Linear Algebra

SECTION I: Course Overview

Course Code: MATH250PRG
Subject Area(s): Mathematics
Prerequisites: See Below
Language of Instruction: English
Total Contact Hours: 60
Recommended Credits: 4

COURSE DESCRIPTION

In this course, we will cover material related principally to linear systems of equations, vector spaces, and linear transformations. Solving systems of linear equations is a basic tool of many mathematical procedures used for solving problems in science and engineering. The content of this course will thus focus on the mathematical theory and methods of linear algebra.

LEARNING OBJECTIVES

Upon successful completion of this course, you will be able to:

- Execute mathematical expressions specific to linear algebra: solving linear equations, performing matrix algebra through Gauss-Jordan elimination, calculating determinants, and finding eigenvalues and eigenvectors.
- Relate a matrix as a linear transformation relative to a basis of a vector space and understand the difference between span and basis.
- Understand image, kernel, nullity, and rank.
- Recognize the inner product as the definite integral from calculus.
- Describe the concept of orthogonality of vectors, the Gram-Schmidt procedure, and QR factorization.

PREREQUISITES

Before enrollment, this course requires you to have completed Calculus III.

SECTION II: Instructor & Course Details

INSTRUCTOR DETAILS

Name:	TBD
Contact Information:	TBD
Term:	SUMMER

GRADING & ASSESSMENT

The instructor will assess your progress towards the above-listed learning objectives by using the forms of assessment below. Each of these assessments is weighted and will count towards your final grade. The following section (Assessment Overview) will provide further details for each.

Engagement	**20%**
Quizzes	**30%**
Midterm Exam	**25%**
Final Examination	**25%**

ASSESSMENT OVERVIEW

This section provides a brief description of each form of assessment listed above. Your course instructor will provide further details and instructions during class time.

Engagement (20%): Engagement in class is expected of all CEA CAPA students. Guidelines for engagement can be found on the list of academic policies.

Quizzes (30%): Students will be given a quiz each week, except on weeks where there is an exam. There will be 3 quizzes.

Midterm Examination (25%): A comprehensive midterm examination halfway through the term.

Final Examination (25%): A comprehensive final examination during the last week of classes.

ACTIVE LEARNING

CEA CAPA courses are designed to include a variety of active learning component that will take you out of the classroom and allow you to explore your local, host city. This course includes:

- Technical Museum

REQUIRED READINGS

The reading assignments for this course are listed below. All required readings must be completed according to the due date assigned by the course instructor. You will not need to purchase these readings; the instructor will provide these selected readings to you in class (either in paper or electronic format) and/or through CEA CAPA's online Moodle classroom.

SELECTED READING(S): The selected readings for this course are listed below. You will not need to purchase these readings; the instructor will provide these selected readings to you in class (either in paper or electronic format).

Lay, David C., Lay, Steven R., McDonald, Judy J. *Linear Algebra and Its Applications*, 5th ed.

RECOMMENDED READINGS

The recommended reading(s) and/or text(s) for this course are below. These recommended readings are not mandatory, but they will assist you with research and understanding course content.

Strang, Gilbert. *Linear Algebra and Its Applications*, 4th ed.

Edwards, Jr, C.H. and Penney, David E. *Elementary Linear Algebra*, 1st ed.

KEY RESOURCES

In order to ensure your success abroad, CEA CAPA has provided the academic resources listed below.

- **UNH Online Library**: As a CEA CAPA student, you will be given access to the online library of the University of New Haven (UNH). You may access the UNH online library here. You must comply with UNH Policies regarding library usage.

