Linear Algebra with Application to CME200

Engineering Computations M. Gerritsen

Autumn 2013

CME200/ME300A Syllabus

All course materials, including assignments, and grades and announcements are published on the coursework website for CME200 (go to <http://coursework.stanford.edu>). With the exception of this syllabus, hard copies of course materials will NOT be distributed in class.

CME 200 provides a solid background in linear algebra and matrix computations that is needed to solve engineering problems. A good background in matrix computations and linear algebra is essential for the engineer because many engineering problems require the solution of generally very large systems of nonlinear or linear equations. With the strong base provided in this course, more advanced algorithms used in research or industry can be studied and understood. The course material is supported by engineering examples presented in the lectures, and consolidated by weekly workshops and weekly assignments.

Assignments and exams cover both application of new algorithms and the mathematical theory on which they are based. CME200 is not an applications course. We discuss theory as well as applications, and course assessment is based on both your theoretical knowledge, as well as your ability to apply this knowledge to engineering problems.

Instructor

Prof. Margot Gerritsen, Green Earth Science Bldg 088, margot.gerritsen@stanford.edu , (650) 725 2727.

Prof. Gerritsen will teach all Monday and Wednesday lectures. The Friday workshops will be taught mostly by ICME graduate students.

Teaching Assistants

The course has 8 teaching assistants:

Eve Ninsuwan (eveve@stanford.edu)

Carl-Frederik Arndt (cfarndt@stanford.edu)

Andy Gewitz (gewitz@stanford.edu)

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Jang-Hwan Choi (jhchoi21@stanford.edu)

All TAs are graduate students in ICME except for Jang-Hwan, who is from ME.

Andy is the dedicated TA for the SCPD students. If you are an SCPD student, you will receive an e-mail at the start of the quarter which outlines the SCPD office hours and the procedures for homework hand-in and hand-back as well as midterm and final.

Office Hours

Professor Gerritsen’s office hours are Mondays from 2:30 – 4pm in the open workspace, lower level Huang (in front of the ICME suite). As noted above, SCPD students will confer with Andy directly to set up office hours.

Online Support

We will be using an interactive course bulletin system called Piazza, which will host a page dedicated to the course. All enrolled students should register at Find our class page at: [https://piazza.com/stanford/fall2013/cme200me300a/home](https://piazza.com/class/hlt0fhnud2328e?cid=4). The TAs will monitor the board and respond to posted questions in a timely fashion. Students are encouraged to help the TAs answer the questions of fellow students.

Course schedule

In general, the lectures are scheduled for Monday and Wednesday 11:00-12:15, and the workshops are given on Friday, 11:00-12:15, all in the Gates B1 Auditorium. See the detailed lecture schedule at the end of this syllabus.

Computers and Software

In this course, we will make use of a software package called MATLAB. MATLAB provides a highly interactive development environment and specialized solvers for linear algebra, data analysis, and graphics. If you intend to use your own computer in this course, we recommend you get a MATLAB student version, which can be obtained through the Stanford bookstore or online at [www.mathworks.com](http://www.mathworks.com) (you need a copy of your student ID to obtain the student discount online). MATLAB is used in many other courses, so the (limited) expense is worth it. MATLAB is installed on most public computer clusters found on campus.

Textbook and notes

Your class notes and extra handouts are the primary sources for your studies.

The recommended textbook for this course is "Linear Algebra and Its Applications", fourth edition, by Gilbert Strang. The textbook can be purchased in the bookstore, and is on reserve in the Engineering library. The lectures do not follow the text in detail, but almost all material covered in the lectures is also discussed in the book.

Class on video and online

The class lectures and workshops are recorded by the Stanford Center for Professional Development (SCPD), and are available online at SCPD's website: <http://scpd.stanford.edu>. Videos can be accessed at any time during the quarter, and are normally posted soon after the end of a class meeting.

Assessment

Your final grade will be based on assignments, a midterm and a final. We compute your final course grade by weighting assignments, midterm and final grades. Assignments count for 40%, the midterm 20% and the final exam 40%.

All assignments and exams will contain two types of questions. Around 75% of the assignment and exams will be comprised of base questions that you will be able to answer relatively easily if you understand the material given in class. The remaining 25% is comprised of so-called starred (\*) questions that are more challenging.

**Approximate guidelines for final grades:**

Historically, the average score on assignments is 90% or higher, with an occasional tough assignment coming in a bit lower. Historical averages for the midterm and the final exams hoover around 75%. If your scores are average, both for assignments and exams, you likely will receive a B+ in this course. To receive an A you must be able to solve a reasonable number of the starred questions correctly in addition to the base questions. To receive an A+, you must typically have scores in the high 90s on all your exams and assignments.

Final grade assignments are at the discretion of the instructor. If you have any questions about your standing in the class during the quarter, please contact the instructor.

**Assignments**:

There will be eight graded assignments. Assignments 2, 4, 6 and 8 are computational and require MATLAB programming. Assignments 1, 3, 5 and 7 test theoretical knowledge. Only the six highest scores are recorded.

