ACMS 60-690-01: Fall 2010

Numerical Analysis 1

Instructor: Zhiliang Xu
Contact: zxu2@nd.edu

Textbook: David Kincaid and Ward Cheney, Numerical Analysis: Mathematics of Scientific Computing, Third Edition, ISBN: 978-0-8218-4788-6

Class time: M, W, F, 3:00pm – 3:50pm.

Course Description

This course is the first of a two semester sequence of courses. It is an introductory graduate level course designed to introduce mathematics, engineering, and science students the fundamental concepts in numerical analysis and scientific computing. This is a three credit course.

Main Topics

1. **Preliminaries of Computing**
   a) Basic concepts, orders of convergence, Truncation error, floating point arithmetic, Ill-conditioning, stability, etc..
2. **Numerical solution of Nonlinear Equations**
   a) Bisection method, Newton's method, secant method.
   b) Functional iteration, computing roots of polynomials, homotopy methods.
3. **Applied Linear Algebra**
   a) Direct methods for solving linear systems, numerical factorizations.
   b) Eigenvalue problems.
4. **Interpolation and Approximation**
   a) Polynomial interpolation, Hermite interpolation, least squares and FFT.
5. **Numerical integration and differentiation**
   a) Trapezoidal rule, etc., Romberg integration, Gaussian quadrature and Euler-Maclaurin formula.
6. **Numerical Solution of Ordinary Differential Equations**
   a) Initial value problems, existence and uniqueness of solutions; difference methods - consistency, stability and convergence.
   b) One-step methods: Euler's Method, Runge-Kutta methods, etc..
   c) Multistep methods: Adams-Bashforth, Adams-Moulton, predictor-corrector methods.
   d) Boundary-value problems and stiff equations.

Prerequisites:

The course requires a moderate amount of programming. FORTRAN or C or C++ programming languages are preferred. However, students may also use software programs including Matlab, Mathematica.

References

[1] J. Stoer and R. Bulirsch, Introduction to Numerical Analysis, Springer-Verlag, ISBN 0-387-90420-4
[2] Eugene Isaacson and Herbert B. Keller, Analysis of Numerical Methods, Courant Institute of Mathematical Sciences
[3] L.N. Trefethen and D. Bau, Numerical Linear Algebra, Society of Industrial and Applied Mathematics
[4] C.T. Kelley, Iterative methods for linear and nonlinear equations, Society of Industrial and Applied Mathematics