MATHEMATICS 2270
Introduction to Linear Algebra
Spring semester 2007

Time: Tu-Th 4:20–6:00pm JTB 130

Instructor: Professor Grant B. Gustafson[1], JWB 113, 581-6879.

Office Hours: JWB 113, MWF 8:45-10:15am, Tu-Th 3:15-4:15 Other times will appear on my door card. From computers, read the door card link at the course web site.

Telephone: 581-6879. Please use email whenever possible.

Email and web site: `ggustaf@math.utah.edu` `http://www.math.utah.edu/~gustafso/`

Texts:

> *Linear Algebra with Applications*, 2nd edition, by Otto Bretcher, Prentice-Hall 2001 (the required text).
>
> *Student Solution Manual*, for Otto Bretcher's text *Linear Algebra with Applications*, 2nd edition.
>
> *WWW documents for 2270*, by GB Gustafson, at web site `www.math.utah.edu/~gustafso`. All are pdf or text documents that can be printed from `mozilla` or `MS explorer` web browsers.

Prerequisites

Math 1210 and 1220 or the equivalent (Calculus I and II). This is first-year Calculus, with a very brief introduction to linear differential equations. The old Math courses 111-112-113 of 1997-98 fulfill the requirement. In addition, background is required in planar curves, velocity and acceleration vectors from Physics 2210 or Math 2210 (Calculus III), or their equivalent courses.

A passive knowledge of `maple` is assumed. Persons without the passive knowledge of `maple` and `unix` may attend one of the *tutorials* on the subject offered during the first two weeks of the term. The instructor for these tutorials is Angie Gardiner, 585-9478, `gardiner@math.utah.edu`. Angie's web page is `www.math.utah.edu/ugrad/tutoring.html`. Her office is MC 155A in building LCB.

Persons without computer training and no maple experience can survive for the first three weeks with a graphing calculator and Microsoft's `Excel` or the MathWork's `matlab`. Free software exists for PC Intel hardware to duplicate most of matlab's functionality. Only matlab has a licensed maple engine, and this is the main reason why matlab provides a route through the course, without learning a lot of maple details.

Tutoring

The Math Department Tutoring Center is located in LCB, and it is open for free tutoring from 8 a.m. to 8 p.m. on M-Th, and from 8 a.m. to 6 p.m. on Friday. Some, but not all of the math

[1]Pronunciation: In the phrase *Gust of Wind* change *Wind* to *Sun*

tutors welcome questions from Math 2270 students. To see the times and specialities of various tutors, consult the web address `www.math.utah.edu/ugrad/tutoring.html`.

Course material and requirements

This course is an introduction to linear algebra for mathematics majors and science majors. Chapters 1-9 in the Bretcher text plus class notes and `www` documents will make up the course material. If you study in isolation, then please know that some topics are enriched in class. Your grade in the course may be reduced by isolation, because the enriched material is tested on exams.

Grading:

Final grades will be based on:

> Textbook problems, the major part of the **dailies**, about 132 scores.
>
> Four computer projects form the minor part of the **dailies**. Each project is counted like several textbook problems, for a total of 11 scores, making 132+11=143 dailies. About 8 of these are dropped to make a total of 135.
>
> Three written midterm examinations.
>
> Final exam. This in-class 2-hour examination counts as two additional midterm scores.

Written In-Class Exams:

There are three (3) midterm exams. There is a 2-hour in-class final exam as scheduled by the university. The midterm and final exams are graded by G.B. Gustafson. These exams are scheduled for Wednesday 4:30pm. An additional exam time is scheduled for the next day at 3pm in 113jwb (my office, 581-6879), to cover people who work, or have baby-sitting limits, or are simply ill and miss the Wednesday exam. Please notify me in advance of the exam date, that you will miss the Wednesday exam and take it the next day. Email `ggustaf@math.utah.edu` is best, phone `581-6879` works too. Please know that once you miss the exam, the crisis has ended, and recovery is the next plan. Please respond ASAP.

