MATH 447/847: Numerical Analysis
UNL, Fall 2015, Section: 001, CRN: 24407/25090
Lecture: M,W,F, 10:30 am-11:20 am, Avery Hall 11

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Office Hours: M,W,F, 9:30 am - 10:20 am, or by appointment.

Prerequisites: Math 314/814 or equivalent (i.e., linear algebra, also known as matrix theory) with a grade of C or better, basic knowledge of computers and the ability to learn programming. **We will be learning and using MATLAB in this course.**

Textbook: Numerical Linear Algebra. Trefethen and Bau. SIAM (1997).

Website: http://www.math.unl.edu/~alarios2/courses/2014_fall_M221/content.shtml

ACE Outcome 3: "Use mathematical, computational, statistical, or formal reasoning (including reasoning based on principles of logic) to solve problems, draw inferences, and determine reasonableness." Your instructor will provide examples, you will discuss them in class, and you will practice with numerous homework problems. The exams will test how well you've mastered the material. The final exam will be the primary means of assessing your achievement of ACE Outcome 3.

Contacting me: The best way to contact with me is by email, alarios@unl.edu. Please put [MATH 447] somewhere in the title and make sure to include your whole name in your email. Polite, courteous emails are appreciated; see my website for tips on email etiquette. My office is in Avery Hall, room 305, and my office hours are M,W,F, 9:30 am - 10:20 am. Drop-ins are welcome during these times. If you want to meet me at a different time, please email me in advance, and we will try to schedule a time to meet.

NOTE: Because of privacy rights, **I cannot discuss grades over email or telephone. Please do not email me asking about your grade. I will not be able to give you any information.** Of course, I am happy to discuss grades in my office.

Motivation: This is a one-semester course on numerical analysis which gives an introduction to various topics in numerical methods and provides a firm basis for future study. We will introduce some of the fundamental concepts of numerical analysis: consistency, stability, approximation, and orthogonality. They are studied as essential analytical tools applied to problems like interpolation, quadrature, and iterative solution methods.

Numerical methods lie at the heart of an extremely large number of practical and theoretical problems in science, mathematics, and engineering. Our growing understanding of these methods has yielded a massive amount of progress for human kind.

Furthermore, the unsolved problems are enormously varied, rich, and challenging. New algorithms and techniques are being invented every day, and many recent breakthroughs have changed the world. Numerical methods are found at the cutting edge of nearly every discipline in science and mathematics, with recent progress exploiting cutting-edge mathematical tools, and the fastest supercomputers in the world.

Scientists, mathematicians, and engineers who have grown comfortable with computations and learned to wield the full power of numerical methods have been able to explore depths that once seemed unfathomable, and have soared to highest that once seemed impossible.

We will focus on rigorous development of numerical methods. The methods involved are incredibly useful in science, and will require us to develop sophisticated and interesting mathematics to handle them.

Homework: Homework is designed to help students understand the material and to prepare them for exams. Homework assignments will be posted on the website. The suggested exercises represent a minimal assignment. Some students may have to work additional exercises from the text to attain sufficient mastery of the material. Late homework will be accepted at a penalty of 10% per day, up to a maximum of 3 business days late. Homework can be turned in in class, or into box #80 outside of Avery Hall 203.

Reading & Exercises: It is impossible to learn this subject without doing exercises, both on paper and in the computer. You are expected to read the appropriate sections of the text **before** coming to the class meeting in which the topic is scheduled. You are also expected to work through the indicated exercises after the corresponding material is presented in class, and **before** the next class meeting.

Scheduling: A tentative schedule of assignments and exams is included in this syllabus. These details are presented as a guide. Your instructor may change the dates for each assignment and/or exam, modify the exercises, and/or add assignments. It is your responsibility to keep track of the course details and schedule.

Collaboration: Collaboration is encouraged in this course. However, copying someone else's work and submitting it as your own is unacceptable. This act of academic dishonesty will be prosecuted in accordance with university policy.

`MATLAB`: `MATLAB` is one of the most widely used programming languages in science and engineering. It is also probably the easiest to learn. You are not expected to have seen `MATLAB` before this course, and you will be taught the basics in class. However, as is true of any computer language, most of it is learned by doing. Pay close attention to the error outputs, and look things up online frequently. Programming assignments will be announced in class, and will be posted on the course website. Students may use Matlab in the classroom or on personal computers. Students without access to a computer outside of class should talk to the instructor immediately.

Electronics: Calculators, laptops, tablets, cell phones, and other non-medical electronic devices are not permitted during exams unless otherwise stated. During class, cell phones should be set on silent or off. During class, if you need to take a call, send a text message, etc., please quietly leave the classroom to do so, so that you do not distract other students. You are welcome to return to class quietly when you are finished. If you wish to take notes using an electronic device, you must first demonstrate to me that you can type or write fast enough to do so properly, and that you can do it without distracting others, before the privilege to use such devices may be granted. If you are found to be abusing this privilege, you risk forfeiting it.

Grading: Your minimal course grade will be computed as follows. If need be, a "curve" may be applied to the total scores, but only in such a way that it benefits the students.

