Math 6370 **Numerical Linear Algebra** Spring 2012

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Office Hours: MF 11 – noon; TR 3 – 4pm.

Prerequisite: A graduate level course in linear algebra (Math 510), and programming experience in Fortran/C/C++. A first course in numerical analysis (Math 507) is also required. See the handout entitled "Notes to the Student" for a list of linear algebra concepts that you should be familiar with.

Text: L. N. Trefethen & D. Bau, *Numerical Linear Algebra*, (1997), published by the Society for Industrial and Applied Mathematics (SIAM). Available at discount prices to SIAM members. If you are not a member of SIAM, then become one by going to http://www.siam.org/students/. There is no charge for students, as WMU is an institutional member of SIAM.

References:

1. J. W. Demmel, *Applied Numerical Linear Algebra*, SIAM 1997. Available in electronic version from the library.
2. G. H. Golub and C. F. Van Loan *Matrix Computations*, 3rd Edition (1996), Johns Hopkins University Press, Baltimore, Maryland.
3. N. J. Higham, *Accuracy & Stability of Numerical Algorithms*, 2nd Edition (2002), SIAM. Available in electronic version from the library.
4. G. W. Stewart, *Matrix Algorithms*, Vol 1: Basic Decompositions. SIAM, 1998.
5. David S. Watkins, *Fundamentals of Matrix Computations*, Third Edition, Wiley, 2010.

Software: MATLAB, The MathWorks. A high-level interactive system containing state-of-the-art routines for numerical computation. Matlab stands for "MATrix LABoratory". Available on the PCs in the College of Arts and Sciences Computer Lab, 3rd Floor, Rood Hall. For lab hours see http://www.wmich.edu/math/ASLab/. You may purchase the student edition from the Mathworks web site http://www.mathworks.com/academia/. Or, on your home computer you may use the freely available Matlab clone, GNU Octave. See http://www.octave.org/ for more details. Binaries for Linux and Windows are available.
An on-line MATLAB tutorial is available at http://www.mathworks.com/academia/.

Course Rationale: As Trefethen and Bau point out, the field of numerical linear algebra is more beautiful, and more fundamental, than its rather dull name suggests. More beautiful, because it is full of powerful ideas that are quite unlike those emphasized in an abstract linear algebra course. And more fundamental because it is here that one finds the essential ideas that every mathematical scientist needs.

Syllabus: We plan to cover the following topics, found in Chapters 1 – 3, 5, 6 of Trefethen and Bau. Please bring the text to class, as we will refer to it frequently.

- **Fundamentals**. Matrix Norms, Condition Numbers, Stability.
- **Decompositions**. QR factorization, Schur Decomposition, Singular Value Decomposition.
- **Eigenproblem**. Reduction to Hessenberg form, Rayleigh quotients, Inverse Iteration, QR algorithm, QR with shifts, Jacobi Method.
- **Iterative Methods**. Arnoldi, Lanczos, Conjugate Gradients, Preconditioning (as time permits).

Homework: Problems covering both theoretical and numerical concepts will be regularly assigned. MATLAB will be used for numerical experiments.

Examinations: Midterm approximately on Thurs Feb 22, and a cumulative Final on Tues Apr 24, 10:15am - 12:15pm. Your grade will be calculated thusly:

Homework	50%	Midterm	20%	Final	30%

Grading: Your grade will be determined by the scale:

A	92 – 100	B	81 – 86	C	67 – 75	D	55 – 59
BA	87 – 91	CB	76 – 80	DC	60 – 66	E	< 55

Class participation will be used to boost border-line grades.

Academic Integrity: I encourage you to discuss problems with each other. The work you submit, however, must be your own. Copying each other's work will have serious consequences. If you have received help/ideas from a fellow student or another source, it is important to cite them.

Here is the formal warning: You are responsible for understanding the policies and procedures in the Graduate Catalog (pp. 25-27) that pertain to Academic Integrity. These policies include cheating, fabrication, falsification and forgery, multiple submission, plagiarism, complicity and computer misuse. You should consult with me if you are uncertain about an issue of academic dishonesty prior to the submission of an assignment or test. Violations of the academic honesty policies can result in failing grades for the assignment and the course. Additional penalties can be imposed by the University.

Important Dates:

MLK Day (no classes): Jan 16	Sprirt Day, Spring Break: March 2 – 9
Last day to drop with "W": Mar 19	Last day of instruction (for this class): Apr 19.

Final Exam: Tues 24 Apr, 10:15am – 12:15pm.

Incompletes: A grade of Incomplete will be given only if you have completed most of the course work with a satisfactory grade, and circumstances beyond your control prevent you from completing the remainder of the course. Incompletes will not be given in case of a low or failing grade.