Hand-written Dailies:

There will be 143 dailies due during the semester, including textbook problems and four maple labs. They will be graded in part by a staff of readers employed by Angie Gardiner.

Records:

Accounting of exams and the dailies is initially on paper and ultimately by `excel` computer records. The electronic records are web-based, with keys replacing names. During the course, the currently available electronic record is printed and distributed in class like returned homework. This usually happens about the last day of class or shortly thereafter. Electronic records are available later, on the web.

If you ask for record information before it is electronic, then the request involves 10-20 minutes of my time, to retrieve it from paper records. Please keep your own records. Correction of records, when required, can be made by email communication.

Homework, computer labs, midterms and final

Textbook problems

Those problems to be submitted for grading are listed on the `gradesheet` for the course and also at the end of the syllabus. Visit the web site for extra copies. The due dates for problems appear only on the web site. They are dynamically updated to reflect the reality of what was discussed in class. Generally, problems are submitted shortly after class discussion.

Students are requested to complete each textbook problem and submit their work in their own handwriting.

Homework problems are submitted one problem per package with your name, class time and a problem label. **Please write the class time 4:20pm and the problem label near your name**, e.g., write problem label **1.2-5** for problem 5 in section 1.2 of Bretcher's textbook.

There are certain **rules** for writing up the textbook problems. A full accounting of the *format suggestions* contributed by students of 2250 appears on the internet course page as *format for submitted work*. Kindly apply the ideas therein to your written work. It is not a requirement that you follow any advice, but rather, a suggestion that you may rob successful ideas from the document aforementioned.

Computer projects

There will be four computer projects assigned during the semester, related to the classroom material. Each project counts the same as 2 or 3 daily problems from the textbook, for a total of 11 scores on the dailies. They will be written by hand and use the software package `maple`.

Packaging rules for homework problems apply to maple labs as well.

There is a Math Department Computer Lab in building LCB at which registered students automatically own accounts, and there are other unix labs around campus where `maple` is also available, for example at the College of Engineering CADE lab. Most unix labs can launch remote X-windows sessions on math hosts using `ssh`. Remote files on math hosts can be transferred to your local unix computer with `sftp`. For information on how to do the same for personal computers, visit the campus computer help sites.

Drop-in tutoring in the computer lab in the basement of building LCB starts the second week of the semester. The staff there is best at elementary topics from algebra and calculus. A few of them can handle 2270 questions.

Midterm exam details

Past midterm in-class exams appear on the web. Your exam is modeled after the old exams. A sample exam will be supplied. Available on the web page are solution keys to old exams. You may print these for reference. The final exam has a separate study guide, also available at the site.

Books, tables, notes and calculators are not allowed on exam day.

An in-class Midterm exam has different presentation rules, and none of the textbook problem rules

apply in this case. Basically, the in-class exam is a first draft. No answer checks are expected.

Final exam details

Two hours are reserved for this written exam. As published by the university, the final exam is

4:30 class Tuesday May 1, 2007, 4:30pm to 8:30pm [JTB 130]

The final exam is comprehensive. It covers chapters 1 through 9 with weight distributed evenly. A study guide consisting of problem types by chapter plus a few final exam solution keys for previous final exams appear at the web site.

No notes, calculators, tables, books or aids of any kind are allowed on the final exam. Please bring pencils and eraser. Paper will be supplied.

Due dates, extra credit and late work

Due dates

Please prepare submitted work according to the tentative schedule of due dates. The actual due date is the same date, or one day later, as documented on the web site.

Due dates are updated dynamically at

`www.math.utah.edu/~gustafso/s2270/2270duedateS2007.html`.

Browse this site often. To repeat: **the due dates are not given in class**! Sometimes, email communication about due dates and exams will be made from the registrar's list.

Email notification

You will be sent email about due dates, exam reviews and exam dates during the semester. This service depends on your email address being up to date.

Look up your campus information data by visiting the registrar's campus WWW site (where you add classes). Find out your email address, then test it by emailing a message to yourself. To update the information, return to the registrar's site and edit your personal data.

