SYLLABUS

Code: **MATH 285** **Title**: **LINEAR ALGEBRA**

Institute: STEM **Department: MATHEMATICS**

Course Description: This is an introductory course in concepts and applications of linear algebra. Topics include solutions of systems of linear equations using matrices and determinants, vector spaces, linear transformations, eigenvalues and eigenvectors, and the problem of diagonalizing a square matrix. Applications, including Markov chains, the least squares fit problem, and polynomial interpolation, are included throughout the course. Problems are approached from a variety of perspectives, including graphical, numerical, verbal, and algebraic through the use of computer software in class.

Section Information: All tests will be proctored in person.

Prerequisites: A grade of C or higher in MATH 172.

Credits: 3 **Lecture Hours:** 3 **Lab:** 0

REQUIRED TEXTBOOK/MATERIALS:

Textbook: Lyryx Learning, an open text based on the original text by K. Kutler, A First Course in Linear Algebra, Version 2017, Revision A, an Open Text (Creative Common License CCBY).

Recommended Materials:

Computer software: – Maple is used in this course. Your instructor will provide options for accessing Maple.

Note: In compliance with copyright law, the Mathematics Department cannot give students copies of software. Unauthorized copying and /or distributing of software owned by Brookdale Community College is **illegal**.

Graphing Calculator: – If you are purchasing a new calculator, the TI-83 (any version) or TI-84 (any version) will be sufficient. The TI-89 has more advanced capabilities, and its use is not allowed on tests and quizzes. If you are considering buying one of these, talk to your instructor first.

Additional Time Requirements:

- In addition to the regular class hours, you will need to set aside time each week for homework. The weekly time will vary by topic and level of difficulty, but as an estimate, you should expect two homework hours for *each* class hour per week. For example, if your class meets for three hours per week, you should expect to spend about ***six*** hours per week on homework.
- You may need to allow time on campus to do homework problems that require the use of computer software.
- If you are having any difficulty with the course material, you may need to allow time to see your instructor during office hours or to get help in the Math Lab.

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COURSE LEARNING OUTCOMES:
Upon completion of this course, students will be able to:

- Demonstrate the mathematical skills appropriate to this course. (M)
- Prove properties and theorems. (M)
- Use computer software to understand concepts and to explore and solve problems. (M)

Learning Outcome(s) support the following General Education Knowledge Areas:

- (M) Mathematics

GRADING STANDARD: In this course, you will be evaluated by means of tests and quizzes and possibly homework and projects.

A. TESTS

There will be three tests, one after each unit. All supporting work must be shown on tests in order for your instructor to properly assess your understanding of the material. The tests will be given in class and it is expected that you will be in class to take the test on the day it is given. If you are very ill (verifiable with a doctor's note) or you have some other emergency, you *must* contact your instructor immediately.

Note: All tests will be proctored in person, see Instructor Addendum for more information.

B. QUIZZES/HOMEWORK

There will be periodic quizzes and your instructor may also choose to use certain homework assignments for evaluation.

C. PROJECTS

There may be a project assigned for each unit of the course, to be done in groups outside of class. In the projects, you will apply the concepts and skills learned in class to a problem situation, present the mathematics, write careful explanations, and interpret your results. Specific guidelines for the projects will be handed out with Project 1.

GRADING

Each test is graded on the basis of 100 points and is worth between 25% and 30% of your grade. Quizzes (and possibly homework and projects) result in a combined grade worth between 15% and 25% of your grade. Your instructor's addendum will state the exact percentages.

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FINAL GRADE

Your final grade is determined as follows:

If your final course average is	Your final grade is
90 – 100	A
88 – 89	A-
86 – 87	B+
80 – 85	B
78 – 79	B-
76 – 77	C+
70 – 75	C
60 – 69	D**
Below 60	F

** To use this course as a prerequisite for another mathematics course, you must have a grade of C or better.

Incomplete

INC is only given at the discretion of your instructor. This may occur in documented cases of hardship or emergency. In this case, you must meet with the instructor to discuss the work that must be completed to earn a grade in the course. All work must be completed within 21 days after the end of the term, exclusive of official college closings.

Withdrawal

You may withdraw from the course, without penalty, up to a date set by the College. If you do not withdraw from the course but stop attending, your grade at the end of the semester will be F.

COURSE CONTENT: (TEXT SECTION)

Unit 1: In this unit, you will solve systems of linear equations using a variety of techniques including Gaussian elimination, Gauss-Jordan elimination, inverse matrices, and determinants. You will use computer software to assist in this process. You will begin to study matrices as algebraic objects and perform proofs of certain matrix properties.

