MATH 232, Linear Algebra
Spring 2006

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Contents

1 Introduction

The prerequisite for this course is MATH 122, second semester calculus. This means you should already be familiar with the basic methods and techniques for thinking about and solving mathematical problems. Although this is a course in algebra that focusses on "linear spaces" (and calculus is a course in analysis), we will see that there are many examples of linear spaces from the differential and integral calculus. In fact there are examples of linear algebra almost everywhere you look: physics, chemistry, economics, and computer science to name just a few. Unfortunately there will only be time to explore a few of these applications this semester. See MATH 232 Syllabus[1] for the department's official description of this course.

Linear algebra is the first "proof-based" course offered in our mathematics curriculum and serves as the gateway course to upper-division mathematics. In addition, it meets the university's "Writing in the Major" requirement. This means there will be at least as much focus on providing **detailed written explanations** of why the mathematical tools of linear algebra work as on the problem-solving strategies used to determine when, where and how to use them. Hence, you are expected to provide clear justifications for each and every logical step in your presentations of the writing assignments. I go into more detail about the writing assignments below.

Thus, by the end of the semester, you should have learned to

- read a mathematical text for content and deep understanding (see "How to Study" [2] for an excellent description of how to read mathematics and other efficient ways to study),
- analyze a given problem to determine which tools should be used in its solution,
- use a variety of strategies to determine and prove a solution of the given problem, and
- follow accepted mathematical style to present an accurate and carefully written formal proof of your solution.

The best way for all this to happen is if you and I work as a team. And in order to do that efficiently, I need to know how you learn. For example, are you a visual learner? Do you need an abstract explanation before specific examples make sense or do you find that the only way to understand something abstractly is to see lots of examples? Are you highly self-motivated or do you need someone to "force" you to keep up, do homework, etc. Are you too shy to work in a study group or are you so driven that no one will work with you? Of course, almost everyone falls somewhere between these various extremes but the point is that the more I know about you and about your "learning styles" the better I can tailor the class to help you learn.

On the other hand, for you to learn well, you need to do some things for me. For example, the more actively you participate in the material the better you will learn. This includes speaking up in class when you don't follow something I've said, being ready for class, practicing the concepts by doing homework, discussing the ideas with other students, and using efficient study techniques (as noted above, "How to Study" [2] is an excellent resource for study techniques).

Below is an outline for one way to run this course. I have used this structure before and it has worked well, but it might not be the best one for this particular class. So read it over and see if the tests, homework, reading expectations, et cetera are set up in a way that will help you learn the material. We can discuss making changes during the first week of class. Hopefully we can find a course structure that will work well for everyone.

2 Course Information

2.1 Textbook

The textbook is *A First Course in Linear Algebra, version 0.70,* by Robert A, Beezer, ©2006, and is published by Professor Beezer under the GNU Free Documentation License rather than by a commercial publishing house.

This means many things that will benefit you, the first is that the entire book can be found online at `linear.ups.edu` and the second is that I can supply you with a printed copy for Kinko's $25.00 printing cost. This cost is low because we will print a large number of copies. It will cost about twice as much to print a single copy in a separate run.

Since this is likely to be your first exposure to proof-based mathematics, you should also consider buying one of the many books on "how to do proofs". I recommend "The Nuts and Bolts of Proofs" but one of the other books listed below might appeal to your learning style better. The links point to Amazon.com but you might find better prices elsewhere on the web.

- "The Nuts and Bolts of Proofs", Antonella Cupillari [6]
- "How to Read and do Proofs", Solow [7]
- "Thinking Mathematically", Mason/Burton/Stacey [8]
- "Mathematical Thinking: Problem-Solving and Proofs", West and D'Angelo [9]
- "How to Prove It: A Structured Approach", Velleman [10]
- "Proofs and Fundamentals: A First Course in Abstract Mathematics", Bloch [11]

2.2 Calculator

I require a calculator that can perform the following matrix operations for this course: row operations, reduced row echelon form, transpose, determinant, and eigenvalues/eigenvectors. I will allow the calculator to be used on some examinations but will not allow its use for some problems.

I do not care what calculator you use but I am most familiar with Texas Instrument machines, particularly the TI-86. If you do not have a manual for your calculator, you should be able to find one on the internet – for example at
`http://education.ti.com/us/product/tech/86/guide/86guideus.html`. [4] Be sure to see the department's Calculator Policy [3] for more information on calculator use.

