MATH 103, SUMMER 2006

1. Course Content

Math 103, *Matrix Theory and its Applicatoins*, is an introduction to linear algebra. The course begins by investigating techniques for solving systems of linear equations, in turn paving the way for an abstraction to matrices and matrix operations. Exploring the properties of matrices will translate our initial algebraic questions into geometric ones, a dictionary which will ultimately provide most of the interesting applications in the subject. As the course title suggests, there will be a strong focus on applications to the sciences.

Although we will cover a large portion of the text in our short time together, the concepts we will focus on will remain fairly concrete. Students who hold on to a geometric understanding of the material should find the topics we cover quite natural and easy to remember. That said, linear algebra is usually a student's first introduction to the abstraction that comes along with post-calculus mathematics. You will find that the course requires you to learn a new language, and you will not be able to succeed unless you spend time learning the new vocabulary and syntax.

Specific topics which will be covered include, but are not necessarily limited to, solutions to: systems of linear equations, Gaussian elimination, matrix algebra, vectors and their properties, linear transformations, dimension theory, the Gram-Schmidt algorithm, least squares, eigenvalues and eigenvectors, discrete and continuous dynamical systems, and the singular value decomposition.

2. Course Details

2.1. **Instructor.** The instructor for this class is Andrew Schultz. His office is in the basement of the math building, room 380-G. He is readily available by email at `aschultz@math.stanford.edu`. His office hours are Tuesdays and Wednesdays from 2:45 to 3:45, though you can schedule additional meeting times if you cannot make these times.

2.2. **Course Assistant.** The course assistant and grader for the term is Baosen Wu. His office is in the basement of the math building also, room 380-R. You can contact him by email at `bwu@math.stanford.edu`, but it is suggested that you direct your questions to the instructor. His office hours are Mondays and Thursdays from 3 to 4:30.

2.3. **Time and Location.** The course will be held Monday through Thursday at 11am in room 61A.

2.4. **Text.** The course is centered around Bretscher's *Linear Algebra with Applications*. Homework assignments will be taken primarily from this book, so students should have a copy of the text for the course.

3. Expectations

3.1. Prerequisites. Students are expected to have a solid understanding of standard, high school-level algebra and trigonometry. Students should also be familiar enough with differential and integral calculus that they can easily perform standard computations.

3.2. In-class expectations. A student's engaged presence is expected in classroom lectures. While the professor is in charge of determining what content is covered during a class period, students share the responsibility of directing lectures so each is as clear as possible. In particular students should feel comfortable stopping the professor to repeat a particular exposition, to present a concrete example of an abstract concept, or to explain a confusing concept in a new way. Classroom time is there for the benefit of students, so should be treated as an interactive resource.

3.3. Assignments. Mathematics cannot be learned without a large amount of personal effort, so this course will have a number of written assignments to solidify your understanding of the material and to provide the professor a gauge with which to assess your understanding. Students are expected to work diligently, thoughtfully, and cleanly when completing assignments.

4. Grading

4.1. Homework. A student's best opportunity to engage with the material from lecture is through homework, as homework problems are frequently one's first hands-on encounter with new material. It is imperative that homework solutions be written neatly, both for the sake of the grader and the student. Treating homework seriously is a student's best preperation for quizzes and tests, and hence the best way for a student to score well in the class.

It is suggested that students observe the following guidelines when writing their homework solutions. First, a student should work out each problem on scratch paper. After a solution has been determined for a problem, a complete solution–without excessive erasures–should be copied on the front side of a clean sheet of paper. Solutions should include more than just mathematical symbols; they should also contain phrases which explain what is happening or being checked in a particular computation. Standard mathematical conventions should be observed while writing solutions. For example, one should not use an equal sign to mean 'implies.' Handwriting should be more than legible, and one should not try to fit too many things on a single line or piece of paper. It is fine to write solutions to multiple problems on a single sheet of paper, provided that ample space has been provided between each problem. Homework papers should not have ragged edges. A student's solution set should be stapled if it contains more than one sheet of paper. The grader will deduct points from solutions sets which are messy or illegible.

Students are welcomed to talk to the instructor or each other in order to solve homework problems, but *each student must write up his or her own solutions without the benefit of notes from discussions with the instructor, course assistant, or other students.* While writing solution sets you are welcome to look at scratch work that you have completed on your own, but any work you have completed with the help of another person should first be recreated by yourself–without notes–before you use it as a reference in writing solutions.

There will be one homework assignment due each Wednesday, with the exception of the first week of classes. Homework will be due fifteen minutes after the beginning of class, and late homework is not accepted. If you must miss class on a day that an assignment is due, it is your responsibility to hand your homework in before the beginning of the class period in which the assignment is due. Your homework grade is determined by averaging your six homework grades from the term.

