Math 3013.25578 - Linear Algebra

Syllabus - Spring 2022

Instructor: Dr. Birne Binegar
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Lectures: M,W,F 11:30am–12:20pm CDT, MSCS 445
This course will be conducted primarily through face-to-face lectures. Students are expected to attend and participate in each class meeting. However, initially, lectures will be streamed live and recorded. Throughout excused absences will be readily accommodated.
Zoom Meeting ID: 943 1918 0577 (streamed concurrent with regular class meetings)

Office Hours: Mondays and Wednesdays: 2:00pm – 3:00pm CDT via Zoom
Zoom Meeting ID: 942 5647 4563 (no passcode necessary)
The instructor can also be reached via phone or email. Just use the contact information given at the top.

Homework: Homework assignments will be carried out via WebAssign. These assignments and their due dates will be listed on Canvas. However, students will have to log in to WebAssign at

https://www.webassign.net

to complete their assignments.
Use the class key

okstate 2920 1911

to set up your WebAssign account.

Exams: There will be two midterm exams and a final exam. The final exam will be conducted at time prescribed in the Spring 2022 Schedule of Classes which is

Monday, May 2, 10:00 - 11:50 am CDT

Grades: The final grades will be determined from homework, midterm, and final exam scores as follows:

Homework	50 possible pts.
Midterm 1	100 possible pts
Midterm 2	100 possible pts
Final Exam	150 possible pts.
	400 possible pts.

Final letter grades will be assigned as follows:

A:	360	-	400 pts.
B:	320	-	359 pts.
C:	280	-	319 pts.
D:	240	-	279 pts.
F:	0	-	239 pts.

Additional Notes

(1) Due to the ongoing Covid-19 pandemic, it is requested (but not mandated) that students wear masks while in class. If you feel ill, please do not attend class.
(2) If you are hesitant to attend face-to-face class meetings because of ongoing pandemic, please contact Dr. Binegar so that appropriate accommodations can be arranged Contacting Dr. Binegar early will be especially important if you need accomodations for the course's in-class exams.
(3) Please make sure that, in the settings page of your Canvas account, you have opted to receive all class announcements immediately via email. Otherwise, you may miss some important announcements.
(4) Please see the Spring 2022 Syllabus Attachment on Canvas for an overview of the general university rules and regulations for the Spring 2022 semester.
(5) **Academic Integrity**: Simply put, do not cheat. Do not copy off of other students, allow other students to copy your work, or present work you find in printed or electronic sources as your own. You may get help on homework from other people or sources such as the MLSC tutors, but you should write your solutions independently without looking at anything someone else has produced. Having cell phones or other prohibited devices out during a quiz or exam is an academic integrity violation regardless of what you are doing with the device. If you need to access your device during an assessment for some reason, please clear it with me first.

    In particular, you are not allowed to use Chegg or other similar services in this class. Use of Chegg or similar services on homework, classwork, quizzes, exams, or any other activity is an academic integrity violation in this class. These services do a poor job of facilitating learning and are frequently simply a source of (often incorrect) solutions that students copy without understanding. By "similar services," I mean any website, app, or other service that allows access to solutions to textbook exercises and/or user-submitted exercises.

    For questions about academic integrity, contact the Office of Academic Affairs, 101 Whitehurst, (405) 744-5627,
    https://academicintegrity.okstate.edu.

Math 3013 Course Outline

Lecture 1: Vectors and Vector Spaces

- Three ways of thinking about vectors
- Fundamental Vector Operations
  - Vector Addition
  - Scalar Multiplication
- Additional Vector Operations
  - Vector Subtraction
  - The Dot Product and the Geometry
    - The Length of a Vector
    - The Angle Between Two Vectors

Lecture 2: Vector Space Geometry

- Linear Combinations
- The Span of a Set of Vectors
- Lines, Planes and Hyperplanes

Lecture 3: Matrices

- Motivation: Systems of Linear Equations
- Matrix Multiplication
- The Identity Matrix

Lecture 4: Matrix Algebra

- Addition of Matrices
- Scalar Multiplication of Matrices
- The Transpose of a Matrix

Lecture 5: Solving Systems of Linear Equations

- Geometric Form of Solution Sets
- The Substitution Method
- Manipulating Equations instead of Variables
  - Elementary Operations on Equations
- Augmented Matrices and Elementary Row Operations
- Gauss-Jordan Method
  - Row Echelon Form
  - Reduced Row Echelon Form
  - Row Reduction
  - From Augmented Matrix of Solution to Solution as a Hyperplane

Lecture 6: Inverses of Square Matrices

- Definition of Matrix Inverse
- Properties of Matrix Inverses
- Elementary Matrices
- Calculation of Matrix Inverses
- The Fundamental Theorem of Invertible Matrices

Lecture 7: Review for First Midterm Exam

First Midterm Examination

Lecture 8: Subspaces, Bases, and Linear Independence

- Closure under Scalar Multiplication
- Closure under Vector Addition
- Definition of Subspace
- Two Basic Prototypes of Subspaces
  - the Span of a Set of Vectors
  - the Solution Set of a Homogeneous Linear System
- Subspaces Associated to a Matrix
- Bases
- Linear Independence

Lecture 9: Construction of Bases, Dimension, and Rank

- Construction of Bases
  - Basis for Solution Set of a Homogeneous Linear System
  - Basis for the Span of A Set of Vectors
- The Dimension of a Subspace
- Finding Bases for Row Space, Column Space and Row Space of a Matrix
- The Rank of a Matrix

Lecture 10: Linear Transformations

- Functions between Sets
- Definition of a Linear Transformation
- Linear Transformations and Matrices
- Subspaces Associated to Linear Transformations
- Composition of Linear Transformations

Lecture 11: Review for Second Midterm Exam

Second Midterm Examation

Lecture 12: Determinants

- Determinants of 2×2 Matrices
- Matrix Minors
- Cofactors
- Cofactor Expansions and Determinants of Square Matrices
- Computing Determinants via Row Reduction
- Properties of Determinants

Lecture 13: Eigenvalues and Eigenvectors

- The Eigenvector/Eigenvalue Problem
- The Characteristic Polynomial and Computing Eigenvalues
- Finding Eigenvectors
- Algebraic and Geometric Multiplicities of Eigenvalues

Lecture 14: Diagonalization of Matrices

- Definition and Properties of Diagonal Matrices
- Criteria for Diagonalizability
- Application: Inertia Tensors
- Application: Systems of Linear ODEs

Lecture 15: Coordinatization and Change of Basis

- The Standard Basis for $\mathbb{R}^n$
- Alternative Coordinates
- Change of Basis

Lecture 16: Orthogonality

- Projection of A Vector onto Another Vector
- Projection onto Subspaces

Lecture 17: The Gram-Schmidt Algorithm

- Orthogonal and Orthonormal Bases
- The Gram-Schmidt Algorithm

Lecture 18: Abstract Vector Spaces and Concrete Examples

- Axioms of an Abstract Vector Space
- Examples of General Vector Spaces
- Vector Space Isomorphisms
- Finite Dimensional Vector Spaces

Final Exam