Unit 1 Outcomes: You will:

- Distinguish between linear and non-linear systems of equations. (1.1)
- Determine whether systems are consistent or inconsistent. (1.1)
- Solve linear systems graphically and symbolically. (1.2)
- Use elementary row operations to solve linear systems. (1.2)
- Represent linear systems with augmented matrices. (1.2)
- Solve linear systems with Gaussian and Gauss-Jordan Elimination. (1.2)
- Use the row-reduced matrix to interpret the nature of the solutions. (1.2)
- Distinguish between homogeneous and non-homogeneous systems. (1.2)
- Find traces and linear combinations of matrices. (1.2)
- Use the Ax = b form of a linear system. (1.2)
- Perform matrix addition, scalar multiplication, and matrix multiplication. (2.1)

- Represent matrices in three different ways. (2.1)
- Use computer software to perform matrix operations. (2.1)
- Use properties of matrix operations in proofs. (2.1)
- Solve matrix equations. (2.1)
- Find the transpose of a matrix. (2.1)
- Determine if matrices are symmetric. (2.1)
- Find the inverse of a matrix. (2.1)
- Use computer software to find transposes and inverses of matrices. (2.1)
- Prove properties of inverse matrices. (2.1)
- Use inverses to solve linear systems. (2.1)
- Evaluate determinants of *n* x *n* matrices using cofactor expansion. (3.1)
- Evaluate determinants using elementary row operations. (3.1)
- Use properties to evaluate determinants. (3.1)
- Use computer software to evaluate determinants. (3.1)
- Write a polynomial function from a set of points. (3.2)
- Use determinants with Cramer's Rule (3.2)
- Use determinants to find the area of a triangle and to test for collinear points. (3.2)
- Test solutions of linear homogeneous differential equations for linear independence. (3.2)
- Find the Wronskian of a set of functions. (3.2)

Unit 2: In this unit, you will make calculations and perform proofs related to vectors and vector spaces. You will find linear combinations, dot products, magnitudes, and orthogonal projections of vectors. You will find spanning sets, bases, and the dimension of vector spaces.

Unit 2 Outcomes: You will:

- Perform vector addition and scalar multiplication. (4.1)
- Prove properties of vector addition and scalar multiplication. (4.2)
- Find a linear combination of vectors. (4.2)
- Define a vector space. (9.1)
- Prove that a set of vectors with given operations is a vector space. (9.1)
- Give examples of sets with operations that are/are not vector spaces. (9.1)
- Define a subspace of a vector space (4.10, 9.2)
- Determine if subsets are subspaces (4.10, 9.2)
- Define a spanning set of vectors (4.10, 9.2)
- Find the span of a set of vectors. (4.10, 9.2)
- Test a set of vectors for linear independence. (4.10)
- Find standard and non-standard bases of a vector space. (4.10)
- Find the dimension of a vector space. (4.10)
- Determine if a set of vectors forms a basis for a vector space. (4.10)
- Use computer software to determine if a set of vectors forms a basis for a vector space. (4.10)
- Find the coordinates and coordinate matrix of a vector. (4.7)
- Find transition matrices. (4.7)
- Use computer software to find transition matrices. (4.7)
- Find magnitudes, dot products, and angles between vectors. (4.7)
- Define an inner product space. (Appendix)
- Find the orthogonal projection of a vector. (4.7)
- Use the Gram-Schmidt Process to find an orthonormal basis. (4.11)
- Use computer software and the Gram-Schmidt Process to find an orthonormal basis. (4.11)

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Unit 3: In this unit, you will make calculations and perform proofs related to linear transformations. You will use matrices to represent linear transformations, and you will use your knowledge of matrices and vector spaces in working with linear transformations.

Unit 3 Outcomes: You will:
- Define a linear transformation (5.1)
- Prove properties of linear transformations. (5.1)
- Determine whether or not a function is a linear transformation. (5.1)
- Use a linear transformation to find the image and preimage of a vector. (5.2)
- Find the inverse of a linear transformation. (5.3)
- Find the standard matrix for a linear transformation. (5.4)
- Determine if linear transformations are one-to-one and onto. (5.5)
- Define an isomorphism. (5.6)
- Identify isomorphic vector spaces. (5.6)
- Use computer software to find the inverse of a linear transformation. (5.6)
- Prove that the composition of linear transformations is a linear transformation. (5.6)
- Find the kernel and the basis for the kernel of a linear transformation. (5.7)
- Find a basis for the range of a linear transformation. (5.7)
- Find the rank and nullity of a linear transformation. (5.7)
- Find the eigenvalues and eigenvectors of matrices and linear transformations. (7.1)
- Use determinants to find eigenvalues. (7.1)
- Diagonalize a matrix. (7.2)

DEPARTMENT POLICIES:

The Math Department wants you to be successful in this course. Because of this, we have compiled a list of strategies and behaviors.

