not make your travel plans to conflict with the final exam schedule.

**Some important dates:** The last day to drop a course without a W grade is Tuesday, September 27. The last day to file a conflict final form is Friday, September 30. The last day of regular fall classes is Wednesday, December 7. The last day to drop a course with a W grade is Thursday, December 8. Please keep December 8 (Reading Day) open in your schedule. There may be a review session on that date.

The university will be closed (i.e., no classes) on the following holidays:
Monday, October 10, Columbus Day
Wednesday, November 23 and Thursday, November 24 Thanksgiving Break

If you want to see me, but cannot do so during my office hours, then please talk to me before or after any class to set up a convenient time.

At the end of the semester, every student is expected to complete the online TRACE survey evaluations of the course as well as the Math Department’s evaluation form.

The instructor reserves the right to make changes in the syllabus. It is the responsibility of each student to be aware of all assignments and any syllabus changes announced in class or on the Blackboard website, and to be aware of information given when absent.