

Algebra C

Numerical Linear Algebra

Description

Direct methods of numerical linear algebra. Eigenvalue computations. Iterative methods. Other topics as time permits.

Course objectives

This course is a graduate level introduction to numerical linear algebra. The course details the mathematical theory behind numerical algorithms for solution of linear systems and eigenvalue problems. Students who take this course should enter with a firm command of linear algebra and calculus.

Syllabus

- 1. Basic concepts and review.** Vector spaces. Linear independence. Rank. Bases. Orthogonality. Projectors. Eigenvalues. Multiplicity. Schur form, Jordan normal form. Norms of vectors and matrices. Singular value decomposition. Functions of matrices.
- 2. Direct methods of numerical linear algebra.** Triangular systems. Gaussian elimination and LU decomposition. Pivoting. Backward error analysis. Conditioning and roundoff errors.
- 3. Eigenvalue computations.** Power methods for symmetric and non-symmetric problems. QR algorithm for symmetric problems. Jacobi methods and tridiagonal methods for symmetric problems. Hessenberg form. Schur form and the QR algorithm for non-symmetric problems.
- 4. Iterative methods of numerical linear algebra.** Classical linear iterations and their convergence. Line search methods and conjugate gradient methods. Other Krylov subspace methods. Preconditioning.

Other Information

Recommended texts are:

- [1] Gene H. Golub and Charles F. Van Loan. *Matrix computations*. Johns Hopkins Studies in the Mathematical Sciences. Johns Hopkins University Press, Baltimore, MD, third edition, 1996. ISBN 0-8018-5413-X; 0-8018-5414-8. xxx+698 pp.
- [2] Eugene Isaacson and Herbert Bishop Keller. *Analysis of numerical methods*. Dover Publications Inc., New York, 1994. ISBN 0-486-68029-0. xvi+541 pp.
- [3] Gilbert Strang. *Linear algebra and its applications*. Academic Press [Harcourt Brace Jovanovich Publishers], New York, second edition, 1980. ISBN 0-12-673660-X. xi+414 pp.
- [4] Lloyd N. Trefethen and David Bau, III. *Numerical linear algebra*. Society for Industrial and Applied Mathematics (SIAM), Philadelphia, PA, 1997. ISBN 0-89871-361-7. xii+361 pp.