When is work late?

Due to the number of dailies being collected, work is considered late and therefore unacceptable when the stack of papers is graded. Registered students whose paper is not in the stack get a zero for the assignment.

Are you an exception? It is better to ask than to assume anything. Depend on extra credit problems (see below) to make up for work not submitted on schedule. The same advice applies, if submitted work earns a grade of 55 or 0. While a zero generally means no work was submitted, sometimes I reject a paper completely and mark it zero, as though nothing was submitted. You'll get the paper back and maybe an explanation of why I did that.

The state of submitted work is locked at the point when the stack is graded and recorded. The grading filters out the good work from the bad work and records the result. This record is never appended, it is only corrected for errors.

The lowest eight (8) dailies are dropped from consideration in order to eliminate makeups. There is no distinction between a problem from the textbook and a maple lab problem, they earn the same credit.

If more than ten (10) textbook problems have zero scores, then please call 581–6879 or email `ggustaf@math.utah.edu` and discuss the situation. It is better to talk about it than to try to catch up by yourself.

Extra credit

Extra credit problems are enumerated at the web site, and do not appear in this syllabus or on the gradesheet. Instructions for extra credit problems appear at the end of this document, just before the lecture and homework list. Briefly, the deadline for extra credit in a chapter is the due date of the first problem in the next chapter.

Withdrawal

It is the Math Department policy, and mine as well, to grant any withdrawal request until the University deadline. This promise also means that such a withdrawal requires no explanation. Withdrawals are always initiated by the registered student. All paperwork is the duty of the student. My job is the signature.

ADA statement

The American with Disabilities Act requires that reasonable accommodations be provided for students with physical, sensory, cognitive, systemic, learning, and psychiatric disabilities. Please contact me at the beginning of the semester to discuss accommodation (113 JWB or 581-6879), which is to say, accommodation shall be made.

Grading details

Grading Scale

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A  = 95-100, A- = 92-94, B+ = 88-91, B  = 84-87,
B- = 80-83,  C+ = 75-79, C  = 65-74, C- = 60-64
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This scale is determined from 40% passing use GPA increments. It is used for grading and for final letter grade reporting. This scale is for internal use only. Fractional scores are truncated (not rounded) when fitting a score to a letter grade – see below for examples.

Final grade

A grade of E is assigned if the Dailies score sums to less than 5000, which is 50 dailies, or 40% of the required dailies. Please read the **Rite of passage** paragraph below.

The letter grade is determined from the *Grading Scale* above as follows:

$$\text{Final Grade} = \frac{30}{100}(\text{Dailies Average}) + \frac{70}{100}(\text{Midterm+Final Average}).$$

An example: the Dailies Average for 135 textbook problems and maple labs is 91% and the Exam Average of the three midterms and the final exam is 86%. The final grade is $0.3(91) + 0.7(86) = 87.5\%$, which by the scale above is a B. While 87.5 rounds to 88, a $B+$, the deciding factor is really the exam average of 86, which is squarely a B. The final grade is B. If the dailies average was 93 or higher, then the final grade would be 88.1 or higher for a B+.

A precise description of the method of assigning letter grades follows. First, compute the course average $A = 0.3A_1 + 0.7A_2$ from the dailies average A_1 and the exam average A_2. Truncate A to an integer (e.g., $A = 94.96$ truncates to 94). Assign a letter grade L according to the grading scale (see above). Look at the final exam score F and the exam average A_2. If F would give a higher letter grade, then change L to the next possible higher letter grade, e.g., change a $B+$ to an $A-$ (but not $B+$ to A). In some cases, when F is low or A_1 is low, the average A_2 will be used to decide on the letter grade. An example: $A = 94.96$, $F = 92$, $A_1 = 94.86$, $A_2 = 95$. The letter grade is $A-$, but the exam average is 95 or A, therefore the letter grade $A-$ should be promoted to an A.

