ESSEX COUNTY COLLEGE
Mathematics and Physics Division
MTH 239 – Introduction to Linear Algebra
Course Outline

Course Number & Name: MTH 239 Introduction to Linear Algebra

Credit Hours: 3.0 **Contact Hours:** 3.0 **Lecture:** 3.0 **Lab:** N/A **Other:** N/A

Prerequisites: Grade of "C" or better in MTH121 or placement

Co-requisites: None

Instructor: TBA

Email: TBA

Office Hours: By appointment

Course Description: This course is an introduction to the theory and applications of linear operatorson finite dimensional vector spaces. Topics include linear systems, matrix algebra, Euclidean and general vector spaces, subspaces, change of basis and similarity, the eigenvalue problem, projections, orthogonality and least squares, inner product spaces and quadratic forms.

Textbook: *Linear Algebra & Its Applications*, 3rd edition, by David Lay; published by Pearson, Addison Wesley; ISBN #: 0321287134

General Education Goals: Upon successful completion of this course, students should be able to do the following:

1. **Written and Oral Communication**: Students will communicate effectively in both speech and writing.
2. **Quantitative Knowledge and Skills**: Students will use appropriate mathematical and statistical concepts and operations to interpret data and to solve problems.
3. **Scientific Knowledge and Reasoning**: Students will use the scientific method of inquiry through the acquisition of scientific knowledge.
4. **Technological Competency/Information Literacy**: Students will use computer systems or other appropriate forms of technology to achieve educational and personal goals.

5. **Society and Human Behavior**: Students will use social science theories and concepts to analyze human behavior and social and political institutions and to act as responsible citizens.
6. **Humanistic Perspective**: Students will analyze works in the field of art, music, or theater; literature; and philosophy and/or religious studies; and will gain competence in the use of a foreign language.
7. **Historical Perspective**: Students will understand historical events and movements in World, Western, non---Western, or American societies and assess their subsequent significance.
8. **Global and Cultural Awareness of Diversity**: Students will understand the importance of global perspective and culturally diverse peoples.
9. **Ethics**: Students will understand ethical issues and situations.

Course Goals: Upon successful completion of this course, students should be able to do the following:

1. Demonstrate knowledge of the fundamental concepts and theories from linear algebra; (GEG 2)
2. Utilize various problem---solving and critical---thinking techniques to set up and solve applied problems in engineering, sciences, business and technology fields; (GEG 2)
3. Communicate accurate mathematical terminology and notation in written and/or oral form in order to explain strategies to solve problems as well as to interpret found solutions; (GEG 1, GEG 2)
4. Use appropriate technology, such as graphing calculators and computer software, effectively as a tool to solve such problems as those described above. (GEG 2)

Measurable Course Performance Objectives (MPOs): Upon successful completion of this course, students should specifically be able to do the following:

1. Demonstrate knowledge of the fundamental concepts and theories from linear algebra:
   1.1 determine and interpret the solution set of a system of linear equations both algebraically and geometrically;
   1.2 perform matrix operations such as addition and multiplication, find the inverse of matrices, and evaluate the determinant of square matrices;
   1.3 solve systems of linear equations using various methods such as reduced Echelon form methods, the inverse matrix method, and Cramer's Rule;
   1.4 define the vectors, linear independence, and linear transformations for Euclidean spaces;
   1.5 determine the subspaces of Euclidean spaces and evaluate the dimension and rank of the subspaces;
   1.6 define the general vector spaces, linearly independent sets, and the dimensions;
   1.7 determine and evaluate the eigenvalues, eigenvectors, and eigenspaces of a matrix;
   1.8 define and evaluate the inner product, length and orthogonality and inner product spaces; and
   1.9 define the quadratic forms and perform singularization of symmetric matrices

2. Utilize various problem---solving and critical---thinking techniques to set up and solve applied problems in engineering, sciences, business and technology fields:

