MATH 220 LINEAR ALGEBRA, Section 02, Fall 2011

Handout 1: Course specification

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Course Aims: To learn some fundamental theory, methods and techniques of linear algebra, and to develop some skills of mathematical reasoning and general deductive reasoning.

Do not be afraid of proof. A proof is nothing more nor less than a very clear deductive explanation. In rational discourse generally, not just in mathematics, one does not understand something if one cannot explain it clearly to other people.

What is linear algebra? It has always been a pedagogical topic, never really a topic for mathematical research. It is a systematic theory which arose, during the late 19th and early 20th centuries, from many different areas of pure and applied mathematics. For that reason, there are not many genuine applications which can be handled using linear algebra just on its own. Rather, linear algebra is core component of mathematics. It is, in particular, a prerequisite for *MATH 240 Differential Equations*, which I believe is taken by second-year ME students next semester.

Essentially, linear algebra is concerned with functions f such that, given any suitable vector x, then $f(x)$ is a vector, furthermore, given any suitable numbers a, b and any suitable vectors x, y, then $f(ax + by) = af(x) + bf(y)$. Of course, in genuine applications, such functions are rarely implicit in the statement of a problem, but they do often arise in methods for solving the problem.

Practical usage of linear algebra has been changing in recent decades though the development of computational techniques. In most numerical applications, the large amounts of data necessitate the use of computers. But, in this introductory course, we shall be working with very small amounts of data, carrying out the calculations by hand, because that is the best way to get a feel for the techniques and the ideas.

Course Texts:

Primary: Bernard Kolman, David R. Hill, *Elementary Linear Algebra with Applications*, 9th Edition, (Pearson Education. 2008).

Secondary: Howard Anton, *Elementary Linear Algebra*, 6th Edition, (Wiley, 1991).

Classes: Wednesdays 13:40 - 14:30 EB 204, Fridays 15:40 - 17:30, EB 204.

It is in the nature of a mathematics course that, sometimes, it is impossible to understand everything during the class. To fully grasp the ideas, you must study them on your own, firstly by working through lecture-notes and textbooks, secondly by tackling exercises.

It is also in the nature of a mathematics course that one simply cannot pick up the material during the two days before an exam. If the exam is only two days away, and if you do not know the material yet, then you should give up. For that reason, there will be no special office hours during the few days before an exam.

Office Hours: Wednesdays 13:40 - 14:30, in my office, Science Faculty Building, A Block, room SA 129 or, when demand requires, in the classroom, EB 204. In exceptional cases, I may be available at other times, by appointment.

The Office Hours is important, because it is your main opportunity to have a sustained one-to-one or several-to-one dialogue with me. And it is my opportunity to get some feedback about the course. It is often during office hours that I learn about major difficulties that have been affecting many of the students.

During Office Hours, you may ask me about the homework questions. Office Hours is also an appropriate time to ask me anything else about mathematics, on or off the syllabus.

Class announcements: You will be held responsible for being aware of any announcements made in class, whether or not you were in attendance. That includes announcements about locations of Midterm Exams and any announcements about changes of exam times.

Grading method: Curve, in coordination with Math 220 Section 3.

Exams: The exams are closed-book. Make-ups will be harder than Midterms, and will be granted only if a medical note from a doctor is produced.

- Midterm I, 25%, 3 November, 18:00 - 20:00.
- Midterm II, 25%, 8 December, 18:00 - 20:00.
- Final, 35%.

A note on marking in mathematics: A good solution is one which would clearly communicate the reasoning to another student. Clear reasoning with a slip in the calculations is much more valuable than incomprehensible reasoning with the right answer, because a reader can learn from the former and can correct the slip.

Attendance and Quizzes, 12 percent and grade control: A minimum of 75 percent attendance is obligatory. Attendance will be measured by counting returned scripts for pop-up quizzes. Failure to hand in scripts for at least 75 percent of the quizzes will result in a grade reduction (B- to C+, or B to B-). Medical notes for quiz absences will not be accepted.

Participation and Discipline, 3 percent: When lecturing, I like questions and comments from the audience. In fact, I need questions and comments as feedback on what the class finds easy or difficult or interesting or boring. Do not be afraid to ask questions about things which the fast students have already understood. The chances are that, if you would like an answer to some particular question, then some other people in the class would like an answer to it too.

However, when the class is in session, all questions and comments must be made at an appropriate time, and must be directed to the whole class. Students may not communicate vocally just to their neighbours. If you must communicate with your neighbours, do it with sign-language, or by using pencil and paper, but not vocally. If I find that I am being distracted by background murmuring, then I may randomly select one of the murmuring students and ask him or her to leave the room.

All the students in the class will receive the same mark for Participation.

Homework: As noted above, it is more-or-less impossible to understand everything thoroughly during class. Besides, skill in mathematics comes only through regular practise. There

are two main kinds of homework:

Reading homework: After each class, work slowly the lecture-notes and textbooks, making sure that you understand all the concepts, arguments and methods.

Homework exercises: Some of the homework exercises will be set by me. You must tackle the exercises before I present the solutions. If you are lazy, and just wait for me to present the solutions, then you might not fully appreciate where the difficulties lie, and so you might not fully appreciate the crucial ideas behind the solutions. You will also find plenty of other exercises in textbooks.

Warning: If you postpone the homework until shortly before an exam, then you will not get enough practise for the skill to settle in. That would be similar to postponing tennis practise until shortly before a tennis tournament.

Since homework-copying in this topic is hard to police, the homework will not be marked. Of course, since homework is necessary preparation for the quizzes and exams, credit for homework is assessed through the quiz and exam marks.

If you have difficulty with any of the set homework exercises, then you should come to Office Hours to ask me for help. If you have difficulty with any interesting exercises that you have found in a textbook, then you can ask me either in Office Hourse or else in class. (Of course, if I cannot do a difficult exercise immediately in class — excluding routine questions that require long tedious calculations — then that becomes homework for me, to be presented in the subsequent class.)

Syllabus: Week number: Monday, subtopic (Primary textbook section number).

- 1: Sept 26, Systems of linear equations, matrices, 1.1-1.5.
- 2: Oct 3, Echelon form of a matrix, non-singular matrices, 2.1-2.3.
- 3: Oct 10, Elementary matrices, LU factorization, 2.3-2.5.
- 4: Oct 17, Determinants and applications, 3.1-3.5.
- 5: Oct 24, Vector spaces, subspaces, 4.1-4.5.
- 6: Oct 31, Linear independence, basis and dimension, 4.5-4.6.
- 7: Nov 7, Holiday
- 8: Nov 14, Coordinates, homogenous systems and rank, 4.7-4.9.
- 9: Nov 21, Inner product spaces, 5.1-5.2.
- 10: Nov 28, Gram-Schmidt Process, orthogonal complements, 5.3-5.4.
- 10: Dec 5, Linear transformations, 6.1-6.2.
- 10: Dec 12, Matrix representations of linear transformations, similarity, 6.3, 6.5.
- 10: Dec 19, Eigenvalues, eigenvectors, 7.1-7.2.
- 10: Dec 26, Diagonalization 7.3.
- 10: Jan 2, Applications of eigenvalues and eigenvectors.

Summary of Grading:

Quizzes: 12%,
Participation: 3%,
Midterm I: 25%,
Midterm II: 25%,
Final: 35%.