Math 432 **Fall 2013**

Course:	**Numerical Linear Algebra**
Instructor:	Lyudmyla Barannyk, Brink Hall 317 (208) 885-6719, barannyk@uidaho.edu
Office Hours:	M,W 3:30-4:30 pm, Th 4:30-5:30 pm or by appointment
Book:	*Numerical Linear Algebra and Applications*, Second Edition by Biswa Nath Datta
Time and Location:	MWF 1:30 - 2:20 pm, TLC 247

Other suggested reading:

Numerical Linear Algebra by L.N. Trefethen and D. Bau III, SIAM, 1997, Internet QA184.T74 1997
Fundamentals of Matrix Computations by D. Watkins, Wiley, 2010, QA188.W38 2010
Applied Numerical Linear Algebra by J.W. Demmel, SIAM, 1997, Internet QA184.D455 1997

There is a class email list: math432-f13@uidaho.edu. You can make an alias for it. You can use the email list to ask me questions that might be of interest to others in the class. You can also email me at barannyk@uidaho.edu with other questions.

Course web site: http://www.webpages.uidaho.edu/∼barannyk/Teaching/Math432.html

Math 432 is an introduction to numerical linear algebra, a core subject in scientific computing. Three types of problems are considered: (1) solving a system of linear equations ($Ax = b$), (2) computing eigenvalues and eigenvectors of a matrix ($Ax = \lambda x$), and (3) least squares problems ($min||Ax-b||_2$). These problems arise in applications in science and engineering, and many methods have been developed for their solution, but standard methods may fail if the problem is large or ill-conditioned, e.g. the operation count may be prohibitive or computer roundoff may ruin the answer. Well investigate these issues and study some of the accurate, efficient, and stable methods that have been devised to overcome these difficulties.

Topics:

- vector and matrix norms, orthogonal matrices, projectors, singular value decomposition (SVD)
- stability, condition number, IEEE floating point arithmetic, backward error analysis
- direct methods for $Ax = b$, Gaussian elimination, LU factorization, pivoting, Cholesky factorization
- least squares problems, QR factorization, normal equations, Gram-Schmidt orthogonalization, Householder triangularization
- eigenvalues and eigenvectors, Schur factorization, reduction to Hessenberg and tridiagonal form, power method, inverse iteration, shifts, Rayleigh quotient iteration, QR algorithm
- iterative methods for $Ax = b$, Krylov methods, Arnoldi iteration, GMRES, conjugate gradient method, preconditioning
- applications: image compression by SVD, finite-difference scheme for a two-point boundary value problem, Dirichlet problem for the Laplace equation, least squares data fitting

Exams: *Midterm*, Friday, October 11 in class
Final Exam - Tuesday, December 17, 12:30 – 2:30 pm, TLC 247

Prerequisites: a course in linear algebra (e.g. Math 330) and Calculus III (Math 275); computing will be required on some homework - Matlab is recommended

Grading Policy: Homework = 40%, Midterm Exam = 25%, Final Exam = 35%

Math 432: Numerical Linear Algebra

Learning Outcomes

- Students will be introduced to modern concepts and methodologies of numerical linear algebra including various factorizations, iterative methods and their analysis, that can be used to solve linear algebra problems arising in many applications in physics and engineering.
- Students will learn theoretical aspects such as stability and convergence that will enhance their understanding of the numerical methods.
- Students will be able to select or design a method or approach for solving a problem in numerical linear algebra; evaluate a method for its accuracy, stability, and computational cost; and discuss efficiency implications in a computer implementation of a method, including parallel computing aspects.
- Students will gain experience in implementing and observing the numerical performance of the various numerical methods using Matlab.