   2.1 apply derivative matrix algebra on Leontief---output models and computer graphics;
   2.2 apply vector spaces to Markov Chains and differential equations;
   2.3 apply eigenvalues and eigenvectors in solving systems of differential equations;
   2.4 apply the least squares method to linear models from business applications

3. Communicate accurate mathematical terminology and notation in written and/or oral form in order to explain strategies to solve problems as well as to interpret found solutions:

   3.1 write and explain solutions to application problems including differential equations, discrete dynamical systems, and optimization in two, three or higher dimensional spaces

4. Use graphing calculators effectively as a tool to solve such problems as those described above:

   4.1 use a graphing calculator or web-based application programs such as Applet to visualize vector spaces and graphs of solution sets in two or three dimensional spaces;

   4.2 use mathematical software such as Mathematica and Maple to calculate the partial inverse and determinant of square matrices

Methods of Instruction: Instruction will consist of a combination of lectures, presentation of sample problems, clarification of homework exercises/textbook material, and general class discussion.

Outcomes Assessment: Test and exam questions are blueprinted to course objectives. Data is collected and analyzed to determine the level of student performance on these assessment instruments in regards to meeting course objectives. The results of this data analysis are used to guide necessary pedagogical and/or curricular revisions.

Course Requirements: All students are required to:

1. Maintain regular attendance; excessive absences will negatively affect student understanding and performance.
2. Complete reading and problem---solving homework in a timely manner and contribute to class discussions. Mathematics cannot be understood without doing a significant amount of outside study.
3. Participate in a peer study group that meets regularly and maintains effective member communication links.
4. Take tests and exams when scheduled. The first missed test will be recorded as a zero until the end of the semester, at which time the **final exam grade will also be used to replace the**

missing test grade. The Comprehensive Final Exam is required and cannot be rescheduled unless some **extraordinary** event occurs and prior arrangement is made with the instructor.

Attendance Policy: Regular and prompt attendance is essential for academic success. Faculty members take attendance at each scheduled class session. Students are expected to attend and be on time for all classes. Individual faculty members may establish specific attendance policies. Attendance records will be turned in to the appropriate Division/Department Chair and/or Program Director at the end of the term and in the interim upon request. Any students with more than three unexcused absences will automatically fail the course.

Methods of Evaluation: Final course grades will be computed as follows:

Grading Components	% of final course grade
• **Optional Assignments** Problem sets, research projects, etc. are designed to enhance understanding of the applications of linear algebra in engineering, business, and technology.	**0 - 10 %**
• **Tests** (dates specified by the instructor) Tests will show evidence of the extent to which students meet course objectives, including, but not limited to, identifying and applying concepts, analyzing and solving problems, estimating and interpreting results, and stating appropriate conclusions using correct terminology.	**40 - 50 %**
• **Midterm Exam** The same objectives apply as with tests, but it is anticipated that students will provide evidence of synthesizing a combination of concepts.	**20 - 30 %**
• **Final Exam** The **comprehensive** final exam will examine the extent to which students have understood and synthesized all course content and achieved all course objectives.	**20 - 30 %**

NOTE: The instructor will provide specific weights, which lie in the above given ranges, for each of the grading components at the beginning of the semester. Also, students may use a scientific or graphing calculator or laptop computer to enhance understanding during class or while doing homework. However, no form of technological aid can be used on tests/exams.

Grading System:

A	**90% - 100%**	**Superior**
B+	**87% - 89%**	**Very Good**
B	**80% - 86%**	**Good**
C+	**77% - 79%**	**Above Average**
C	**70% - 76%**	**Satisfactory**
D	**60% - 69%**	**Passing**
F	**59% - 0**	**Failing**

Academic Integrity: Dishonesty disrupts the search for truth that is inherent in the learning process and so devalues the purpose and the mission of the College. Academic dishonesty includes, but is not limited to, the following:

- plagiarism – the failure to acknowledge another writer's words or ideas or to give proper credit to sources of information;
- cheating – knowingly obtaining or giving unauthorized information on any test/exam or any other academic assignment;
- interference – any interruption of the academic process that prevents others from the proper engagement in learning or teaching; and
- fraud – any act or instance of willful deceit or trickery.

