Youngstown State University
Department of Mathematics and Statistics

Course Outline for Mathematics 5825

(Also see the additional information sheets attached for more information about this course.)

Course Title: Advanced Linear Algebra

Text: Applied Linear Algebra, Lorenzo Sadun, Prentice Hall

Course Description: A study of abstract vector spaces, linear transformations, duality, canonical forms, the spectral theorem, and inner product spaces. Prereq: MATH 3721

Course Objectives: The goals for students in this course include:

- developing an understanding of the fundamental concepts of abstract vector spaces, linear transformations, duality, canonical forms, the spectral theorem, and inner product spaces, along with some consequences
- continuing to develop the ability to read and understand advanced mathematical definitions, theorems, and proofs
- continuing to develop the ability to communicate in mathematics and produce well-written proofs

Course sections from our required test:

Time permitting, our work will be based on topics from the following, with varying emphases, sophistication, methods, and possibly varying order. We could use other sources for certain topics or to supplement certain topics. You could be asked to read some topics intended for limited coverage, or in cases where topics are viewed as very similar to topics covered in Math 3720 or its equivalent.

Outline of Sections to Cover:

Some of these sections will be covered in more detail than others. In some cases, only a part of the section will be covered. Class lectures and homework could come from other sources as well. If there are any undergraduate students in this class, then each graduate student will also be required to make an oral presentation, which will be incorporated into other topics we do (more on this below).

This course will include an emphasis on some of the abstract concepts related to vector spaces and linear transformations. This is not a course in matrix algebra (which is assumed as a prerequisite since Math 3720, or its equivalent, is a prerequisite for Math 3721, mentioned above); although matrices will be used to both help illustrate the abstract concepts of this course, as well as to aid in certain calculations done within the context of this course. Some aspects of Math 3720 (or its equivalent) relating to vector spaces and linear transformations will be reviewed in context (more on this below), but Math 5825 will include significantly more depth and breadth than was included in many areas in both pure and applied mathematics. In some cases, allusion to other areas of mathematics might be mentioned. The Math 3721 prerequisite will be used less extensively, and primarily in two ways: (i) in some cases familiarity with terminology will be important (or useful); and (ii) in the general mathematical maturity gained form having previously encountered axiomatic developments. The Math 2683 (or its equivalent) prerequisite for Math 3721 will also be used in connection with the ability to read and write mathematical theory.

Although other sources might be used to substitute or supplement, we will primarily work from the text mentioned above. The following sections will provide the bulk of our material, though occasional use of other sections might be made by the instructor in lectures and by students on their own who might need some review. (The text is fairly self-contained and could be used by students to review some concepts from Math 3720 or its equivalent on their own.) Not all sections will necessarily receive the same emphasis with regard to scope of coverage.
Chapter 2. Vector Spaces and Bases

Chapter 3. Linear Transformations and Operators

Chapter 4. Eigenvalues

Chapter 6. Inner Products

Chapter 7. Hermitian and Unitary Operators

Chapter 8. Miscellaneous Applications from Chapters 5 and 8

Students with Disabilities: In accordance with University procedure, if you have a documented disability and require accommodations to obtain equal access in this course, please contact the Office of Equal Opportunity and Disability Services at the beginning of the semester or when given an assignment for which an accommodation is required. Students with disabilities must verify their eligibility through the Office of Disability Service in Beeghly Hall, room 3310, (330-941-1372) intake procedure

Instructor: Dr. Buoni

Office: Math. Office Cushwa Hall

Phone: (330) 941-1971

Office Hours (could change with notice): MW, 200 - 300

**General Statement about course content and relationship to the program.**

This is a second course in linear algebra. If you have not already successfully completed all of the “prerequisite” courses discussed above, then you should see me as soon as possible.

The subject of linear algebra is an important prerequisite (and bridge) to many later more advanced courses in mathematics. The vocabulary, results, and mathematical maturity developed and/or improved in Math 5825 could form the foundation for many later studies in mathematics, although since this is considered a second course in linear algebra here at YSU, it will be assumed that you have already attained a certain level of mathematical maturity.

