**LINEAR ALGEBRA: APMA 3080 (Sections 1, 4, 5) Spring 2015**

**INSTRUCTOR:** Diana Morris

Office: Olsson 238F

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**LECTURES**: Section 1: MWF 10:00 - 10:50 in Olsson Hall 009

Section 4: TR 9:30 - 10.45 in Thornton E303

Section 5: MWF 9:00 - 9:50 in Thornton D223

**OFFICE HOURS**: T 11:00 - 12.00

W 8.00-9.30 **pm**

**TEXT**: Linear Algebra with Applications, First Edition, by Jeff Holt

We will be covering Chapters 1-11 as outlined in the table at the end.

**AN OVERVIEW**: The course is an introduction to the basic topic of matrix theory and linear algebra. It will be targeted to the needs of SEAS students. You will learn how to manipulate matrices, how to solve systems of linear equations; how to compute determinants, eigenvalues/eigenvectors, etc. These topics will be put on the unifying setting of vector spaces, in particular inner product spaces, and linear transformations. These abstract concepts are essential ingredients towards developing an understanding of the different situations encountered in the solution of linear systems of equations, and thus will form a major part of the course. In light of this, it is essential that you attend each lecture and come to class prepared – the pace of the course will be quick and you are expected to be familiar with the basic concepts of high-school level matrix algebra. Illustrations to Engineering and Science will be highlighted as required and time permitting.

**COURSE OBJECTIVES**: The specific course objectives are listed below.

* To understand the theory of systems of linear equations, and to know how to set up and solve a system of linear equations in matrix form
* Understand the nature of a best-possible solution (in the least-squares sense) to an unsolvable system when **b** is not in the range of **A**, and how to obtain it
* Know the basic algebraic operations on vectors and matrices and their properties, and how to compute them efficiently
* Understand the theory of abstract vector spaces, and know the archetypal examples, Euclidean spaces, spaces of matrices, and the spaces of functions (including polynomial functions, continuous functions, and integrable functions)
* Understand the concept of abstract linear transformations, and what properties to expect of them (range and kernel, rank and nullity, one-to-one or onto)
* Know how to represent (coordinatize) abstract vectors and linear transformations with respect to given bases, but understand that vectors and transformations have an existence independent of a particular representation and that it is often important to choose different representations (such as diagonal ones)
* Understand the theory of abstract inner product spaces and what properties to expect of them, as well as how to use the Gram-Schmidt process to turn any basis into an orthonormal one
* Understand how orthogonal projections provide a least-squares solution to an unsolvable system, and how they provide approximations to a given vector (often a function) by vectors from an “easier” subspace
* Understand the concepts of eigenvalue, eigenvector, and eigenspace for transformations and matrices, and how these concepts relate to diagonalization
* Understand that linear algebra is applicable to a wide variety of situations and models in physical and social sciences, and be able to adapt the tools learned in this course to any situation that arises

**FORMAT**: **The five sections of this course taught by two different instructors will be coordinated, with two common midterms and the final exam.** TAs will be available for help at the Applied Math Workshop/Help Center at times to be announced; we have two or three TAs for the three APMA3080 sections so students should feel free to visit either of the TAs at the Workshop.

**HOMEWORK:**

Homework will be assigned every week, and it will be completed by each **Wednesday**. It will consist of Webwork problems that will be completed by midnight and automatically graded online, as well as problems taken from the course textbook. The latter will be placed in a box outside my office for grading by 6:00 pm. The reading assignments for the entire semester are listed in the attached syllabus, which will be updated regularly on the course website as required. Please submit your homework in a neat and legible form, just remember: you want to have it graded! Late homework will not be accepted. Homework assignments are not pledged. Since the purpose of the homework is to gain a better understanding of the material, students may discuss the homework problems with each other and may receive help from others, but must write up their homework solutions on their own.

Copying another student’s homework is a violation of academic integrity.

For written homework, we drop the lowest score, and this covers all reasons.

For WeBWorK, we count all of the problems as one big assignment, and drop the 5 lowest problems, counting the rest.

**QUIZZES**: Every two weeks or so, we will have a 25 minute quiz. Before each exam, we will have a longer quiz, called a "Practice Test". This will count as a regular quiz, but will cover more material and will be done in groups. One quiz will be dropped, however there are **no make up quizzes**.

