

Program Cover Sheet --- MAT 205: Linear Algebra

I. Basic Course Information

MAT 205: Linear Algebra is a primarily sophomore level course. It will have two 80-minute meeting periods each week and an addition one-hour third period for a computer lab. The prerequisite for the course is MAT 128 or MAT 200 or CSC 270.

Linear Algebra studies the solution of linear equations in many variables, a subject which naturally arises throughout the science, engineering, and social science disciplines. Due to its widespread uses, Linear Algebra is a fundamental mathematics course. In addition, Linear Algebra is a bridge course that connects the single-variable courses in algebra in the high school curriculum (Algebra I, II) with more advanced applied courses such as Differential Equations and Numerical Methods as well as the Abstract Algebra course that forms the foundation of algebra in modern mathematics.

II. Learning Goals

MAT 205: Linear Algebra has three primary learning goals. The first goal is to give students a solid foundation in linear algebra for future courses. Linear Algebra is a fundamental course in the mathematics curriculum due to its many applications. The course will provide an overview of the topics in the traditional introductory linear algebra course. Students will be exposed to the computational and abstract aspects of the subject and will see numerous applications of it. Material learned in Linear Algebra is critical for students going on to take courses such as MAT 305: Abstract Algebra or MAT 326: Differential Equations.

The second primary learning goal of Linear Algebra is the continuing development of a student's mathematical maturity. Abstract thinking, logical reasoning skills, the ability to read and write mathematics, and the ability to do proofs are all skills that need to be developed in a successful mathematics major. All mathematics courses work on these skills, but the course sequence of MAT 200 and MAT 205 has been devised by the department as a sequential series of courses in which these skills will be emphasized and developed in order to prepare students for the more advanced reasoning and communication skills expected of them in the required major courses of Abstract Algebra, Real Analysis, and Complex Analysis.

Linear Algebra's third main goal is to develop students' skills with working with technological tools. The third weekly meeting period of Linear Algebra is a computer lab and is the first course in the mathematics sequence where students will be required to work with computer software packages. In this lab, students will use packages such as MATLAB (a linear algebra software package) as well as locally developed software and computer applets to help visualize the material they have learned and apply the theory to applications. The use of a computer enables students to tackle more difficult, but more realistic, problems than otherwise possible.

III. Student Assessment

Students will receive regular feedback on their work through the assignment of homework, quizzes, student presentations and examinations. Through this feedback, students will be able to see and correct their misunderstandings and improve their performance. Student performance on these assessment instruments and the performance of students in their future courses such as Abstract Algebra and Differential Equations will be used to assess the success of Linear Algebra in achieving its learning goals and its contribution to the fulfillment of the MATA, MATT, and MATC program goals. Peer reviews and student evaluations will also be used to evaluate the course.

IV. Learning Activities

Learning activities will consist of a combination of lectures, group work, student presentations, and computer assignments. The specific choice will depend upon the individual instructor. Outside of class, students are expected to do a significant amount of individual and group homework to achieve the

learning goals. These learning activities are typical of the learning activities in the MATA, MATT, MATC programs. By giving students a multitude of ways to learn and do mathematics, the learning activities promote a deeper understanding of the concepts of linear algebra and contribute to the learning goals of the programs.

Updated 2/10/14

Departmental Course Syllabus --- MAT 205: Linear Algebra

Introduction: A typical syllabus for Linear Algebra follows this sheet. Any syllabus for Linear Algebra should include the points listed below (the required course requirement sections).

I. Basic information on course and instructor

- A. Purpose statement: The Linear Algebra course provides students with a solid foundation in linear algebra. The subject matter of the course is a cornerstone of many higher level courses in mathematics, the sciences, and engineering. Students will be exposed to both the theory and the concrete applications of linear algebra. Students will be taught to use computer software tools as an aid to solving problems. The course will also further develop a student's abstract reasoning ability, their ability to read and write mathematics, and their ability to do proofs. The course should give appropriate training for students continuing directly on to Abstract Algebra. Finally, through the use of fun, challenging problems, the course should also develop a student's problem solving ability and introduce students to the joys of mathematics.
- B. Course description: An introduction to vector spaces and systems of linear equations essential for the understanding of both pure and applied mathematics. Selected topics include: systems of linear equations, matrices, linear transformations, linear independence, determinants, vector spaces, eigenvalues and eigenvectors, and orthogonality.
- C. Course prerequisites: MAT 128 or MAT 200 or CSC 270