4.2. **Quizzes.** There will be one in-class, timed quiz per week, except for the first week of class and on those weeks when you have an exam. Quizzes will last 10-15 minutes and are given on Thursdays. Calculators may not be used on quizzes. Quizzes test the material covered in the week's homework assignment as well as important definitions and concepts from class. Your quiz average is computed by averaging your six quiz grades.

4.3. **Tests.** There will be 2 midterm examinations and 1 final. The first midterm will be held during class on Thursday, July 13, and your second midterm will be held during class on Thursday, August 3. Since the exams are held during class, no students should have conflicts which prevent them from taking the exam during the scheduled time. If there are exceptional circumstances which prevent you from being in class on these days, you may be able to reschedule the exam sometime *before* the scheduled in-class exam. Make sure you see the professor as early as possible to report these conflicts so appropriate accommodations can be made. Your final will be held on Saturday, August 19 at 8:30am.

4.4. **Attendance.** More than any other discipline, mathematics requires that a student understand one concept before moving on to the next. Therefore it is critical that you attend this class on a regular basis in order to stay on track with the material we cover. Students with excessive absences will see their grade diminished. More than 3 unexcused absences over the course of the term will be considered excessive.

4.5. **Computing your grade.** Your grade is computed as follows:

- `Midterm 1` 15%
- `Midterm 2` 25%
- `Quiz Average` 20%
- `Homework Average` 10%
- `Final` 30%

5. RESOURCES

5.1. **Office Hours.** Students are highly encouraged to attend office hours to discuss concepts covered in class or ask questions about homework assignments. There are several office hours per week for this class.

5.2. **Text.** In addition to have lots of problems to help you work through new concepts, your text also provides another source of understanding the course material.

5.3. **Course Webpage and Course Notes.** Homework assignments and practice exams, together with solutions, will be posted at the course webpage `http://math.stanford.edu/~aschultz/summer06/math103`. Course notes (pun intended) for the lectures will also be posted; these will cover the material discussed in lecture and should be posted by the end of each lecture day.

5.4. **Tutoring.** The Center for Teaching and Learning offers free tutoring to undergraduates. You can find out more about this at the tutoring webpage: `http://tutoring.stanford.edu`.

5.5. **Your classmates.** Discussing problems with classmates is a great way to hear new ideas for attacking problems. Remember, though, that students must write up homework assignments on their own.

6. Tentative Course Calendar

Below is a sketch for how our term will run. It is extremely unlikely that we will follow this schedule exactly during the term, but it should give an idea of the pace of and topics covered by the course.

Date	What We'll Do In Class	Bretscher Reference
June 27	Introductions Systems of Linear Equations Gaussian Elimination	1.1 & 1.2
June 28	Solutions to Systems of Linear Equations Matrices, Vectors, and relevant operations	1.2 & 1.3
June 29	Linear Transformations **Quiz 1**	2.1 & 2.2
July 3	No class	
July 4	No class	
July 5	Image and Kernel of a Linear Transformation Inverse of a Linear Transformation **Homework 1 due**	2.3 & 3.1
July 6	Operations on Linear Transformations Matrix Products **Quiz 2**	2.4
July 10	Subspaces of $\mathbb{R}^n$ Linear Combinations and Independence Bases	3.2
July 11	Dimension	3.3
July 12	Coordinates **Homework 2 due**	3.4
July 13	**Midterm 1**	1.1 - 3.3
July 17	Orthogonality	5.1
July 18	Gram-Schmidt Algorithm QR Factorization	5.2
July 19	Orthogonal Transformations Orthogonal Matrices **Homework 3 due**	5.3
July 20	Least Squares and Data Fitting **Quiz 3**	5.4
July 24	Determinants	6.1
July 25	Algebraic Properties of the Determinant	6.2

Date	What We'll Do	Bretscher Reference
July 26	The Geometry of the Determinant **Homework 4 due**	6.3
July 27	An Introduction to Discrete Dynamical Systems Eigenvalues and Eigenvectors **Quiz 4**	7.1
July 31	Computing Eigenvalues and Eigenvectors	7.2 & 7.3
August 1	The Geometry of Eigenvalues Complex Eigenvalues	7.5
August 2	Solving Discrete Dynamical Systems Sketching Solutions to Discrete Dynamical Systems Stability **Homework 5 due**	7.6
August 3	**Midterm 2**	1.1 - 7.3 & 7.5
August 7	Diagonlization	7.4
August 8	The Singular Value Decomposition	8.3
August 9	Sweet Applications of SVD **Homework 6 due**	N/A
August 10	More Sweet Applications of SVD **Quiz 5**	N/A
August 14	Continuous Dynamical Systems	9.1
August 15	Sketching Solutions to Continuous Dynamical Systems	9.2
August 16	**Homework 7 due**	9.2
August 17	Course Finale **Quiz 6**	