**Mathematics 15a - Applied Linear Algebra - Summer 2008**

**Instructor:** Nate Stambaugh (nstambau@brandeis.edu). My office is Goldsmith 113.

**Course website:** I will be using Latte to distribute homework and other course materials.

**Course meetings:** The course will be offered from 11:10 to 1:00 on Mondays, Tuesdays, Wednesdays, and Thursdays from **June $2^{nd}$** to **July $1^{st}$** in Goldsmith 226. Because of the fast pace of the course, attendance is strongly suggested.

**Office hours:** Mondays and Wednesdays from 10:00 to 11:00 and also after each class meeting as needed. Evening help will also be available by appointment.

**Text:** Linear Algebra With Applications, 3rd Edition, by Otto Bretscher, Prentice-Hall, 2005; ISBN 0-13-145334-3.

**Homework:**

- Two homework assignments each week, due Monday and Thursday.
- Homework assignments will be posted on Latte.
- You are encouraged to discuss the homework with your fellow students, but you must write up the solutions by yourself without collaboration with others.
- Late homework will only be accepted with prior consent.
- The reading assigned with each homework is essential. Some topics not covered fully in class will be left to the reading and you will be expected to pick up those additional details.
- Some of the homework problems will be difficult. We want you to think about the material and learn to apply it in unfamiliar settings and interpret it in different ways.

**Quizzes, Exams and Grading:**

- There will be short (usually 5 - 10 minute) quizzes during (almost) every class.
- There will be two in-class hour long exams on **Thursday, June $12^{th}$** and **Thursday, June $26^{th}$**.
- The Final Exam will be on **Wednesday, July $2^{nd}$** from 1-4.
- Grades will be computed as follows: Each hour exam: 20%, Homework: 25%, Quizzes: 10%, and Final Exam: 25%

**Students with Disabilities** If you are a student with a documented disability on record at Brandeis University and wish to have a reasonable accommodation made for you in this class, please see me immediately. Any information you share will be kept in confidence. Please keep in mind that reasonable accommodations are not made retroactively.

**Academic Dishonesty** You are expected to be familiar with and follow the University's policies on academic integrity (see www.brandeis.edu/studentlife/sdc/rr/html/rr_ section4.html). Instances of alleged dishonest will be forwarded to the Summer School Director for adjudication within the Student Judicial System. Potential sanctions included failure in the course, suspension from the University and permanent dismissal.

**Use of Technology:** In some of the homework problems you will be asked not to use any technology (calculators or software packages). If no restriction is made, you may use the form of technology of your choice. You will probably want to have access to some form of technology. Only calculators will be permitted on exams, although an effort will be made to write the exams in such a way that all problems may be solved without technology.

**Recommended Prerequisites:** The best prerequisite for this course is some "mathematical sophistication." Typically this includes one full year of single variable calculus, perhaps some multivariable calculus. Note that neither of these are truly necessary for successful completion of this course. It will be very helpful if you have some familiarity with the algebra and geometry of lines and planes in $\mathbb{R}^2$ (a.k.a. high school algebra and geometry), and have thought about what happens in $\mathbb{R}^3$, and possibly $\mathbb{R}^n$. We will assume little familiarity with vectors or matrices. Toward the end of the course it may be helpful if you can set up and solve simple differential equations.

**Philosophy:** This course is greatly dependent upon your participation. The best lessons you will learn are those derived from discussion and practice. Outside of class, it is essential that you read the assigned text sections, do the assigned homework, and bring any questions to class or to office hours. **Mathematics is not a spectator sport**. Think about the problems posed, your strategy, the meaning of the computations you perform, and the answers you get. This will be the best preparation for interaction in the classroom and for the exams.

**Words of Caution and Advice:** This course may prove to be more demanding than your previous mathematics courses. To make this manageable over the summer, be sure to take advantage of the many office hours provided. **Because of the condensed summer schedule, it is very important that you are able to spend some time every day digesting the material, discussing it with a peer, and/or coming to office hours.** If there is interest, organized group problem or study sessions will be arranged. This is because the weekly assignments may be somewhat time-consuming, and you may find it helpful to set aside regular hours to wrestle with them. Even when offered during the regular semester this course has a fast pace, thus it is highly improbable that you will do well in this course without working the homework assignments in a timely fashion. New material builds on old, so don't fall behind. If you find yourself falling behind, please contact me immediately so that options for assistance may be discussed.

| Text Chapter | Topics (some topics may be omitted) | Text sections |
|---|---|---|
| Chapter 1 | Systems of linear equations and their solutions; coefficient matrices and augmented matrices; row reduction; reduced row-echelon form; consistent vs. inconsistent systems; rank of a matrix; parameterization of solutions; matrix form of a linear system. | 1.1 - 1.3 |
| Chapter 2 | Linearity and linear transformations; matrix of a linear transformation; finding the matrix of a geometrically defined linear transformation; meaning of the columns of a matrix; matrix algebra; matrix products and the composition of linear transformations. | 2.1 - 2.4 |
| Chapter 3 | Subspaces; span; linear independence; kernel and image of a linear transformation; dimension; rank and nullity; basis of a subspace; coordinates relative to a basis; matrix of a linear transformation relative to different bases; similarity of matrices. | 3.1 - 3.4 |
| Chapter 4 | General linear spaces (vector spaces); examples of spaces of matrices, spaces of functions; matrix of a general linear transformation defined on a finite-dimensional linear space; isomorphisms. | 4.1 - 4.3 |
| Chapter 5 | Orthogonality; isometries; orthogonal matrices; orthonormal basis for a subspace; Gram-Schmidt process for producing an orthonormal basis from any basis; orthogonal projection; approximate (least squares) solutions; data fitting. | 5.1 - 5.4 |
| Chapter 6 | Determinants; multilinearity property of determinants; volume of a k-dimensional parallelepiped. | 6.1 - 6.3 |
| Chapter 7 | Invariant subspaces; eigenvalues and eigenvectors; algebraic and geometric multiplicity of an eigenvalue; diagonalization; discrete dynamical systems; diagonalization; powers of a matrix; stability; working with a) real eigenvalues, b) complex eigenvalues; and c) repeated eigenvalues. | 7.1 - 7.6 |
| Chapter 8 | Spectral Theorem; symmetric matrices; quadratic forms. | 8.1 - 8.2 |
| Chapter 9 | Continuous dynamical systems; systems of (1st order) linear differential equations; evolution matrices; stability of an equilibrium. | 9.1 - 9.2 |
| Supplements, etcetera | Nonlinear continuous dynamical systems; equilibrium analysis; phase-plane analysis. | 9.3 and supplements |