2.3 Basic Information

You can find information pertinent to all of my classes at the link below and, once there, information specific to this class by clicking on the Math 232 link.

`http://math.ups.edu/faculty/~bryans/` [12]

2.3.1 Logistics

Professor Bryan Smith	Thompson 321E	879-3562	bryans[at]ups.edu
Office Hours	My office	4:30 - 5:20 P.M.	M
(trial office hour)	Thompson 320	7:15 - 8:30 P.M.	W
	My office	2:00 - 2:50 P.M.	Th
	My office	10:00 - 10:50 A.M.	F
Classroom	Thompson 320	12:00 - 12:50 P.M.	M,W,F
	Thompson 320	12:30 P.M. - 12:20 P.M.	Th

I am also available to meet at other times. If you have trouble meeting during office hours please make an appointment for a better time.

2.4 Day to Day Structure

The class weeks will be typically be structured as follows.

Monday, Wednesday, Friday These days will be devoted to lectures. Very little time, if any, will be given for questions.

Wednesday On test weeks, Wednesday during class will be a review session. I am also scheduling a 7:15 P.M. office hour on a trial basis.

Thursday All examinations are scheduled for Thursday.

On weeks when there is no examination, Thursday will be devoted to questions and discussions about the course material.

2.5 Examinations

There will be five (5) 100 point, one hour, in-class examinations and I will drop the lowest score. Make-up examinations are occasionally granted but require that arrangements are made well before the exam. You **should not** expect examination questions to closely mimic textbook examples or assigned homework problems. On the other hand, some exam questions will be similar to problems or examples that can be found in the textbook.

Examination One	Thursday February 2
Examination Two	Thursday February 23
Examination Three	Thursday March 30
Examination Four	Thursday April 20
Examination Five	Monday May 10 (Simultaneous with the Final Exam.)

2.6 Final Examination: Wedesday May 10 at 8:00 A.M.

The final examination and the fifth regular examination will both take place during this two (or three) hour period. The final examination portion will be comprehensive. The final cannot be rescheduled so do not schedule plane flights (or anything else) that will conflict with it.

2.7 Writing Projects

There will be a writing project assigned for each week we don't have an examination. These projects are designed to help you both better understand the current topic and develop the writing skills necessary to meet the university's Writing in the Major requirement. They will be graded both for mathematical content and for written presentation using the grading rubric on the last page of this document. I will collect these projects at the beginning of class on Friday. Note:

- Feel free to use (or not) any technology that you like (e.g., calculators, *Mathematica*, MATLAB, etc.).
- You may work with others in solving these problems but there is to be **no collaboration on the written exposition of the solutions.**
- You must include a reference paragraph at the beginning of your paper either affirming the work is completely yours or citing each resource you use: names of participants in discussions (other than the in-class discussions), technological tools, reference texts employed, and anything else other than your own thoughts. Failure to include references is intellectual theft!

2.8 Homework

I expect you to work a large number of the homework exercises in the textbook. I will provide feedback on these exercises during our scheduled discussion sessions but, since I will not be collecting them, I am making it **your responsibility** to work enough exercises and ask enough questions to ensure you understand the material.

2.9 Reading

It is very important that you read the material at least twice. Once before and once after it is discussed in class. It is also important that you read correctly. Mathematics requires that you read **slowly** and with a pencil and paper at hand. (See "How to Study"[2] on the course webpage for more details.)

Currently I plan on providing some motivation for doing the reading by including the textbook's "Reading Questions" in your grade. If the class agrees this is a good idea then each section's reading questions will be due, by email, at 8:00 A.M. on the morning we cover that material in class. When you submit your answers you **must** have "232" and your name in either the subject line or body of your email – preferably the first line.

As an additional ongoing assignment, please write down the topic in each section that you find hardest to understand and bring it to the class when we discuss that section. I will poll a number of students for these topics and focus the lecture on the results. This will let us use our limited time on the topics that need the most discussion. Of course, this means you will need to rely on your reading skills for the more straight-forward material since you are responsible for understanding all the topics in the sections we cover.

2.10 Course Information Updates

If you wish, I will post (and update) a grade report on your current standing in the class on my university web page. You should keep track of your grades on the various assignments and check them against these reports. If there are any discrepancies they should be dealt with immediately.

