Program Cover Document --- MAT 315: Topics in Linear Algebra

I. Basic Course Information

MAT 315: Topics in Linear Algebra will be scheduled for two lecture periods each of length 80 minutes. Mat 205: Linear Algebra is a prerequisite.

II. Learning Goals

The Topics in Linear Algebra (MAT 315) course will consist of a collection of topics that are typically not covered in the Linear Algebra (MAT 205) course but build upon the material learned in the MAT 205 course. The class will be a mix of theoretical and applied subjects, and the choice of material to be covered will depend on the background of the students in the class and on the instructor. The MAT 315 course will serve to expose students to concepts in Linear Algebra that were beyond the scope of the first Linear Algebra course.

At the end of this course we expect our students will be able to construct proofs and write proofs in a logical manner, transform physical problems into systems of equations, and analyze and compare methods of solution of systems of equations. We expect that this course will further the mathematical maturity of our majors, and illustrate connections between Linear Algebra and other areas of Mathematics, such as Algebra, Differential Equations, Graph Theory, Complex Analysis, Numerical Methods, and Real Analysis.

While the specific choice of material will be left to the individual instructor, some possible topics to be covered include: QR Factorization and Least Squares, Inner Product Spaces and Fourier Series, Spectral Theorem for Symmetric Matrices, Quadratic Forms and Constrained Optimization, Unitary and Hermitian Matrices, Positive Definite Matrices, Singular Value Decomposition and PseudoInverse, Jordan Canonical Form, Bilinear Forms, Schur's Theorem, Cayley-Hamilton Theorem, Gershgorin Theorem, Iterative Methods for Solving Linear Systems, Power Method, QR method, and applications such as Linear Programming, Markov Chains, Graphs and Networks, Systems of Differential Equations.

III. Student Assessment

Students will receive feedback on their work via homework assignments and projects, and examinations. The performance of students in future mathematics courses will be used to evaluate the success of Topics in 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.

Course Syllabus Guide -- MAT 315: Topics in Linear Algebra

Introduction: A sample syllabus for Topics in Linear Algebra follows this sheet. Any syllabus for Topics in Linear Algebra should include the points listed below (the required course requirement sections) however course content will be at the discretion of the instructor.

I. Basic information on course and instructor
   A. Purpose statement: Topics in Linear Algebra is the successor to the required Linear Algebra course, and further explores and extends topics learned in the earlier course.
   B. Course description: A second course in linear algebra covering both theoretical and applied topics in Linear Algebra.
   C. Course prerequisites: Linear Algebra.

II. Learning goals
   A. Content goals: The choice of topics covered and their emphases should be at the discretion of the instructor
   B. Performance goals: At the completion of the course, students should be able to analyze systems of equations, understand matrix theory, and recognize connections between Linear Algebra and other subjects in Mathematics that they study as part of the major. Students should have improved their ability to write and explain mathematics.

III. Student assessment
   A. Assessment plan: Students will receive regular feedback on their work through the assignment of homework and examinations. A syllabus should clearly describe the schedule for these assessment tools and how they will be used to calculate grades.
   B. Rationale: Students understand mathematics concepts by doing mathematics. Feedback on problems assigned allows students to correct mistakes and better understand the material at hand.
   C. Methods and criteria: We will use the assessment of homework and examinations to evaluate student accomplishment of the 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 and examinations should be spaced at appropriate intervals throughout the semester.
   C. Rationale: A regular spacing of assessment tools insures that students receive continual regular feedback on their work.

MAT 315
Topics in Linear Algebra

Instructor: Prof. Clark
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Email: kclark@tcnj.edu
Office Hours: Tuesdays & Fridays 10:00-11:00 and by appointment
Text: I will distribute course notes weekly. You should have a Linear Algebra textbook (preferably Lay's text from the first Linear Algebra course) on hand for reference.
I will also put several texts on reserve in the library.

This course is a successor to the MAT 205: Linear Algebra course. It is expected that all students are comfortable with the material in the first course including concepts of solving linear systems by Gaussian Elimination, Matrix Arithmetic, Determinants, Vector Spaces, Orthogonality, and Eigenvalues. This course will extend the earlier concepts to more general cases and cover topics that were beyond the scope of the first class.

Learning Goals:
It is expected that students will become familiar with a variety of techniques for solving and analyzing solutions of linear systems of equations. Here is a sample of some of the questions I expect to address during the semester:
We learned how to diagonalize matrices and about the benefits of doing so. However what if the matrix doesn't have a full linearly independent set of eigenvectors? Can we do anything similar for these matrices? What if the matrix isn't even square?
To find the eigenvalues of a matrix involves solving a polynomial equation. What techniques do we have for estimating the eigenvalues when the matrix is large, and thus the polynomial is of high degree?
What if the eigenvalues of a matrix are complex? How do we find the eigenvectors?
We learned about applications and properties of Linear Tranformations in the earlier course. What are the analogous concepts for Transformations with two "inputs"?
I expect at the end of the course that you will have improved your ability to construct proofs, transform physical problems into systems of equations, and be able to compare methods of solution of systems of equations.

Assessment and Course Requirements:
Homework = 30%
Exams = 40%
Final = 30%
1. Homework: There will be weekly homework assignments which will usually be assigned each Tuesday and will be due the following Tuesday. The homework will be posted on SOCS. These assignments will fall into two categories –

Non hand in homework: part of the assignment will consist of problems which will not be collected. Students will be required to present some of these homework problems at the board during Tuesday's class. You will be given advance notice when it is your turn to put homework on the board. If you are unable to attend class on the day that you are assigned to put up

homework, you should notify me of the absence before the start of class. If this happens more than once it will affect your grade.

Hand in homework: part of the assignment will consist of problems to be graded. You may work on these in groups of two or three people if you wish. If you do work in a group, you should acknowledge whom you worked with on the top of your homework paper. Each member of the group should hand in a copy of the assignment, and these should be written up separately (i.e. I do not want to see homework papers that are identical).

The homework assignments are due at the beginning of class. I will deduct 10 percent for each day that the homework is late, and will not accept it more than three days late. The lowest homework score will be dropped in computing the homework average at the end of the semester.

2. Exams: There will be two in-class exams. The first exam will occur during the 6^{th} week of class and the second exam will occur during the 12^{th} week of class. If you are ill and unable to attend the exam a makeup can be arranged only if you call my office or email me before the start of the exam, and if you get a doctor's note. Makeup exams will be more difficult than the original.

3. Final: There will be a cumulative final exam at the end of the semester.

4. Class participation: I will consider class participation in computing your final grade if your grade is borderline. By "class participation" I include putting homework on the board on Tuesdays.

Learning Activities:

Students are expected to keep current with the homework assignments, to review material in groups as much as possible, and to consult reserve texts from the library to supplement the course notes. The homework assignments are meant to provide a means to practice writing proofs, and to solve problems based on the material discussed in lecture. We may occasionally be using the software package MATLAB to assist in analyzing specific problems. I may periodically break the class up into groups during lecture time to work on problems to be presented to the class. As there is no set list of topics for the course I expect regular feedback from the class if you are struggling with a particular topic, are enjoying a particular topic and would like to see more of it, or have an interest related to Linear Algebra that you would like to see discussed in the course.