**MID-TERMS**: There will be two 2-hr tests scheduled outside of the class hours and a final examination. Dates of the two mid-terms are as follows:

**Mid-term #1: Thursday, February 26th 2015 (7:00 - 9:00 pm)** Gilmer 130

**Mid-term #2: Thursday, April 9th, 2015 (7:00 - 9:00 pm)** Gilmer 130

There will be *no make-up tests*, unless truly exceptional circumstances arise which need to be duly documented to the instructor’s satisfaction as soon as possible.

*Leaving early for spring break or end of the semester is NOT a reason for a make-up!* Grades on tests/quizzes are final after one week.

**FINAL EXAM**: The Final Exam will be given on Thursday, **April 30th, 2015, 7–10pm, room TBA**. The Final Exam is comprehensive. Early examinations are NOT permitted (UVa policy, no exceptions).

Calculators are NOT allowed during any tests/exams.

**COURSE GRADE**: The final grade for the course will be based on the four course components given in the table below.

|  |  |
| --- | --- |
| **Component** | **Points** |
| Homework and Webwork | 20 |
| Quizzes | 10 |
| Midterms (2) | 40 |
| Final Exam | 30 |
| **TOTAL SCORE** | **100** |

**This course covers a lot of ground and it is essential that you keep pace. We will not have time to cover all the material in lectures, or to work all examples or problems. Read the material and try to work the homework problems BEFORE CLASS, so you know what material is causing you difficulties and can ask questions during class. Make sure you have clearly understood all definitions and concepts covered (for these may appear on a test). Do not work with your laptop during class time.**

For weekly *planned* syllabus see following table:

|  |  |  |  |
| --- | --- | --- | --- |
| Week | Text sections | | |
|  |  | | |
| Week # 1  Jan 12 – Jan16 | 1.1: Lines and linear equations  1.2: Linear systems and matrices  1.4: Applications of linear systems (time permitting) | | |
| Week # 2  Jan 20 - Jan23 | 2.1: Vectors  2.2: Span  (2.3: Linear independence) | **Quiz # 1**  **on Thursday / Friday** | |
| Week # 3  Jan 26 – Jan30 | 2.3: Linear independence  3.1: Linear transformations  3.2: Matrix Algebra |  | |
| Week # 4  Feb2- Feb6 | 3.3: Inverses  3.4: LU factorization  3.5: Markov chains | **Quiz # 2**  **on Thursday / Friday** | |
| Week # 5  Feb9 – Feb13 | 4.1: Introduction to subspaces  4.2: Basis and dimension |  | |
| Week # 6  Feb16 – Feb20 | 4.3: Row and column spaces  5.1: The determinant function  5.2: Properties of the determinant |  | |
| Week # 7  Feb23 – Feb27 | 5.3: Applications of the determinant  6.1: Eigenvalues and eigenvectors | **Practice Test on Mon / Tues**  **1st Midterm on Th, Feb26** | |
| Week # 8  March2 – March6 | 6.3: Change of basis  6.4: Diagonalization |  | |
|  | SPRING BREAK |  | |
| Week # 10  March 16 – March20 | 7.1: Vector spaces and subspaces  7.2: Span and linear independence  7.3: Basis and dimension | **Quiz # 4**  **on Thursday / Friday** | |
| Week # 11  March23 – March27 | 8.1: Dot products and orthogonal sets  8.2: Projection and the Gram-Schmidt  Process |  | |
| Week # 12  March30 – Apr3 | 8.3: Diagonalizing symmetric matrices  (8.4: The singular value decomposition, time permitting) |  | |
| Week # 13  Apr6 – Apr10 | 8.5: Least squares regression  9.1: Definition and properties of linear  transformations  9.2: Isomorphisms | | **Practice Test on Mon / Tues**  **2nd Midterm on Th, Apr 9** |
| Week # 13  Apr13 – Apr17 | 9.3: The matrix of a linear transformation  10.1: Inner products | |  |
| Week # 14  Apr20 – Apr24 | 10.2: The Gram-Schmidt process revisited  10.3: Applications of inner products  11.1: Quadratic forms | | **Quiz # 6**  **On Thursday / Friday** |
| Week # 15  Apr27 | Course review |  | |
| **Apr 30, 2015**  **7-10pm** | Final, **no early exams allowed** (UVa policy)  **Check for exam conflicts early!** | | |  |