Violations of academic integrity will be dealt with by imposing appropriate sanctions. Sanctions for acts of academic dishonesty could include the resubmission of an assignment, failure of the test/exam, failure in the course, probation, suspension from the College, and even expulsion from the College.

Student Code of Conduct: All students are expected to conduct themselves as responsible and considerate adults who respect the rights of others. Disruptive behavior will not be tolerated. All students are also expected to attend and be on time all class meetings. No cell phones or similar electronic devices are permitted in class. Please refer to the Essex County College student handbook, *Lifeline*, for more specific information about the College's Code of Conduct and attendance requirements.

Course Content Outline: This is a tentative course schedule, the instructor reserve the right to make changes on it to make it better for the student`s development. Notice will be given should any changes take place.

Class Meeting (90 minutes)	Topics to be Covered/ Class Activities
1 – 2	Orientation & Course Introduction/Review of Class Syllabus
	CHAPTER 1 LINEAR EQUATIONS IN LINEAR ALGEBRA
3	1.1 Systems of Linear Equations
	1.2 Row Reduction and Echelon Forms
	1.3 Vector Equations
4	1.4 The Matrix Equation Ax = b
	1.5 Solution Sets of Linear Systems
5	1.6 Applications of Linear Systems
	1.7 Linear Independence
	1.8 Introduction to Linear Transformations
6	1.9 The Matrix of a Linear Transformation
	1.10 Linear Models in Business, Science & Engineering
	CHAPTER 2 MATRIX ALGEBRA
7	2.1 Matrix Operations
	2.2 The Inverse of a Matrix
8	2.3 Characterizations of Invertible Matrices
	2.4 Partitioned Matrices
9	2.5 Matrix Factorizations
	2.6 The Leontief Input/Output Model
10	2.7 Applications to Computer Graphics
	2.8 Subspaces of Rn
	2.9 Dimension and Rank
11	**Test #1** on Chapters 1 & 2

Class Meeting (90 minutes)	Topics to be Covered/ Class Activities
12	3.1 Introduction to Determinants
	3.2 Properties of Determinants
	3.3 Cramer's Rule, Volume & Linear Transformations
13	**Midterm Exam**
	CHAPTER 4 VECTOR SPACES
14	4.1 Vector Spaces and Subspaces
	4.2 Null Spaces, Column Spaces & Linear Transformations
15	4.3 Linearly Independent Sets; Bases
	4.4 Coordinate Systems
16	4.5 The Dimension of a Vector Space
	4.6 Rank
17	4.7 Change of Basis
	4.8 Applications to Difference Equations
	4.9 Applications to Markov Chains
18	**Test #2** on Chapters 3 & 4
	CHAPTER 5 EIGENVALUES AND EIGENVECTORS
19	5.1 Eigenvectors and Eigenvalues
	5.2 The Characteristic Equation
20	5.3 Diagonalization
	5.4 Eigenvectors and Linear Transformations
21	5.5 Complex Eigenvalues
	CHAPTER 6 ORTHOGONALITY AND LEAST SQUARES
22	6.1 Inner Product, Length, and Orthogonality
	6.2 Orthogonal Sets

Class Meeting (90 minutes)	Topics to be Covered/ Class Activities
23	6.3 Orthogonal Projections
	6.5 Least-- - Squares Problems
	6.6 Applications to Linear Models
24	6.7 Inner Product Spaces
	6.8 Applications of Inner Product Spaces
	CHAPTER 7 SYMMETRIC MATRICES AND QUADRATIC FORMS
25	7.1 Diagonalization of Symmetric Matrices
	7.2 Quadratic Forms
26	Final Exam