CS 6210 ADVANCED SCIENTIFIC COMPUTATION I

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Course Description

Survey of scientific computation relevant to Computational Science and Engineering students. Topics covered include: floating point arithmetic, systems of linear equations (solutions by direct and iterative techniques), linear least squares, nonlinear equations (univariate and multivariate), interpolation and differentiation (divided differences), integration (interpolatory, Newton-Cotes and Gaussian quadratures, optimal quadratures).

Details

In this offering the basic properties of scientific algorithms, like stability and optimality are investigated. Many problems important for engineers and computer scientists are considered including nonlinaer and linear systems of equations and implementations of algorithms for solving them. Some emphasis will be put on optimality of discussed algorithms.

Knowledge of a programming language belonging to the set of C, C++ and Fortran is essential. Students will have a choice of machines and languages to complete their homework.

Suggested Reading

This course will rely on instructor's notes and the texts: Scientific Computing, An Introductory Survey, 2nd Ed., by M. Heath , McGraw-Hill, 2002; Optimal Solution of Nonlinear Equations by K. Sikorski, Oxford Press, 2001; Applied Numerical Linear Algebra by J. Demmel, SIAM, 1997; and Selected Topics in Approximation and Computation, by Kowalski, Sikorski and Stenger, Oxford Press, 1995.

Covered topics

Introduction

1. Basic concepts in computation
2. Floating point arithmetic
3. Stable and Well behaved algorithms
4. Double precision and quasi double precision

Systems of Linear Equations

5. Preliminaries - matrices, vectors, norms.
6. Gaussian elimination and Cholesky's algorithms
7. Householder's algorithm
8. Iterative methods

Linear Least Squares

9. Linear Least Squares
10. Orthogonalization methods
11. SVD decomposition

Eigenvalues and Eigenvectors

12. Einevalues and Eigenvectors
13. Singular Values

Nonlinear Equations

14. Bisection method, Newton's method and Secant method
15. Multivariate Newton's method

Interpolation and Differentiation

16. Polynomial interpolation
17. Divided differences
18. Estimating derivatives

Integration

19. Trapezoid and Simpson's rules
20. Gaussian quadratures
21. Optimal integration

Homework

There will be several programming/homework assignments throughout the course.

Final Grades

A final grade will be based on the homework grades. There will be no regularly scheduled exams.

CES requirements

This class fulfills one of the requirements for the Computational Engineering and Science (CES) Program here at the University. Enrollment in the program is necessary to obtain CES Certificate or MS credit. If you are interested in learning more about the CES program, please visit www.ces.utah.edu or contact Coralee Bernard (coralee@cs.utah.edu, 581-3455).