II. Learning goals

- A. Content goals: Students will become proficiency with many basic topics in linear algebra. Topics covered will include solving systems of linear equations, matrix algebra, determinants, Cramer's rule, vector spaces, linear transformations, linear independence, eigenvalues and eigenvectors, and orthogonality. Optional topics at the discretion of the professor include: the method of least-squares, difference equations, LU decomposition, systems of differential equations, and quadratic forms. Students should also be exposed to different methods of proof and the use of technological tools as an aid to linear algebra.
- B. Performance goals: At the completion of the course, students should demonstrate competence with linear algebra concepts. A successful linear algebra student should be able to solve a system of linear equations using several methods. They should understand the meaning of eigenvalues and eigenvectors and understand their usefulness for many applications. They should be able to recognize when a real world problem involves linear algebra and be able to translate it into a mathematical form. Students should also possess improved reasoning and proof-writing ability and should exhibit a more mature ability with proofs than would normally be expected of a student at the completion of MAT 200. In particular, they should be comfortable with proofs involving abstract concepts such as linear independence and vector subspaces.

III. Student assessment

- A. Assessment plan: Students will receive regular feedback on their work through the assignment of homework, lab homework, quizzes, student presentations and examinations. A syllabus should clearly describe the schedule for these assessment tools and how they will be used to calculate grades.
- B. Rationale: Through the use of regular feedback from homework, quizzes, student presentations and examinations, students will be able to see and correct their misunderstandings and improve their performance.
- C. Methods and criteria: We will use the assessment of homework, quizzes, student presentations, and examinations to evaluate student accomplishment of the course learning goals. These assessment tools are similar to the manner in which students will need to use their knowledge in the future of and are an appropriate way to assess the accomplishment of course learning goals.

IV. Learning activities

- A. Summary of learning activities: Learning activities will consist of a combination of lectures, group work, student presentations, and computer assignments. The specific choice will depend upon the individual instructor. Outside of class, students are expected to do a significant amount of individual and group homework to achieve the learning goals.
- B. Calendar or outline: A guide to the organization of the course, a schedule of assessment tools, and a plan for the coverage of topics should be provided to the students. Homework, quizzes, and examinations should be spaced at appropriate intervals throughout the semester. As a general rule, it is expected that each of the major topics of systems of linear equations, matrices, vector spaces, eigenvalues/eigenvectors, and orthogonality will be given equal emphasis during the course of the semester.
- C. Rationale By giving students a multitude of ways to learn and do mathematics, the learning activities promote a deeper understanding of linear algebra and contribute to the learning goals of these programs. A regular spacing of assessment tools insures that students continual regular feedback on their work.

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MATH 205: LINEAR ALGEBRA

Course Syllabus

Instructor: Prof. T. Hagedorn
Phone: x-3053, Email: hagedorn@tcnj.edu

Office: Science Complex 207
Office Hours: M: 4-5:30, Th: 1:30-3, and by
appointment.

Books: *Linear Algebra and its Application, 3rd Edition* by David Lay, *Linear Algebra Labs with Matlab, 2nd edition* by David Hill and David Zitarelli.

Course Goals: Math 205: Linear Algebra is a freshman/sophomore level course providing an introduction to many topics in linear algebra. Linear Algebra is an incredibly useful subject that finds applications throughout the sciences, social sciences and engineering, as well as mathematics. The type of subject matter will vary with the topics. We will start with some very concrete examples and concepts as Linear Algebra is very important for applications (and is a basis for the work you might see in the *Differential Equations*, *Numerical Methods*, and *Linear Programming* courses). But over the course of the semester, we will also introduce more abstract ideas. Linear Algebra is in many ways a bridge course between the algebra courses of high school and those (Math 305/306: *Abstract Algebra I, II*) of modern mathematics and it is one of the main goals of this course to develop your proficiency with abstract concepts. A related goal of the course is to improve your ability to read, write, and understand mathematical proofs, particularly when working with abstract ideas. In the beginning part of the course, we will review the basic material concerning proofs, however, it is expected that you have had some previous exposure to proofs, such as in Math 200: Principles of Mathematics.

Course Content Overview

At its most basic level, linear algebra is the study of how to solve a system of several linear equations in many unknown variables. Previously, in high school algebra courses, you have seen how to solve a system of two equations in two unknowns such as:

$$\begin{aligned}x+y&=7 \\ 2x+3y&=21\end{aligned}$$

We will begin the course by seeing how one can use similar methods to find all solutions to a system of 3 equations in 3 unknowns, a system of 5 equations in 7 unknowns, and in general, a system of n variables in m unknowns. We will then introduce the topics of matrices and determinants, which provide additional methods to solve these equations. This material should take up the first third of the semester.