This course is highly theoretical in nature, with emphasis on proofs and examples of relevant results. Class work as well as homework will reflect this theoretical nature. You will not only be expected to ultimately master many of the definitions, proofs, and examples covered in class, but you will also be expected to construct and write your own proofs and examples in problems which appear in the homework, and in problems similar to homework problems. This is not a spectator course. In order to succeed in and gain from this course, it is absolutely essential that you spend the necessary time outside of class to master the class work and to do the homework. A willingness and ability to read mathematics is important in order to do well in this course, and should be developed more so during this course. Some material may be assigned for you to read on your own, especially if it is very similar to material covered in Math 3720, or its equivalent. Also, since improving your way of writing mathematics is an important component of this course, some of the homework will be collected in order for me to give you feedback and aid in the learning process. (More on these matters elsewhere.) Thus, the time you spend outside of class should include: reading your notes; reading relevant portions of the text; rewriting your notes; attempting all assigned homework (asking for help from me when necessary); possibly forming study groups with fellow classmates; and exercising proper study habits while preparing for exams. Sometimes the best way to learn something is to teach it, and so you are encouraged to verbally explain concepts to anyone who will listen, even if that means just verbally explaining material to a “virtual student”. A weakness in understand can
sometimes surface while you are trying to verbalize something that you thought you understood. Make lists of results to summarize what you must know and keep studying your lists. Often it is necessary to spend significant time outside of class in order to understand material, which was covered inside of class. Reading, writing, and verbalizing: these are all important phases of the learning process, which should take place during this course. And if you are successful, you will develop a pattern of learning and studying which will serve you well in future mathematics courses (or even other subject areas) as well.

This course qualifies to be part of the additional required upper division hours for mathematics or mathematics secondary education undergraduate students, and this course is also part of our “Graduate Core”, and hence is required for graduate students wishing to receive a Master of Science Degree in Mathematics at YSU. Also, as is required by the Graduate School, students taking this course for graduate credit will be required to do additional work beyond what is required of students taking this course for undergraduate credit. (More on this below.)

We have before us a challenge to exceed our expectations. With all our joint hard work, I hope to see each of you succeed!

**Grading Policy**

Your grade for this course will be based upon a preponderance of evidence gathered from the following:

- Two exams before the Final Exam (see below)
- Comprehensive Final Exam (see below)
- Multiple Major Homework Assignments to turn in, including one computer lab assignment (also see the Homework Policy and relevant information about the computer lab assignment below)

And for each student taking this course for graduate credit:

- One oral presentation to the class (see more on this below)

**The Oral Presentations to be made by Students taking this course for Graduate Credit**

The Graduate School requires that students receiving graduate credit for a “swing” course be required to do something extra beyond what is required by students receiving undergraduate credit in the same course. Since our course, Math 5825, is such a course, I will require student who are receiving graduate credit for this course to make one oral presentation to the class. Although more direction could be given during the semester, this oral presentation should be at least ten minutes in length, and discuss some topic in linear algebra which is not formally part of the other class work we will cover in the course. Prior approval of topics by me will be required. More guidelines, including a tentative timetable will be given during the semester. This assignment will be graded as “SATISFACTORY”, or “NOT SATISFACTORY”, depending on content and presentation, or as “ZERO” (if the assignment is not completed). If a student who is required to give a presentation receives “SATISFACTORY” for this assignment, then this student’s grade for the course will be determined by the percentages and guidelines given below, no adjustment to the letter grade range determined. If a student who is required to give a presentation receives “NOT SATISFACTORY” or “ZERO” for this assignment, then the student’s grade could be adjusted downward by as much as one full letter grade from the determination made according to the percentages and guidelines given below. Further obligation(s), if any, of other students in the class could be imposed depending on the topic of an individual talk, but will be announced within one class period after the talk is completed.

Exams will be based on class work and homework. You will be given opportunities to ask questions about homework problems. More suggestions about homework (see more on homework below), studying, and seeking help will be given during the course. Homework and class work could be taken from sources other than our text, and homework to be turned in will be governed by a Homework Policy (see below). The following initial weightings will then be used in helping to determine your letter grade for this course.
Exam No. 1: 25%
Exam NO. 2: 25%
Multiple Major Homework Assignments, including one extensive computer lab assignment, all turned in for grading (see below for the homework policy) 20%
Final Exam: 30%

**Homework Policy**

(See elsewhere in all the information for more on homework.)