Homework:	20%	A- to A+	90%	–	100%
Midterms:	$2 \times 20\% = 40\%$	B- to B+	80%	–	89.99%
Final Exam:	20%	C- to C+	70%	–	79.99%
Projects:	20%	D- to D+	60%	–	69.99%
Total:	100%	F	0%	–	59.99%

Attendance: Daily attendance for class lectures is expected and is extremely important. While attendance is not recorded, missing even one class will put you behind. Note that there is a strong correlation between class absences and poor grades. You are responsible for all material and announcements in class regardless of whether or not you attended. **You are also responsible for making arrangements with another classmate to find out what you missed. You should not ask me to go over material you missed (due to tardiness or absences) during office hours or over email.**

Make-up exams: Make-up exams will only be given with valid written evidence of an official university excused absence.

Incompletes: A grade of "incomplete" may be considered if all but a small portion of the class has been successfully completed , but the student in question is prevented from completing the course by a severe, unexpected, and documented event. Students who are simply behind in their work should consider dropping the course.

ADA Statement: Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the **Services for Students with Disabilities (SSD) office**, 132 Canfield Administration, 472-3787 voice or TTY.

Grade Questions: Any questions regarding grading/scoring of homework, exams, or projects must be made within two class days from when they were handed back, or no change in grade will be made.
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Special Dates:

Jan. 23, 2015 (Friday):	Last day to withdraw from this course and not have it appear on your transcript.
March 6, 2015 (Friday):	Last day to change your grade option to or from Pass/No Pass.
April 10, 2015 (Friday):	Last day to drop this course and receive a grade of W. (No permission required.)

Departmental Grading Appeals Policy: Students who believe their academic evaluation has been prejudiced or capricious have recourse for appeals to (in order) the instructor, the departmental chair, the departmental appeals committee, and the college appeals committee.

Final Exam Policy: Students are expected to arrange their personal and work schedules to allow them to take the final exam at the scheduled time. The final exam for this course is:
Friday, May 8, 2015, 7:30 am-9:30 am (in usual classroom).

Disclaimer: While this syllabus was prepared carefully and according to information available at the beginning of the semester, changes may be necessary in the interest of good teaching. To the best of the instructors knowledge, this syllabus is not in conflict with official university policies in any way, and was prepared with the intent to abide by university policy. However, if such a conflict exists, official university policy will of course take precedent over the syllabus. Changes to any of the information above will be announced in class and/or posted on the class web site and/or blackboard. This includes in particular possible updates or corrections to the syllabus, changes of exam dates, and announcements related to homework and/or projects.

Rough schedule: The following tentative schedule is a rough guide to the material covered in the course, but is subject to change. **Updates and changes to the content will be announced in class and/or on the course website.**

#	Day	Date	Material	Notes
1	M	1/12	Introduction to `MATLAB`	
2	W	1/14	Orthogonal Vectors and Matrices	
3	F	1/16	Matrix norms, condition numbers, SPD Matrices	
–	M	1/19	NO CLASS	MLK Holiday
4	W	1/21	Finite number systems, stability. More on `MATLAB`	
5	F	1/23	Singular Value Decomposition (SVD)	**Early Drop Deadline**
6	M	1/26	More on SVD	
7	W	1/28	Projectors	
8	F	1/30	QR-factorization	
9	M	2/2	Gram-Schmidt Orthogonalization	
10	W	2/4	Gaussian elimination, operation count	
11	F	2/6	Analysis of Gaussian elimination	
12	M	2/9	LU-factorization	
13	W	2/11	Direct methods for simple systems	
14	F	2/13	LL^T-Cholesky	
15	M	2/16	Householder triangulization	
16	W	2/18	Catch up and review	
17	F	2/20	**Exam 1**	In usual classroom
18	M	2/23	Basic iterative methods	
19	W	2/25	The Fundamental Theorem of Iterative Methods	
20	F	2/27	Convergence for diagonally dominant matrices	
21	M	3/2	Convergence for SOR for SPD matrices	
22	W	3/4	Arnoldi/Krylov methods	
23	F	3/6	Variational methods: Steepest Decent (SD)	**Pass/No Pass Deadline**
24	M	3/9	Variational methods: Conjugate Gradient (CG)	
25	W	3/11	Convergence of CG	
26	F	3/13	Variational methods: GMRES	
27	M	3/16	Preconditioning	
28	W	3/18	Eigenvalue problems	
29	F	3/20	Classical eigenvalue algorithms	
–	M	3/23	NO CLASS	Spring Break
–	W	3/25	NO CLASS	Spring Break
–	F	3/27	NO CLASS	Spring Break
30	M	3/30	Modern approaches to eigenvalues	
31	W	4/1	Catch up and review	
32	F	4/3	**Exam 2**	In usual classroom
33	M	4/6	Trigonometric interpolation	
34	W	4/8	Fast-Fourier Transform (FFT)	
35	F	4/10	Quadratures, Newton-Cotes	**W-Drop Deadline**
36	M	4/13	Gaussian quadrature	
37	W	4/15	Initial Value Problems	
38	F	4/17	Euler and Runge-Kutta methods for IVPs for ODEs	
39	M	4/20	R-K methods, local truncation error, error estimates	
40	W	4/22	Adams-Bashforth and Adams-Moulton methods	
41	F	4/24	Dahlquist equivalence theory	
42	M	4/27	Stability, consistency, and convergence	
43	W	4/29	A-stability of ODE methods	
44	F	5/1	Catch up and review	
–	F	5/8	**Final Exam** 7:30 am - 9:30 am	In usual classroom