Attendance and class participation
- If you want to be successful in this course, attend every class.
- Come to class on time, and stay for the entire class period. If you are late or leave during class, you will miss important class material and you will also distract your classmates and your instructor. (See the Student Conduct Code)
- Turn off your cell phone during class. You and your classmates need to be free from distractions. (See the Student Conduct Code)
- Bring your book and calculator to every class.
- Respect your classmates and your instructor. Listen carefully to questions asked and answers given. Treat all questions with respect.
- Participate fully in class. Volunteer answers, work problems, take careful notes, and engage in discussions about the material. Use computers only for designated work. Above all, stay on task.
- Contribute your share to your in-class group work and your projects (if assigned) and do your best to make the group experience a positive one for all members.
- Do your own work on tests and quizzes. Cheating will not be tolerated. (See the Academic Integrity Code.)

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Homework

- Homework is the way you practice the ideas and skills that are introduced in class. To be successful on the tests, you must do the homework. Homework may be collected and homework questions may be included on quizzes or tests.
- When you do the homework, write down all supporting work. Using the correct process is at least as important as getting the correct answer, so your work and steps are very important.
- Remember to check your answers. They will be in the back of the text or in the student's solutions manual.
- If there are questions you can't get or don't understand, ask about them at the beginning of the next class. If you have trouble with more than a few problems, try starting your homework in the Math Lab, where help is available.

Absence

- If you are sick and an absence is unavoidable, please call or email your instructor. You are still expected to read the course material and to try to do the homework.
- Make time to see your instructor when you return so that you can get any papers you missed.
- Remember that you are expected to be in class for the tests and quizzes.

Getting Help

After you have tried the homework, there are ways to get help:

- Look in your text and your class notes for examples similar to the problems you are finding difficult.
- See your instructor during office hours or make an appointment. Bring the work you have done.
- Go to the **Math Lab** to get extra help on your homework or simply go and do your homework there. Someone will be there if you get stuck. You don't need an appointment to use the Math Lab.
- Form a **study group** with other class members. Working with other students can be a great way to learn. If you have a group to work with, consider meeting and working together in the Math Lab.
- Your textbook may have a complete solutions manual available in the Math Lab, which can be used in the Math Lab.
- You can use the computers in the computer lab within the Math Lab to do work related to your math course.
- In the Math Lab, you can get help on how to use your calculator.

Visit the **Math Lab website** to view hours and other useful information about the Math Lab.

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COLLEGE POLICIES:

As an academic institution, Brookdale facilitates the free exchange of ideas, upholds the virtues of civil discourse, and honors diverse perspectives informed by credible sources. Our College values all students and strives for inclusion and safety regardless of a student's disability, age, sex, gender identity, sexual orientation, race, ethnicity, country of origin, immigration status, religious affiliation, political orientation, socioeconomic standing, and veteran status. For additional information, support services, and engagement opportunities, please visit www.brookdalecc.edu/support.

For information regarding:

- Brookdale's Academic Integrity Code
- Student Conduct Code
- Student Grade Appeal Process

Please refer to the **BCC STUDENT HANDBOOK AND BCC CATALOG.**

NOTIFICATION FOR STUDENTS WITH DISABILITIES:

Brookdale Community College offers reasonable accommodations and/or services to persons with disabilities. Students with disabilities who wish to self-identify must contact the Disabilities Services Office at 732-224-2730 (voice) or 732-842-4211 (TTY) to provide appropriate documentation of the disability, and request specific accommodations or services. If a student qualifies, reasonable accommodations and/or services, which are appropriate for the college level and are recommended in the documentation, can be approved.

MENTAL HEALTH:

- Mental Health Crisis Support: From a campus phone, dial 5555 or 732-224-2329 from an external line; off-hours calls will be forwarded to BCC police (2222 from a campus phone)
- Psychological Counseling Services: 732-224-2986 (to schedule an appointment during regular hours)

The syllabus is intended to give student guidance in what may be covered during the semester and will be followed as closely as possible. However, the faculty member reserves the right to modify, supplement, and make changes as the need arises.