Mathematics 614: Numerical Linear Algebra
Fall 2017

Instructor: John Rhodes

Office: 704F Gruening, 474-5445

E-mail: j.rhodes@alaska.edu

Office Hours: M F 11:30-12:30, T 12:00-1:00, and by appointment

Web page: https://jarhodesuaf.github.io/M614.html

Prerequisites: undergraduate Linear Algebra

Credit Hours: 3.0

Textbook: <u>Numerical Linear Algebra</u>, by Trefethen and Bau, SIAM 1997

Class Meetings: MWF 10:30-11:30, in Bunnell 410

Exams: Midterm: Monday, October 16, in class;
    Final: Wednesday, December 13, 10:15am-12:15pm

Course overview and goals:

Linear Algebra is arguably the most important mathematical underpinning for modern scientific computation. Even problems that appear to be based firmly on calculus (e.g., the solution of partial differential equations) are generally translated into linear algebra problems through discretization.

This course covers how linear algebra computations are performed in practice, in order to be both efficient (giving answers in a reasonable amount of time) and accurate (so that the inevitable errors in computer calculations are kept small). As you will quickly learn, some of the approaches emphasized in an undergraduate linear algebra course are computational disasters, and must be replaced with new algorithms. Building on your conceptual understanding from an undergraduate linear algebra course, you should gain a much more comprehensive understanding of how linear algebra should be used on the large-scale problems typical of real applications.

Specific topics include: the Singular Value Decomposition, QR factorization and least squares, conditioning and stability, operation count and problem size, systems of equations and Gaussian elimination, computing eigenvalues, and iterative methods.

While the emphasis will be on the mathematical ideas, understanding them fully requires implementation and experimentation. Students will therefore gain facility with MATLAB (or Octave).

Mechanics of the course:

Lectures The course will be delivered as a lecture, but I prefer to keep it informal. I am happy to be interrupted with questions and comments at any point. It is particularly important to speak up if you do not understand some background material, and also see me outside of class if you find you have some large gap. Asking question during lectures will benefit everyone.

Textbook and Software The textbook is required. It is widely recognized as excellent, and worth owning. You should read sections relevant to the lectures thoroughly.

If your undergraduate linear algebra is rusty, you may want to refer to a text for that as well. Whatever textbook you used is likely to be good enough, but if you need other suggestions, I'd recommend those by Gilbert Strang and David Lay.

You will need regular access to MATLAB (licensed for computers of UAF affiliates, installable on OSX through OIT Self Service, or on Windows through Software Center, see the UAF OIT web pages or call the Help Desk) or, if you prefer Octave (free, but you are on your own for support).

Homework Homework problems will be assigned at least weekly, but only collected each Monday (due in class – hard copy only – but accepted at my office or mailbox until 2pm).

Homework will be posted on the course web page soon after it is assigned. If you miss class, that is where you should look.

Late homework that has not been approved ahead of time will not be accepted. *There will be no exceptions to this* other than for a genuine emergency (e.g., a death in the family, documented illness, etc.).

I encourage you to work with others on the homework, *but to write up the solutions independently.* In writing up your work, you should present your arguments in such a way that an intelligent, but ignorant, person can understand them. In particular complete sentences and a logical presentation are expected.

Examinations Both the midterm and final examinations will be in-class, closed-book exams. For missed examinations that are not approved in advance, no make-up exams will be given, except in case of emergencies.

Grades Your performance will be evaluated based on 55% homework, 20% midterm exam , 25% final exam. Course grades will be determined according to the following cutoffs:

$$A \geq 90\%, \quad B \geq 80\%, \quad C \geq 70\%, \quad D \geq 60\%.$$

I reserve the right to move the cutoff points downward if necessary to ensure fairness. Note that you are not in competition with your peers – everyone in the class may get an A, or everyone may get an F.

University and Department Policies Your work in this course is governed by the UAF Honor Code. The Department of Mathematics and Statistics has specific policies on incompletes, late withdrawals, and early final exams which can be found at

If you have any disabilities that your instructors should know about, bring them to our attention soon so that we can work with the Office of Disability Services to set up any necessary accommodations.

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Tentative Schedule

Week	Dates	Topics
1	Aug 28-Sept 1	Fundamentals
2	Sept 6-8	
3	Sept 11-15	QR and Least Squares
4	Sept 18-22	
5	Sept 25-29	Conditioning and Stability
6	Oct 2-6	
7	Oct 9-13	
8	Oct 16-20	MIDTERM, Systems of Equations
9	Oct 23-27	
10	Oct 30-Nov 3	Eigenvalues
11	Nov 6-10	
12	Nov 13-17	
13	Nov 20-22	Iterative Methods
14	Nov 27-Dec 1	
15	Dec 3-8	