- **CEA CAPA Classroom – Moodle**

COURSE CALENDAR *Linear Algebra*			
SESSION	**TOPICS**	**ACTIVITY**	**READINGS & ASSIGNMENTS**
Week 1			
1	**Course Introduction**	Lecture and In-class problem solving on: *1.* Introducing the instructor(s) 2. Overview of the syllabus 3. Meeting the students *4.* Review some basic Algebra. *5.* Par 1.1: Systems of Linear Equations – *Matrix Notation, Solving a Linear System, Existence and Uniqueness* 6. Par 1.2: Row Reduction End Echelon Forms – *The Row Reduction Algorithm, Pivoting, Solutions to Linear Systems, Back-Substitution*	
2	**Ch. 1 – Linear Equations in Linear Algebra**	Lecture and In-class problem solving on: 1. In Class Exercises 2. Par 1.3: Vector Equations – Vectors in R^2, *Geometric Descriptions of* R^2, *Vectors in* R^3, R^n, *Linear Combinations, Span* $\{v\}$ *and Span* $\{u, v\}$ 3. The Matrix equation $Ax = b$ – *Existence of Solutions, Properties of the Matrix-Vector Product* Ax	Read Ch. 1
3	**Ch. 1 – Linear Equations in Linear Algebra**	In-class problem solving from among: p. 34 no. 2, 4, 6, 12, 16, 22 p. 47 no. 2, 4, 10, 16, 24 p. 58 no. 2, 6, 10, 16, 20, 34 p. 66 no. 1-4, 6, 12, 17 – 20 – mtrx A, 35	Recommended exercises: p. 34 no. 1, 3, 5, 7, 11, 15, 19, 27-34 p. 47 no. 9, 15, 21, 25-32, 42 p. 58 no. 1, 5, 9, 15, 23-32 p. 66 no. 5, 13, 15, 17-20 mtrx B, 23-34

Week 2			
4	**Ch. 1 – Linear Equations in Linear Algebra**	Lecture and In-class problem solving on: *1.5.* Solution Sets of Linear Systems – *Trivial and Non-trivial Solutions, Parametric Vector Form, Non-Homogeneous Systems* *1.6.* Applications of Linear Systems – *Economics, Chemical Equations, Network Flow* *1.7.* Linear Independence – *LI of Matrix Columns, Sets of One or Two or More Vectors* *1.8.* Introduction to Linear Transformations – *Matrix Transformations, Shear Transformations, Contraction and Dilation*	Read Ch. 1
5	**Ch. 1 – Linear Equations in Linear Algebra**	Quiz 1? In-class problem exercises: Lecture and In-class problem solving on: 1.9 The Matrix of Linear Transformations – *Standard Matrix for LT, Geometric Linear Transformations*	**Prepare for Quiz 1**
6	**Ch. 1 – Linear Equations in Linear Algebra**	**Quiz 1** In-class problem solving from among: p. 75 no 2, 8, 18, 26 p. 82 no. 3, 5, 12 p. 89 no. 2, 10, 14, 33, 34 p. 97 no 4, 10, 12, 19 p. 107 no. 2, 4, 6, 10, 8 and 12, 18, 22, 46	Recommended exercises: p. 75 no. 1, 9, 13, 17, 25, 27-36 p. 82 no 1, 7, 11, p. 89 no. 1, 7, 13, 21-28, 39-44 p. 97 no. 3, 9, 11, 13-16, 17 p. 107 no. 1, 3, 5, 7, 9, 17, 33, 21, 23-32, 47

Week 3			
7	**Ch. 1 – Linear Equations in Linear Algebra** **Ch. 2 – Matrix Algebra**	Chapter 1: Lecture and In-class problem solving on: 1.9 The Matrix of Linear Transformations – *Standard Matrix for LT, Geometric Linear Transformations* 1.10 Review Chapter 1 Chapter 2: Lecture and In-class problem solving on: *2.1.* Matrix Operations – *Matrix Multiplication, Properties, The Transpose*	Read Ch. 2
8	**Ch. 2 – Matrix Algebra**	*2.1.* In-class problem solving exercises Chapter 2: Lecture and In-class problem solving on: 2.2. The Inverse of a Matrix – Singular, Non-singular, The Determinant, Elementary Matrices, An Algorithm to Finding A^{-1} 2.3. Characterizations of Invertible Matrices – The Invertible Matrix Theorem, Invertible Linear Transformations	
9	**Ch. 2 – Matrix Algebra**	In-class problem solving from among: p. 115 no. 2, 4, 10, 14 p. 132 no. 5, 6, 10, 27, 28, 35,40 p. 142 no. 2, 8, 10, 28, 36, 42 p. 148 no. 2, 6, 8, 21, 36, 46	Recommended exercises: p. 115 1, 3, 11 p. 132 no. 3, 4, 9, 15-24, 33, 51 p. 142 no. 1, 7, 9, 11-20, 27, 29, 41 p. 148 no. 1, 5, 7, 11-20, 24, 43

