

ADVANCED NUMERICAL METHODS I
MATH/CS 8500

Page 1 of 2

Prerequisite: MATH 1960, MATH 2050

Credit Hours: 3

Catalog Description:

Error propagation, solutions of linear equations by various schemes. Matrix norms and conditioning, computation of eigenvalues and eigenvectors. Additional topics such as non-linear systems, least square problems, etc.

Objectives: The student should become familiar with advanced techniques for solving numerically large problems in linear algebra. In particular, he should become familiar with the effects of ill conditioning, and of ways in which special information about matrices, such as sparsity can be used. An important part of all this is the consideration of error from various sources and ways of controlling its accumulation.

Topics:

- 1.) General error and Algorithm considerations
- 2.) Solutions of Linear Systems
 - a) Gaussian elimination
 - b) Triangular systems
 - c) Sparse and banded systems
 - d) Parallel processing considerations
- 3.) Conditioning
 - a) Matrix norms
 - b) Conditioning
- 4.) Least squares problems
 - a) Overdetermined systems
 - b) Underdetermined systems
 - c) Orthogonal techniques
 - d) QR factorization
- 5.) Eigenproblems
 - a) Diagonalization
 - b) Power Method
 - c) QR methods
 - d) Symmetric problems
 - e) Singular value decomposition
- 6.) Iterative methods
 - a) Splitting techniques (Jacobi, Gauss-Seidel, etc)
 - b) Acceleration techniques
 - c) Multigrid method
 - d) Conjugate gradient method as an iterative method

ADVANCED NUMERICAL METHODS I
MATH/CS 8500

Page 2 of 2

Methods of Instruction and Grading:

The course will be presented in a lecture-discussion format. Grades will be based on graded homework assignments, programming assignments and examinations. The specific weighting of these components is left to the individual instructor.

Bibliography:

- [1] Anton H., "Elementary Linear Algebra", Wiley, 1984.
- [2] Golub G. and Van Loan C., "Matrix Computations", John Hopkins University Press, 1983.
- [3] Hageman L.A. and Young D.M., "Applied Iterative Analysis", Academic Press, 1981.
- [4] Hager W., "Applied Numerical Linear Algebra", Prentice Hall, 1988.
- [5] Horn R. and Johnson C., "Matrix Analysis", Cambridge University Press, 1985.
- [6] Householder A.S., "The Theory of Matrices in Numerical Analysis", Blaisdel, 1964.
- [7] Lang S., "Linear Algebra", Addison Wesley, 1972.
- [8] Noble B. and Daniel J., "Applied Linear Algebra", Prentice Hall, 1988.
- [9] Ortega J., "Matrix Theory" – a second course", Plenum Press, 1986.
- [10] Schendel U., "Introduction to Numerical Methods for Parallel Computers", Ellis Horwood Limited, 1984.
- [11] Stewart G., "An Introduction to Matrix Computations", Academic Press, 1973.

May 2004