It is possible with a very low daily average to have rank one or two in the class and yet earn a final grade of **B**. This happens because the influence of the dailies score is just 30%. An example: final exam grade 100, exam average 99, dailies 55. Then

$$0.3 * 55 + 0.7 * 99 = 85.8 = \mathbf{B}.$$

Rite of passage

A passing grade in the course requires submission of at least 50 of the 135 dailies, which includes computer projects. A grade of E is assigned if less than 50 Dailies are submitted. The scores on the 50 dailies are expected to be 100%.

The right of passage is absolute, similar to the European system, which requires a body of work to be presented before written and oral final exams are taken. For example, the Czech *vypočet* is a requirement to show a body of completed work as the entrance requirement to administration of written and oral final exams.

How dailies are graded

Graders assign scores on dailies as one of 100, 55 or 0. The papers with score 55 or 0 are used to schedule office hours or additional tutorial help. Based on grading history, about 90% of the scores on a given problem are 100%. A score of 0 is given for work not submitted.

A grade of 100 usually means a complete, correct solution was written. I give a score of 100 when the solution method is correct, even if the details contain arithmetic errors and a few missing

steps. Flaws in logic are not excused, even if the correct answer was found, due, for example, to multiple errors canceling the logic error.

A grade of 55 means the written work lacked essential details. This score is given for a written solution with just the answer and a few sketchy details. Examples of sketchy solutions, worth 55 or 0 for a score, appear in the textbook's solution manual.

Extra credit problems

The actual problems are enumerated at the course web site, and appear nowhere else. Possible because of them is 100% credit on each chapter and 100% on each maple lab.

Grades on extra credit problems and extra credit maple lab sections are 99 and 0. Generally expect an extra credit problem to be more difficult than the standard assignment.

To illustrate how credit is applied, suppose that a chapter has 15 dailies and 5 extra credit problems. Consider this record:

Problem Count	Score
9	100
3	55
3	0
4	99

Then the average on the chapter is the smaller of $(9 * 100 + 3 * 55 + 4 * 99)/15 = 97.4$ and 100. The fifth extra credit problem could add 99, then the average is 100.

Extra credit is applied to each chapter individually. For example, an extra credit problem like Ex1.2-12 applies only to chapter 1.

Purpose of the textbook problems

The *purpose* of the problems is to practice doing mathematics, that is, to write out in detail the solutions to problems. A textbook problem is generally an engineering–style "crank" problem or a linear algebra proof. The process:

- **Understand the problem**. Understanding usually involves reading the *problem notes* and the textbook. Answers are usually not provided. You may get an outline of the solution, to increase the probability that the project gets completed on schedule. Problems are discussed in class in finer detail. If transparencies are used, then they are replicated at the web site, as pdf files, ready to print from an internet browser.
- **Background reading**. To solve a problem, a second opinion of the theory and method is essential. It might be that you can flesh it out of your book's examples, the college algebra text, the calculus text or some mathematics textbook. No matter, go to a source that works for you. This is *reading* and not a tutorial.
- **Scratch Paper Write–up**. The initial creation of a solution is the essence of the learning process. Everyone learns by repetition, and here is where you do it. Use a pencil and a big eraser, lots of paper, and flesh out a first draft at full speed. Don't submit this draft!

- **Final Copy**. The final copy of the solution uses the scratch paper draft as raw material to *present* the details of the solution. As such, it is more than a collection of formulas on paper. There is no strict requirement, except that *neatness* and *completeness* are a must.
- **Final Copy Format**. The most successful format to date was invented by several engineering mathematics students over the years 1990–2006. This format is described in some detail below and also in the internet document *format for submitted work*.