Week 4			
10	**Ch. 2 – Matrix Algebra**	Lecture and In-class problem solving on: *2.1.* The Inverse of a Matrix – *Singular, Non-singular, The Determinant, Elementary Matrices, An Algorithm to Finding* A^{-1} *2.2.* Characterizations of Invertible Matrices – *The Invertible Matrix Theorem, Invertible Linear Transformations* *2.3.* Partitioned Matrices – *Multiplication, Inverses* *2.4.* Matrix Factorizations – *The LU Factorization, Applications to Electrical Engineering, Computer Science* *2.5.* The Leontief Input-Output Model – *A formula for* $(I - C)^{-1}$	**Prepare for Quiz 2**
11	**Ch. 2 – Matrix Algebra**	In-class problem solving from among: p. 154 no. 2, 6, 17, p. 162 no. 2, 8, 14, 21, 25, 29 p. 184 no. 1-4, 6, 18, 20, 32 p. 190 no. 2, 4, 8, 10, 14, 16, 34 Lecture and In-class problem solving on: *2.1.* Applications to Computer Graphics – *Homogenous Coordinates, Composite Transformations, 3D computer Graphics, Homogenous 3D Coordinates, Perspective Projections* *2.2.* *Subspaces of* R^n *– Column Space and Null Space, Basis for a Subspace* *2.3.* *Dimensions and Rank – Coordimate Systems, The Dimension. of a Subspace, The invertible Matrix Theorem*	**Quiz 2** Recommended exercises: p. 154 no. 1, 5, *16, * 26 p. 162 no. 1, 7, 11, 19, 29 p. 184 no.5, 17, 19, 21-30, 31, 38, 40 p. 190 no. 1, 3, 7, 9, 13, 15, 17-26, 33
12	Prepare for Midterm Exam		

Week 5			
13	**Ch. 2 – Matrix Algebra** **Ch. 3 – Determinants**	In-class problem solving from among: Lecture and In-class problem solving on: 3.1 Introduction to Determinants – Cofactor Expansion 3.2 Properties of Determinants – Row Operations, Column Operations, Linearity Property of the Determinant Function	
14	**MIDTERM EXAM**		
15	**Ch. 3 – Determinants**	In-class problem solving from among: p. 232 no. 2, 4, 6, 8, 10, 22, 40 p. 243 no. 2, 4, 8, 22, 24, 42 p. 253 no. 2, 4, 6, 14, 16, 43 p. 262 no. 2, 4, 8, 14, 29	Recommended exercises: p. 232 no. 1, 3, 5, 7, 9, 23-32 p. 243 no. 1, 3, 7, 21, 23, 24-38, 40 p. 253 no. 1, 3, 5, 13, 15, 21-32 p. 262 no. 1, 3, 7, 13, *27

Week 6			
16	**Ch.3 – Determinants**	Lecture and In-class problem solving on: *3.3* Cramer's Rule, Volume, and Linear Transformations – *An Inverse Formula, Applications to Engineering* Lecture and In-class problem solving on: 4.1 Vector Spaces and Subspaces – *Definitions, A Subspace Spanned by a Set* 4.2 Null Spaces, Column Spaces, and Linear Transformations – *Definitions, The Contrast between Null Space and Column Space, The Kernel and Range of a Linear Transformation*	Read Ch. 3 and 4
17	**Ch.3 – Determinants** **Ch.4 – Vector Spaces**	Review Midterm In-class problem solving from among: p. 271 no. 2, 10, 12, p. 277. no. 2, 8, 18 Lecture and In-class problem solving on: 4.3 Linear Independent Sets: Bases – *The Standard Basis, The Spanning Set Theorem, Bases for* $NulA$ *and* $ColA$ 4.4 Coordinate Systems – *A Graphical Interpretation of Coordinates, Coordinates in* R^n*, The Coordinate Mapping*	Recommended exercises: p. 271 no. 1, 9, 11, 17-24, 43-48 p. 277. no.1, 7, 11-14, 17