Some homework assignments will not be required to be turned in. The major homework assignments that you do have to turn in will be guided by the following rules;

1. Type or write on only one side of each page (using the paper I provide you to write your final solutions), skipping at least one line between each line of writing or typing, and leaving a margin of at least one inch on all four sides of each page. You should also keep a copy of your submission for yourself when you turn in a copy to me.

2. Attach all pages with a paper clip, writing, or typing your name at the top of each page.

3. Write or type out the homework question at the beginning of each solution, unless I state otherwise.

4. Turn the assignment in by 1:50 P.M. on the day it is due, unless I grant an extension to the entire class for that assignment or part of that assignment. If you are going to be absent, you should arrange for someone to turn in the assignment for you. Exceptions to this rule will not ordinarily be granted, though certain circumstances beyond our control (as a group) may require an exception. **“Late submissions” will not be accepted for formal grading, and will generally receive the “zero grade”**.

5. Unless I state otherwise, you may practice responsible collaboration with other students in this class. You are also encouraged to request help from me, if you need help. Except for these cases, I do not want you to communicate with any other individuals, including other instructors, about the assignment (unless I state otherwise). Collaboration should generally involve “contribution(s)” from each member of the group collaborating. You may use any books you wish to, except a solutions manual for our text, though these should be included in a bibliography when you turn in your assignment. (You may however, use our textbook and any notes taken from my lectures without including them in a bibliography.) Also included in your bibliography (should one be necessary), you should state to what extent each reference helped you with the assignment. Bibliographies, if any, should include the titles, authors, and page numbers of books used. If you collaborated with any fellow student(s) in this class, it is expected that you will still write up the assignment on your own (copying solutions or parts of solutions, or failure to acknowledge sources will never be acceptable, and could be treated as “academic dishonesty” – see below about this subject), and you should include a record of such discussions in a bibliography.

6. Discussions and proofs should be clearly written, and mathematically correct, with individual steps explained carefully. Calculations should include all-important steps. It is your responsibility to convince me that you have proven any statements or completed any calculations in your assignment.

You will be asked in this course to devote at least some of your homework time to using

**Maple/Matlab/Excel in our Computer Lab or a TI-86.** You will then submit some of this work for grading (see below for more on the guidelines for this), and this work will constitute 10% of your grade for this course. (This assignment will be one of the four homework assignments you will turn in during this course, and will be further guided by the homework with these endeavors mostly on your own time outside of class. You may work with others in the class, but of course each of you will be required to ultimately submit your own work.
I will give you more information during the semester about what you will be required to submit, including assigned problems. The assignment will be due to me by 1:50 P.M. on Wednesday, November 24, 2004, with late submissions not accepted for grading. (If circumstances result in a time extension for the entire class, I will set a new deadline. Failure to submit your assignment by any deadline I set will result in a zero grade for this.) Statement(s) of problems(s), with computer printout(s) will be expected. You should also keep a copy of your submission for yourself when you turn in a copy to me.

**Attendance Policy**

It is expected that you will make every possible effort to attend all classes. If you do have to miss a class, you will still be held responsible for anything covered during that class. For this reason, if you do have to miss a class, you should get the notes from fellow students.

**Make-up Policy for an exam before the Final Exam**

If you miss an exam before the final exam, a make-up for that exam will only be given under extraordinary circumstances.

**Important Dates-Fall 2004**

Fall Term Begins ........................................................................................................ Monday, August 23, 2004
Last Day for Adds ........................................................................................................ Thursday, September 2, 2004
Last Day to Drop with Refund or

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Last Day for Withdrawing with a grade of "W" Saturday, October 23, 2004 (1200 Noon)

UNIVERSITY CLOSED - Labor Day ........................................................................... Monday, September 6, 2004
UNIVERSITY CLOSED - Veteran's Day Observed ......................................................... Thursday, November 11, 2004
UNIVERSITY CLOSED - Thanksgiving Day ................................................................. Thursday, November 25, 2004
UNIVERSITY CLOSED - Columbus Day Observed ...................................................... Friday, November 28, 2004
Thanksgiving Academic Break Ends ......................................................................... Monday, November 29, 2004 (0800)

Final Examination  Wednesday , December 8, 2004 1300 - 1530