Math/AMath 594: Iterative Methods for Solving Linear Systems
(Autumn 1998)

Lectures:	MW 3:30–4:50, room 102 Loew
Professor:	Anne Greenbaum, C-434 Padelford, 543-1175
Office Hours:	T, Th 1:30–3:00, or by appointment.
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	Course materials: Click on "Math/AMath 594".

Text: *Iterative Methods for Solving Linear Systems* by Anne Greenbaum, SIAM, 1997. (available at University Bookstore)

Reserve list: The following books are on reserve in the Mathematics Research Library.

1. *Matrix Computations* by Gene H. Golub and Charles F. Van Loan (QA188.G65, 1996)
2. *Iterative Methods for Solving Linear Systems* by Anne Greenbaum (QA297.8.G74, 1997)
3. *Numerical Linear Algebra* by Lloyd N. Trefethen and David Bau, III (QA184.T74, 1997)

The course will follow the development in the text, with occasional outside papers to read for discussion. Topics to be covered include:

- Review of relevant linear algebra: Vector norms and inner products; canonical forms and decompositions (e.g., Jordan form, Schur form, QR decomposition, singular value decomposition); eigenvalues; the field of values.
- The most popular iterative methods: Simple iteration; the conjugate gradient method for Hermitian positive definite problems; MINRES for Hermitian indefinite problems; GMRES, QMR, and BiCGSTAB for general non-Hermitian problems.
- Derivation of error bounds for CG, MINRES, and GMRES: The open problem of precisely describing the worst-case behavior of GMRES; the open problem of deriving realistic error bounds for other non-Hermitian matrix iterations such as BiCG and QMR.
- Effects of finite precision arithmetic on the convergence rate of Lanczos-based iterative methods.
- Discussion of the open search for an optimal or near-optimal short recurrence for non-Hermitian problems.
- Preconditioners: Regular splittings; optimal diagonal and block diagonal preconditioners; incomplete decompositions.
- Multigrid and domain decomposition as preconditioning techniques.

There will be weekly homework assignments (with some programming) (30 %), a course project (40 %), and a final exam (30 %).