Program Cover Document – MAT 315: Topics in Linear Algebra

I. Basic Course Information

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.

Course prerequisites: MAT 205: Linear algebra

II. Learning Goals

At the end of this course we expect our students will be able to

1. construct proofs and write proofs in a logical manner,
2. transform physical problems into systems of equations, and
3. 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 Abstract Algebra, Differential Equations, Graph Theory, Complex Analysis, Numerical Analysis, and Real Analysis.

III. Student Assessment

Students will receive feedback on their work via written assignments, projects, and/or examinations.

IV. Learning Activities

Learning activities will consist of a combination of lectures, group work, student presentations, problem sets, and/or computer programming 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 work, as well as written homework assignments to achieve the learning goals. Students will receive detailed feedback on these assignments. The course will include multiple substantial examinations or projects, on which students will receive additional detailed feedback.

V. List of Major Course Topics

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.

Approved 5/6/2024

MAT 315 Topics in Linear Algebra **Spring 2023**

Instructor: Karen Clark

Email: KCLARK@TCNJ.EDU

Office: SCP 210

The instructor reserves the right to make changes to the syllabus as needed, in keeping with the Learning Goals and Objectives for the course.

OFFICE HOURS:

- Tuesdays & Fridays 12:45-1:45 in SCP 219
- An hour on Wednesday mornings that may be via zoom and may change each week.

Link for Zoom office hours will be posted on Canvas. Students do not need an appointment to attend regular office hours, just show up! If you would like to make an appointment to see me outside of office hours, just send me an email.

CLASS MEETINGS:

Tuesdays and Fridays from 9:30-10:50, in room SCP 219.

COURSE DESCRIPTION: This course consists of a collection of topics not covered in MAT 205 and builds upon the material covered in MAT 205. Such topics may include the Spectral Theorem of Symmetric Matrices, Quadratic Forms, Unitary and Hermitian Matrices, Jordan Canonical Forms, Schur's Theorem, Application to Linear Programming and Markov Chains. 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. The prerequisite is MAT 205. One course unit.

The course will include a fourth hour which will be used to work on problem sets and labs related to the course content, using Matlab or Mathematica.

COURSE MATERIALS: I will post class notes on Canvas. These notes are not to be shared with anyone who is not in the class. Students will be required to use Matlab or Mathematica for homework assignments. Matlab and Mathematica are available from any College campus computer and you may download both onto your personal computer. I have posted links to open source linear algebra texts on Canvas, for reference.

You will need to use MATLAB for assignments. To download MATLAB onto your personal computer you need to go to https://software.tcnj.edu/ , log in and follow the instructions. **The download is free for TCNJ students.** You may also use Matlab online (for free) by setting up an account at https://matlab.mathworks.com/ using your TCNJ email. If you have any difficulty accessing Matlab please let me know as early in the semester as possible.

I will be using Canvas to send weekly course announcements, post links to WebAssign homework, resources for exams, and course assignment deadlines. Students should be checking Canvas for updates frequently.

COURSE REQUIREMENTS:

Homework:

Homework will be assigned periodically throughout the semester. You may work on these assignments 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 write up the assignment independently - I do not want to see homework papers that are identical. All work must be shown in order to receive credit for each problem. **I will assume that you will not be using any outside sources, including those available on the internet, in solving homework problems. All work you turn in must be your own.** I will deduct 10 percent for each day that the homework is late.

Exams: There will be three in-class exams. The tentative dates for these exams are:

- Tuesday February 21,
- Friday March 24,
- Friday April 28.

If you are ill and unable to attend the exam you must contact me before the start of the exam. Old exams with solutions will be posted on Canvas for practice, but you should not expect your exam to look identical to what is posted there.

Final: There will be a cumulative final exam at the end of the semester. Final exams are scheduled for May 9-16.

COURSE PURPOSE & LEARNING GOALS:

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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.

COURSE SCHEDULE:
Midterm progress reports are due on Tuesday March 20 and the last day to withdraw from a class is Monday March 27.
We will not have class on Tuesday April 25 as the Celebration of Student Achievement will be held on that day.
Spring Break will be March 14-17.

GRADING:
Homework= 25%
Exams = 50% (highest two exams = 20% each, lowest exam = 10%)
Final = 25%

The lowest test grade will count for 10% of the final grade, with the remaining two test grades counting for 20% each.

Grades will be calculated as below: round as usual

Letter grade	A	A-	B+	B	B-	C+	C	C-	D+	D	F
Percentage	93-100%	90-92%	87-89%	83-86%	80-82%	77-79%	73-76%	70-72%	67-69%	63-66%	< 63%

COMMITMENT TO DIVERSITY, EQUITY, INCLUSION, ACCESS AND BELONGING:
The TCNJ community is composed of people with diverse backgrounds, perspectives, and experiences, and the college is committed to diversity, equity, inclusion, access and belonging. The college's Campus Diversity Statement can be viewed here:
https://diversity.tcnj.edu/campus-diversity-statement/

CLASSROOM ENVIRONMENT AND COMMITMENT TO STUDENT SUCCESS, SAFETY AND WELL-BEING:
The TCNJ community is dedicated to the success, safety and well-being of each student. TCNJ strictly follows key policies that govern all TCNJ community members rights and responsibilities in and out of the classroom. In addition, TCNJ has established several student support offices that can provide the support and resources to help students achieve their personal and professional goals and to promote health and well-being. You can find more information about

these policies and resources at the "TCNJ Student Support Resources and Classroom Policies" webpage here: https://academicaffairs.tcnj.edu/tcnj-syllabus-resources/

Students who anticipate and/or experience barriers in this course are encouraged to contact the instructor as early in the semester as possible. The Accessibility Resource Center (ARC) is available to facilitate the removal of barriers and to ensure reasonable accommodations. For more information about ARC, please visit: https://arc.tcnj.edu/

ADDITIONAL INFORMATION:
If you feel like your performance in the class is being impacted by your experiences outside of class, please don't hesitate to come and talk with me. Email is a good way to reach me, and students are always able to make an appointment to speak to me.

Email: I might periodically send messages to the class so you should get in the habit of checking your email at least daily. I will respond to email sent to me within 24 hours, and within 48 hours on weekends.

Canvas: I will post information using Canvas announcements frequently. Please make sure you have changed your Canvas settings if necessary to make sure you receive announcements I post.

Weather: If there is any kind of weather event, make sure to check the college webpage and your email before heading to class. At times the college may be open but I may not be able to get to campus. In this event I will send an email to the class. I encourage students to make sure they are signed up for TCNJ Emergency Alerts: Instructions for doing so are located at https://emergency.tcnj.edu/tcnj-alerts/

Cell phones: Please make sure they are turned off during class. Texting is absolutely forbidden during class. If I observe students texting in class it will affect the final course grade.

Background: Students need to be very comfortable with the content of chapters 1-4 in the Lay text that is used for MAT 205. I have posted some optional review problems, and resources for background material, and I encourage all students to complete them at the beginning of the semester.

Course Topics:
We will discuss a subset of the topics below (not necessarily in this order):

Symmetric matrices, orthogonal matrices, and orthogonal diagonalization
Quadratic forms and optimization
Singular value decomposition and Pseudoinverse
Gram Schmidt and the QR decomposition
Least Squares

LU factorization
Jordan Canonical Form
Power method
Inner Product Spaces and Fourier Series
Matrix Norms, condition number
Pivoting Strategies
Gauss Seidel and Jacobi methods
Systems of Differential Equations
Markov Chains and the PageRank Algorithm