

Mathematics 784, Spring 2009
Nonlinear Equations and Unconstrained Optimization
House Rules

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WWW	http://www4.ncsu.edu/~ctk/ (Tim) http://www4.ncsu.edu/~ctk/ma784.html (Course) http://www4.ncsu.edu/~ctk/house_784/house.html (this document)	
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Books:	Iterative Methods for Linear and Nonlinear Equations C. T. Kelley, SIAM, 1995
	Iterative Methods for Optimization C. T. Kelley, SIAM, 1999
	Download books free from SIAM

Prerequisites:	Advanced Calculus (MA 511/2), MA 580, Knowledge of Fortran, C, Matlab	
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Grade:	Homework and Programs (40%), Presentation (60%) Homework must be in typeset (TeX, LaTeX, troff, WORD, ...) Auditors may do as much as they wish.	
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Computing:	NCSU UNIX Workstations in your college or department. University charge applies.	
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Language:	MATLAB,	FORTRAN, C
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We provide software tools (e.g. GMRES, PCG, some solvers) in MATLAB. You'll need MATLAB v 6.1 or higher. FORTRAN/C people are on their own. The algorithms in the text can be easily translated to FORTRAN or C, but debugging is your job. Check the NETLIB (<http://netlib2.cs.utk.edu/>) for its large (and mostly FORTRAN) collection of software. The TEMPLATES collection (<http://netlib2.cs.utk.edu/templates/index.html>) might be particularly helpful. Compilation etc. is your responsibility.

Important Dates

- Thursday, February 26, 1st homework assignment due
- Tuesday-Thursday, March 3,5: No class, Spring Break
- Tuesday, March 26, 2nd homework assignment due
- Thursday, April 23, 3rd homework assignment due
- Friday, April 24: Classes end

Homework

There will be three sets of homework. You must do

- at least one problem from each set, and
- at least six problems in total.

It is ok to do the homework in teams of no more than five people. Those of you who plan to get degrees in numerical analysis should do **more than the minimum** six problems.

Approximate Schedule of Topics

- Week 1–2 Nonlinear equations/optimization in one variable.
Week 2–3 Review of advanced calculus and numerical linear algebra.
Week 3–6 Newton’s method and variations in several variables. Newton Iterative Methods.
Weeks 6–7 Broyden’s method, proof of superlinear convergence.
Week 9 Unconstrained Optimization, Newton’s method for unconstrained optimization.
Week 10–11 Globally convergent variations of Newton’s method.
Week 11–12 Nonlinear least squares, Quasi-Newton methods for unconstrained optimization.
Weeks 13–14 Student presentations.

Things for you to do.

1. Learn \LaTeX (or some other technical wordprocessing program) and MATLAB if you have not already done so. An old version of the MATLAB Primer [11] is available on the course web page. The book by Higham and Higham (see reference list) is also very good. There is considerable help with MATLAB and \LaTeX on the course web page.
2. Start thinking about your presentation. I’d like it to be related to your own research interests. Those of you who are not math majors are welcome to prepare something on nonlinear equations/optimization problems in your thesis work. If you have an idea for a presentation, come talk to me about it.

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- [6] L. KANTOROVICH AND G. AKILOV, *Functional Analysis*, Pergamon Press, New York, second ed., 1982.
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- [8] ———, *Iterative Methods for Linear and Nonlinear Equations*, no. 16 in Frontiers in Applied Mathematics, SIAM, Philadelphia, 1995.
- [9] ———, *Iterative Methods for Optimization*, no. 18 in Frontiers in Applied Mathematics, SIAM, Philadelphia, 1999.
- [10] J. M. ORTEGA AND W. C. RHEINBOLDT, *Iterative Solution of Nonlinear Equations in Several Variables*, Academic Press, New York, 1970.
- [11] K. SIGMOND AND T. A. DAVIS, *MATLAB Primer, Fourth Edition*, CRC Press, Boca Raton, FL, 6 ed., 2002.
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