To have your information posted you need to print your name, the class (MATH 232), and a code on a sheet of paper. Then sign the paper and physically hand it to me. The code is to be a sequence of up to 23 symbols I can type on a keyboard.

2.11 Total Points

Homework	40%
Reading Questions	5%
Examinations	44%
Final Examination	11%

2.12 First Assignment

(Due Friday January 20 at 5:00 P.M.) Look over both my university web page `http://math.ups.edu/faculty/~bryans/` [12]

and the course webpage for MATH 232. Then send a **signed** e-mail message to me at bryans[at]ups.edu (you'll have to replace the word "[at]" with the @ symbol) indicating that you have an account, understand how to access the World Wide Web, and are aware of how to avoid mistakenly sending e-mail to Beverly Smith that is meant for Bryan Smith.

References

[1] Department Syllabus for MATH 232
`http://www.math.ups.edu/~matthews/Syllabi/MA_232_Syllabus.pdf`

[2] William Rapaport's "How to Study"
`http://www.cse.buffalo.edu/~rapaport/howtostudy.html`

[3] Department Calculator Policy
`http://www.math.ups.edu/info/calcpolicy.pdf`

[4] TI-86 Manual
`http://education.ti.com/us/product/tech/86/guide/86guideus.html`

[5] Math 232A Course Webpage
`http://math.ups.edu/~bryans/Current/Spring_2006/232Index_Spring2006.html`

[6] "The Nuts and Bolts of Proofs", Antonella Cupillari
`http://www.amazon.com/exec/obidos/tg/detail/-/0120885093/`

[7] "How to Read and Do Proofs", Solow
`http://www.amazon.com/exec/obidos/ASIN/0471406473/`

[8] "Thinking Mathematically", Mason/Burton/Stacey
`http://www.amazon.com/exec/obidos/ASIN/0201102382/`

[9] "Mathematical Thinking: Problem-Solving and Proofs", West and D'Angelo
`http://www.amazon.com/exec/obidos/ASIN/0130144126/`

[10] "How to Prove It: A Structured Approach", Velleman
`http://www.amazon.com/exec/obidos/ASIN/0521446635/`

[11] "Proofs and Fundamentals: A First Course in Abstract Mathematics", Bloch
`http://www.amazon.com/exec/obidos/ASIN/0817641114/`

[12] Bryan Smith's Homepage
`http://math.ups.edu/faculty/~bryans/`

3 Writing Projects Grading Rubric

Points	Logic and Mathematics
5	Arguments are correct, complete and without inappropriate material.
4	Arguments have one minor error, omission or inappropriate inclusion.
2	Arguments have two minor errors, omissions or inappropriate inclusions.
0	Arguments are more seriously flawed.

Points	Use of Terminology and Notation
3	All technical terms, concepts and notation are used correctly.
2	Arguments have one lapse in terminology and notation
1	There are minor problems with terminology or concepts.
0	There are major problems with terminology or concepts.

Points	Written Presentation
2	Follows citation requirements and all other writing guidelines.
1	Follows almost all of the guidelines with only one or two minor lapses.
0	Has more lapses in following the guidelines.

3.1 Writing Guidelines

It is best to think of these writing projects as officially assigned papers in which you completely explain and justify your analyses of the problems. You may work with others in solving these problems but there is to be **no collaboration on the written exposition of the solutions.** In addition I expect your papers to be

- Fully documented – specifically:

  1. You must include a reference paragraph at the beginning of your paper either affirming the work is completely yours or listing each resource you use: names of participants in discussions (other than the in-class discussions), technological tools, reference texts employed, and anything else other than your own thoughts.
  2. Any idea obtained during brainstorm sessions or in discussions is cited in-line.
  3. All textbook results (theorems, propositions, and lemmas) are cited in-line and include the name of the result.
  4. Any use of technology is cited in-line.

- Carefully handwritten in ink or written with a word processor. (I can show you how to use Scientific Notebook in the labs or you can use Microsoft Word. Please check with me before using any other program.)

- Written using complete, accurately punctuated sentences.

- Presented in active voice, the first person plural and with a clear, easy-to-follow expository style.

- Targeted at an audience consisting of students not in this class but with an equivalent mathematical background – say those currently in another section of this course.