Math/AMath 596: Numerical Solution of Integral Equations
(Spring 2001)

Lectures:	MW 3:30–4:50, room 331A BAG
Professor:	Anne Greenbaum, C-434 Padelford, 543-1175
Office Hours:	MW after class – 6:00, or by appointment or drop in.
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	Course materials: Click on "Math/AMath 596".

Optional text: *The Numerical Solution of Integral Equations of the Second Kind*, by Kendall E. Atkinson, Cambridge University Press, 1997. We also will read some or all of the following papers: Greengard and Rokhlin, *A Fast Algorithm for Particle Simulations*, Jour. Comput. Phys., 73 (1987), pp. 325–348; Carrier, Greengard, and Rokhlin, *A Fast Adaptive Multipole Algorithm for Particle Simulations*, SIAM J. Sci. Comput. 9 (1988), pp. 669–686; Mayo, *The Fast Solution of Poisson's and the Biharmonic Equations on General Regions*, SIAM Jour. Numer. Anal., 21 (1984), pp. 285–299; Greenbaum, Greengard, and McFadden, *Laplace's Equation and the Dirichlet-Neumann Map in Multiply Connected Domains*, Jour. Comput. Phys., 105 (1993), pp. 267–278.

The course will cover:

1. Introduction to integral equations:
   - **(a)** Types of integral equations: Volterra and Fredholm integral equations of the first and second kind, Abel, Wiener-Hopf, and Cauchy singular integral equations.
   - **(b)** Compact integral operators.
   - **(c)** The Fredholm alternative.
2. Boundary integral equations. Green's identities and representation formulae in two and three dimensions.
3. The Nyström method. Error analysis and conditioning of the linear system. Collectively compact operator approximations.
4. Iterative methods for solving the linear systems arising from integral equations. The conjugate gradient method, GMRES.
5. The fast multipole method for computing matrix-vector products associated with integral operators.
6. Computing the solution to a partial differential equation throughout the domain, once the integral representation is known.

There will be homework assignments (with some programming) and a term project or report on a relevant paper in the literature.