Math 151A: General Course Outline

Catalog Description

151A. Applied Numerical Methods. (4) Lecture, three hours; discussion, one hour. Requisites: courses 32B, 33B, 115A, Program in Computing 10A. Introduction to numerical methods with emphasis on algorithms, analysis of algorithms, and computer implementation issues. Solution of nonlinear equations. Numerical differentiation, integration, and interpolation. Direct methods for solving linear systems. Letter grading.

Textbook

R. Burden and J. Faires, *Numerical Analysis,* 8th Ed., Brooks/Cole.

Assignments

Homework assignments in the course consist of both theoretical and computational work. For the computational component, the students should use a language/environment that possesses high level data types so that the students spend more time working with algorithms and not worrying about the details of writing computer code. Matlab and R are good choices (student versions are installed in the undergraduate computing laboratory). C++ (possibly Java) with appropriate class libraries can also be used.

Schedule of Lectures

Lecture	Section	Topics
1	.	General course overview
2	2.1	Background for programming projects. Introduction to the solution of nonlinear equations.
3	2.1	The bisection method.
4	2.1	Convergence estimates for the bisection method. Errors and residuals.
5	2.3	The Newton-Raphson method.
6	2.3	The secant method.
7	2.4	Error analysis for Newton-Raphson and the secant method. Rates of convergence.
8	2.4	Stopping criterion. Relationship between errors and residuals. Comparison of iterative methods. Global convergence properties.
9	1.2	Computer representation of numbers. Limitations imposed by integer representation.
10	1.2	Limitations imposed by floating point representation. Unit roundoff.
11	1.2	Errors in floating point arithmetic computations; catastrophic cancellation.
12	3.1	Polynomial Interpolation. Method of undetermined coefficients. (Vandermonde matrix.)
13	3.2	Newton Divided differences.
14	3.1, 3.2	Lagrange Interpolation Formula. Interpolant existence and uniqueness.
15	.	Midterm
16	3.2	Polynomial interpolation error estimates. (Error estimate for equispaced nodes*.)
17	3.2	Runge phenomenon. (Derivation of Newton dividend difference formulas.)
18	4.1	Numerical differentiation. Error estimates for numerical differentiation formula.
19	4.2	Asymptotic error expansions for numerical differentiation. (Richardson extrapolation.)
20	4.3, 4.4	Numerical integration. Newton-Cotes formulas. Composite integration formulas.
21	4.3, 4.4	Numerical integration error estimates. (Aitken estimation of rates of convergence.)

22	4.7	Gauss quadrature, derivation of 2 and 3 point formulas. Error estimates.
23	6.1	Solving linear systems of equations. Review of Gaussian elimination.
24	6.5	Equivalence of Gaussian elimination and LU factorization.
25	6.2	Construction of the LU factorization. Pivoting. Use of the LU factorization.
26	6.1	Operation counts for Gaussian elimination (LU factorization).
27	6.6	(Special type of matrices. Band solvers, Choleski factorization.)
28	.	Review

Comments

* This topic is not in Burden and Faires. It can be found in Cheney-Kincaid, *Numerical Mathematics and Computing*, Brooks/Cole, section 4.2.

Topics in parenthesis are optional and can be included under the discretion of the instructor.

Outline update: C. Anderson, 9/01
(Requisites updated 12/02)

NOTE: While this outline includes only one midterm, it is strongly recommended that the instructor considers giving two. It is difficult to schedule a second midterm late in the quarter if it was not announced at the beginning of the course.

For more information, please contact Student Services, ugrad@math.ucla.edu.