The next third of the course will be devoted to introducing the concept of an abstract vector space. While linear algebra has many applications ranging from population problems in biology to computer learning in computer science, it is not always initially apparent that linear algebra can be used in a given situation. The concept of an abstract vector space tries to isolate the most important properties of a “vector space” (which we will define) so that it is easier for us to recognize when we can use linear algebra to help solve a problem.

In the final third of the course, we will introduce the topics of eigenvalues/eigenvectors and orthogonality. Both topics are computational in nature and could be introduced without having learned about abstract vector spaces. However, the abstract viewpoint developed above will allow us to have a clearer view of these topics. Both of these topics are the source of many applications to the physical world and we will end the course by working through several real-life applications.

Course and Performance Goals: The goals of the course are for you to learn linear algebra and appreciate its applications, to develop your ability to think abstractly, to develop your ability to read, write, and understand proofs, and to further develop your ability to reason logically. To assist you in accomplishing these goals, we will provide you with a number of different environments in which you can do linear algebra. You will make mistakes. Much of the material in this course will be new to you and the abstract objects in particular will take time and practice to master. The key to doing well and learning in this course is to do many exercises, to make mistakes and then to learn from them so that you do not continue making these mistakes in the future. In addition to lectures, we will have in-class individual and group work, weekly homework, computer labs, out-of-class computer graded homework and quizzes to give you ample opportunities to test and develop your knowledge.

Assessment: The course grade will be an assessment of how well you understand the material of the course. Since mastery of much of the material will take time, the course grade will be heavily weighted towards the examinations at the end of the course and will be calculated using the following formula: Final Examination 40%, First In-class Exam 10%, Second In-Class Exam 15%, Homework 15%, Computer Labs 10%, Quizzes 10%. In addition, good/poor class participation can raise/lower your course grade by up to two-thirds of a letter grade. The professor reserves the right to change or modify this formula.

Examinations will mostly consist of questions taken directly from, or based upon, material presented in-class, and problems done either in-class, on homework, or on quizzes. As a result, it is strongly encouraged that you attend every class and that you take detailed notes. Your notes should accurately represent everything done during class. In particular, all material written on the blackboard should be faithfully and legibly recorded in your notes. One particularly effective study suggestion is to develop the habit of rewriting your notes for a class before the next class. If you should need to miss a class, please ensure that you get the notes from another student in the class. There will be no attendance policy for the lectures (there will be one for the computer labs), but in the past there has been a strong correlation between regular attendance and a good grade in this course.

Homework: Weekly homework will be assigned and you will be expected to work on it in groups of two or three (turning in one copy for the whole group). The homework should represent the efforts of the group and not just one member of the group. We will form initial groups during the first week of class and change them occasionally during the course of the semester.

Computer Labs: The third meeting period each week, on Tuesday, will meet in the mathematics computer lab in Room 201 of the Science Complex. During this period, we will use the computers to enable us to work through linear algebra problems that are too unwieldy to do by hand. In this manner, we will gain additional insight into the essential concepts of linear algebra. Important: To use the computer labs, you will need to logon to the campus network. If you haven't changed it, your initial username and password are those that were assigned to you by Information Technology when you first arrived on campus. If you don't know these values, you need to get them from the help desk x-2660 before coming to the computer lab.

Computer Homework: This semester, we will experiment with using a computerized homework system developed at Temple University for Linear Algebra. The COW system (COW stands for Calculus-On-the-Web) webpage can be found at www.cow.temple.edu. Most weeks, we will have some homework problems that must be done online at the COW site. Further information will be provided in class.

Absence Policy: There will be no makeup quizzes. Makeup exams will only be given in extraordinary circumstances and only when the request has been made at least one week in advance of the exam.

Additional Help: The Office of Academic Assistance in Forcina Hall runs a mathematics help desk and has tutors in Linear Algebra. They have both drop-in sessions and scheduled sessions.

Schedule: On average, we will cover 3 sections of the text each week. The first in-class exam will be cover the material (that we cover) from Chapters 1-3 and will be given around the sixth week of class. The second in-class exam will cover most of the material from Chapters 4 and 5 and will be given around the 10th week of the course. The final examination will be cumulative.