Some Format Suggestions

1. Use engineering paper or plain white paper. Lined notebook paper and graph paper are not acceptable for mathematics, because they introduce flaws in vertical white space.
2. Reports are hand-written in pencil. They start with a problem statement followed by the book's answer or by a final answer summary. Supporting material appears at the end, like a tax return.
3. Every report has an answer check. For problems with textbook answers, it is usual to see "*the answer matches the textbook*," or briefly **B.O.B.** For problems without a textbook answer, a full answer check is expected.
4. Mathematical notation is on the left, text on the right, about a 60% to 40% ratio. One equal sign per line. Justify equations left or align on the equal signs.
5. Text is left-justified on the right side. It includes explanations, references by keyword or page number, statements and definitions, references to delayed details, like long calculations, graphics and answer checks.
6. Rules 4 and 5 can be broken. They are suggestions, not rules.

Cooperative efforts are allowed and encouraged. Kindly produce individual handwritten reports. There is no penalty for getting help from others – it is encouraged. This includes tutorial staff in the Math Center LCB, teaching assistants and fellow students.

English language deficiencies are tolerated but not excused. If English is your second language, then try to improve your writing skills by these actions: (1) shorten comments, and (2) use page references to the textbook.

Presentation is expected to improve throughout the 14 weeks of the course. You are not expected to be an expert in the first week. Correctness of answers will be checked. The problem notes might contain answers plus a solution outline. In class, further details are communicated. Your job is to *improve* on the initial start into the solution. Add the particulars, make comments, and chase down the details from algebra and calculus. College algebra and calculus skills need constant and careful review. Writing up the solution identifies the stumbling blocks and forces a review of background material.

References are required on the first occurrence. After that, omit the citation. It is appropriate to refer to the previous assignment on which the citations originated. A statement like *References parallel Exercises 1-5* is enough.

Extra credit instructions

Extra credit problems add credit to the chapter in which they appear. They do not add credit to any other chapter.

The maximum credit that can be earned in a chapter is 100%. An example:

> Standard problems and maple labs might total 1600 for a chapter, which counts as 16 items on the gradesheet. Extra credit problems could potentially add 5 times 99 or 495. If 1355 was earned on standard problems and maple labs, plus 297 on extra credit, then the total earned is $(1355 + 297)/16 = 103.25$. This total is truncated to 100, because you may earn no more than 100% for a chapter.

Location. The web site `http://www.math.utah.edu/~gustafso/index2270.html` enumerates the possible extra credit problems for each chapter. They do not appear in the syllabus nor the gradesheet, which reference only standard problems and maple labs.

Submissions. Please submit extra credit problems with a special label. To illustrate, extra credit problem **1.2-12** would be submitted with label **Ex1.2-12** next to your name and class time.

Deadline. The deadline for submitting extra credit is the due date for the first problem of the next chapter. The extra credit stack is graded on that date. The records are then locked and never appended, only corrected.

Spring 2007 Tentative Daily Schedule

Week 1, Jan 9,11	Section 1.1, 1.2. Begin first maple lab.
Week 2, Jan 16,18	Sections 1.3,2.1,2.2. Holiday Mon Jan 15.
Week 3, Jan 23,25	Sections 2.3,2.4.
Week 4, Jan 30, Feb 1	Sections 3.1,3.2,3.3.
Week 5, Feb 6,8	Sections 3.4,4.1. Exam 1 Feb 7.
Week 6, Feb 13,15	Sections 4.2,4.3.
Week 7, Feb 20,22	Sections 5.1,5.2,5.3. Holiday Mon Feb 19.
Week 8, Feb 27, Mar 1	Sections 5.4,5.5.
Week 9, Mar 6,8	Sections 6.1,6.2. Exam 2 Mar 7.
Week 10, Mar 13,15	Sections 6.3,7.1,7.2.
Break, Mar 19-25	Happy holiday!
Week 11, Mar 27,29	Sections 7.3,7.4,7.5.
Week 12, Apr 3,5	Sections 7.6,8.1.
Week 13, Apr 10,12	Sections 8.2,8.3. Exam 3 Apr 11.
Week 14, Apr 17,19	Section 9.1,9.2,9.3.
Week 15, Apr 24	Final Exam review. Lectures end Apr 25.
Week 16, Apr 27 to May 3	Final exam period. Final exam for the 4:30 class is 4:30-8:30pm on Tuesday May 1.