Week 7			
18	**Ch.4 – Vector Spaces**	Lecture and In-class problem solving on: *4.5* The Dimensions of a Vector Space – *Finite Dimensional versus Infinite Dimensional, The Dimensions of* $NulA$ *and* $ColA$ *4.6* Rank – *The Row Space, The Rank Theorem, Nullity, The Rank and the Invertible Matrix Theorem* *4.7* Change of Basis – *In* R^n *4.8* Applications of Difference Equations – *Discrete Time Signals, Linear Dependence, Linear Difference Equations, Solutions Set, Nonhomogeneous Equations, Reduction to Systems of First-order Equations* Lecture and In-class problem solving on: 5.1 Eigenvectors and Eigenvalues – *Definitions* 5.2 The Characteristic Equation – *Determinants, Properties of Determinants, Similarity, Applications to Dynamical Systems* 5.3 Diagonalization – *The Diagonalization Theorem, Non-distinct Eigenvalues*	Read Ch. 4 and 5
19	**Ch.4 – Vector Spaces** **Ch.5 – Eigenvalues and Eigenvectors**	In-class problem solving from among: p. 304 no. 2, 4, 8, 10, 35 p. 312 no.2, 10 p. 319 no. 2, 6, 30 p. 326 no.2, 6, 10, 22, 23 p. 334 no. 2, 8, 10, 16 p. 343 no.4, 10, p. 358 no. 3, 16 Lecture and In-class problem solving on: 5.4 Eigenvectors and Linear Transformations – *The Matrix of a Linear Transformation, Linear Transformations from V into V, Linear Transformations on* *5.5* Complex Eigenvalues – *Real and Imaginary Parts of*	Read Ch. 5 **Quiz 3**

		Vectors, Eigenvalues and Eigenvectors of a Real Matrix that Acts on C^n *5.6* Discrete Dynamical Systems – *A Predator-Prey System, Graphical Descriptions of Solutions, Change of Variable, Survival of the Spotted Owl* 5.7 Iterative Estimates for Eigenvalues – *The Power Method, The Inverse Power Method*	
20	**Field Study**		

Week 8			
21	**Ch.5 – Eigenvalues and Eigenvectors**	In-class problem solving from among: p. 304 no. 2, 4, 8, 10, 35 p. 312 no.2, 10 p. 319 no. 2, 6, 30 p. 326 no.2, 6, 10, 22, 23 p. 334 no. 2, 8, 10, 16 p. 343 no.4, 10 p. 358 no. 3, 16	Recommended exercises: p. 304 no. 1, 3, 7, 9, 21-30 p. 312 no. 1, 9, 20, 21-30 p. 319 no. 1, 5, 21-28, 30 p. 326 no.1, 5, 9, 17-20, 22 p. 334 no. 3, 7, 9, 15, 23-26 p. 343 no. 5, 9 p. 358 no.1
22	**Ch.5 – Eigenvalues and Eigenvectors**	In-class problem solving from among: p. 304 no. 2, 4, 8, 10, 35 p. 312 no.2, 10 p. 319 no. 2, 6, 30 p. 326 no.2, 6, 10, 22, 23 p. 334 no. 2, 8, 10, 16 p. 343 no.4, 10 p. 358 no. 3, 16	
23	**Prepare for Final Exam**		
24	**FINAL EXAM**		

SECTION III: CEA CAPA Academic Policies

To see all CEA CAPA academic policies outlined, please follow the following links. Students are expected to review and understand all CEA CAPA student policies, including the academic policies outlined online. CEA CAPA reserves the right to change, update, revise, or amend existing policies and/or procedures at any time.

Class & Instructor Policies can be found here
General Academic Policies can be found here