Math 151B: General Course Outline

Catalog Description

151B. Applied Numerical Methods. (4) Lecture, three hours; discussion, one hour. Requisite: course 151A. 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	5.1	Background for programming projects. Introduction to the solution of initial value problems.
3	5.2	Derivations of Euler's method. Definition of convergence.
4	5.2, 5.3	Error bounds and asymptotic error estimate for Euler's method. Local truncation error, global error.
5	5.2, 5.3, 5.4	Convergence proof for Euler's method. Derivation of Runge-Kutta methods.
6	5.4	Runge-Kutta methods cont. Derivation of the general second order Runge-Kutta methods.
7	AS	Timestep estimation. Model problem analysis; intervals of absolute stability.
8	AS	Timestep estimation for general equations.
9	5.11	Implicit methods (Trapezoidal rule, Backward Euler). Comparison of ODE methods.
10	5.11	Implicit methods. Solving the implicit equations. Stiff differential equations.
11	5.6	Overview of multistep methods.
12	5.9	Numerical methods for systems of ODE's.
13	5.9	Results on numerical methods for systems; convergence results, error bounds, asymptotic error estimates. Regions of absolute stability.
14	11.3	Two point boundary value problems. Finite difference approximation.
15	7.1, 11.3	Review of vector and matrix norms. Error estimates for linear two-point boundary value problem.
16	.	Midterm
17	11.4	Midterm discussion. Programming considerations for two point boundary value problems.
18	7.3	Iterative methods for the solution of linear systems of equations. Gauss-Jacobi.

19	7.3	Iterative methods cont. Gauss-Seidel. Error analysis for iterative methods.
20	7.1, 7.3, 7.4	Error analysis for iterative methods cont. Relationship between error and the residual. Stopping criterion.
21	7.3, 7.4	Convergence results for iterative methods. Condition number.
22	8.1	Discrete least squares approximation. Construction of the normal equations.
23	8.1, DLS	Derivation of the normal equations. Matrix/vector formulation of the discrete least squares problem.
24	DLS	Using the QR decomposition to solve normal equations. Relation of QR to Gram-Schmidt.
25	8.5	Introduction to discrete Fourier approximation.
26	8.5	Fourier approximation cont. Complex form of the discrete Fourier approximation.
27	8.6	The fast Fourier transform.
28	.	Review

Comments

AS: The topics of stiffness and of absolute stability are not well presented in Burden and Faires. Other textbooks should be consulted.

DLS: The matrix form of the discrete least squares problem is not presented in Burden and Faires. Other textbooks should be consulted.

Outline update: C. Anderson, 9/01
(Catalog description updated 4/02)

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.