Assignments are always handed out on Wednesday and are always due the following Wednesday, with the exception of assignment 8, which is due the Monday after Thanksgiving break.

Assignments will be returned to you on Wednesday, a week after the due date, with the exception of assignment 4, which will be handed back to you on Monday October 28 before the midterm to allow review, and assignment 8, which will be handed back to you on Friday December 6.

**All deadlines are noted in the lecture calendar below.**

We can not accept late assignments because of the size of this class and our strict return-within-one-week policy. Note that because we only count the six highest assignment scores, missing up to two homework assignments due to unforeseen circumstances will not affect your final grade.

Homework grading policies are discussed thoroughly between TAs and instructor to avoid bias. We frequently check statistics of homework grades to check if there are any distinct differences in grading, and will correct for differences if they appear.

**Midterm:**

The midterm is on Wednesday October 30 during normal class time. It is closed-book, and will be short to allow ample time for completion. It covers the material of the first 5 weeks.

**Final exam:**

The final exam is on Friday December 13 from 8:30-11:30. Location will be determined later in the quarter. The final exam is closed-book. The final covers all material.

Lecture schedule

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| September |  |  |
| Monday 23  Lecture 1  Intro, Elementary operations  Strang sections: 1.1, 1.2, 1.4, 1.6 | Wednesday 25  Lecture 2  Finite differences, banded matrices  Assignment 1 (background check):  available online  Strang sections: 1.7 | Friday 27  Workshop 1 |
| September/October |  |  |
| Monday 30  Lecture 3  Gaussian Elimination, LU  Strang sections: 1.3, 1.5 | Wednesday 2  Lecture 4  Pivoting, PLU, banded matrices, operation counts  Assignment 1: due  Assignment 2 (computational):  available online  Strang sections: 1.5 | Friday 4  Workshop 2 |
| Monday 7  Lecture 5  Ill-conditioning, condition number  Strang sections: 1.5, 1.7 | Wednesday 9  Lecture 6  Vector spaces and bases  Assignment 1: graded/handed back  Assignment 2: due  Assignment 3 (theoretical):  available online  Strang sections: 2.1, 2.3 | Friday 11  Workshop 3 |
| Monday 14  Lecture 7  Subspaces, solving Ax=b revisited  Strang sections: 2.1 – 2.4 | Wednesday 16  Lecture 8  Determinants, orthogonalization  Assignment 2: graded/handed back  Assignment 3: due  Assignment 4 (computational):  available online  Strang sections: 4.1-4.3, 3.1 | Friday 18  Workshop 4 |
| Monday 21  Lecture 9  Orthogonalization, Gram-Schmidt    Strang sections: 3.1, 3.4 | Wednesday 23  Lecture 10  Iterative linear solvers (part I)  Assignment 3: graded/handed back  Assignment 4: due  Strang sections: 7.1, 7.4 | Friday 25  Workshop 5  Preparation for midterm |
| Monday 28  Lecture 11  Iterative linear solvers (part II)  Assignment 4: handed back  Strang sections: 7.1, 7.4 | Wednesday 30  MIDTERM  Assignment 5 (theoretical):  available online | Friday 1 (November)  Workshop 6 |
| November |  |  |
| Monday 4  Lecture 12  Iterative methods  Extra notes: iterative methods | Wednesday 6  Lecture 13  Least squares/ solutions of nonlinear equations  Midterm handed back  Assignment 5: due  Assignment 6 (computational):  available online  Extra notes: nonlinear systems  Strang sections: 3.3. | Friday 8  Workshop 7 |
| Monday 11  Lecture 14  Nonlinear equations/ Exponential matrix  Strang sections: 5.3, 5.4 | Wednesday 13  Lecture 15  Eigenvalues and eigenvectors  Assignment 5: graded/handed back  Assignment 6: due  Assignment 7 (theoretical):  available online  Strang sections: 5.1 | Friday 15  Workshop 8 |
| Monday 18  Lecture 16  Canonical form, decoupling  Strang sections: 5.1 – 5.6 | Wednesday 20  Lecture 17  Power methods  Assignment 6: graded/handed back  Assignment 7: due  Assignment 8 (computational):  available online  Strang sections: 5.5, 7.3 | Friday 22  Workshop 9 |
| Saturday 23 - Sunday 1 Dec THANKSGIVING BREAK | | |
| December |  |  |
| Monday 2 (start dead week)  Lecture 18  QR method  Assignment 8: due  Strang sections: 7.3 | Wednesday 4  Lecture 19  Singular Value Decomposition (SVD)  Assignment 7: graded/handed back  Strang sections: 6.3 | Friday 6 (last day of classes)  Workshop 10  Assignment 8: graded/handed back |
| Friday December 13  FINAL from 8:30-11:30 (all material) | TUESDAY DECEMBER 17  Grades posted on coursework |  |