ACMS 60690 Numerical Analysis I, Fall 2010

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Textbook

Numerical Analysis: Mathematics of Scientific Computing, Third Edition, by David Kincaid and Ward Cheney, Brooks/Cole, ISBN: 0-534-38905-8, 2002. (The 2009 version by the American Mathematical Society (ISBN: 978-0-8218-4788-6) is the same.)

Course Description

This is an introduction course for graduate students to learn fundamental concepts, theory and techniques in numerical analysis and scientific computing. This is the first semester one of the one year Numerical Analysis course.

Topics

1. **Numerical Solution of Nonlinear Equations**
   - Bisection method.
   - Newton's method.
   - Secant method.
   - Fixed points and functional iteration.
2. **Numerical Linear Algebra**
   - Direct methods and iterative methods for linear system.
   - Numerical methods to find eigenvalues and eigenvectors.
3. **Approximating Functions**
   - Polynomial interpolation; Divided differences.
   - Hermite interpolation; Spline interpolation.
   - Least-Squares Theory; Chebyshev Theory.
4. **Numerical Differentiation and Integration**
   - Richardson extrapolation.
   - Numerical integration based on interpolation.
   - Gaussian quadrature.
5. **Numerical solution of Ordinary Differential Equations**
   - Existence and Uniqueness of Solutions.
   - Taylor-Series method.
   - Runge-Kutta methods.
   - Multistep methods; Accuracy and Stability.
   - Boundary-Value Problems.

Prerequisites: Calculus, Linear Algebra, Differential Equations**,** a programming language (Fortran or C or C++ or matlab, etc.)

References

[1] J. Stoer, and R. Bulirsch, Introduction to Numerical Analysis, Springer, 2002.
[2] L. N. Trefethen, and D. Bau, Numerical Linear Algebra, SIAM, 1997.