



COURSE SYLLABUS

Course Title: Honors Computational Linear Algebra

Abbreviated Title As Appears on Transcript Honors Comp Linear Algebra

Course Number: DMAT 336

Credit Hours: 5 credits [semester credit hours]

Course Description: An honors-level first course in matrix algebra and linear spaces with emphasis on computational software techniques and geometrical analysis. Topics include matrices, solutions of systems of linear equations, determinants, linear spaces and transformations, inner products, higher dimensional spaces, inverses and pseudoinverses, rank, Singular Value Decomposition, change of basis, Eigenvalues and Eigenvectors, matrix decomposition and diagonalization, dynamical systems and the Spectral Theorem. Honors courses will include greater breadth and depth of topics, and develop technical writing skills, culminating in a mathematical term paper on an approved topic.

Prerequisite: Successful completion with grade B or higher in Calculus II or equivalent, or consent of instructor.

Course Workload: 5 semester credit hours • 3 student work hours per credit hour • 14 week Carnegie semester = 210 hours student course workload average

Examination Requirements: Proctored written final examination must be passed at 60% or higher to earn passing grade in course. "B" and "A" grade paths have additional examinations.

See <https://www.distancecalculus.com/grades/> for more information.

Course Professor: Robert R. Curtis, Ph.D. <rcurtis@rwu.edu>, <robert@distancecalculus.com>

University Information: Roger Williams University, University College, 1 Empire Plaza, Providence, RI, USA 02903. Roger Williams University, 1 Old Ferry Road, Bristol, RI 02809.

Accredited by New England Commission of Higher Education (NECHE).

See <https://www.rwu.edu/academics/accreditation/> for more information.

E-Textbook: *Matrices, Geometry & Mathematica* by Davis/Porta/Uhl

Mathematical Software: Mathematica™ Computer Algebra & Graphing System

ADA ACCOMMODATIONS

Roger Williams University has a continuing commitment to providing reasonable accommodations for

students with documented disabilities. Students with disabilities who need accommodations in order to fully participate in this class are urged to contact Student Accessibility Services, as soon as possible, to explore the arrangements needed to be made to assure access. Student Accessibility Services is open Monday through Friday from 8:00AM to 5:00PM Eastern Time; Email: sas@rwu.edu or Voice: 401-254-3841. For more information about SAS, visit

<https://www.rwu.edu/undergraduate/academics/student-academic-success/student-accessibility-services-sas>

Learning Outcomes for DMAT 336 - Honors Computational Linear Algebra

1. To understand the core connection between matrix algebra and a study of systems of linear equations
2. To understand and compute measurements of vectors and their geometry
3. To understand and compute core matrix algebra operations and their geometrical interpretations
4. To understand and compute the fundamental properties of determinants and inverses of matrices, both for square and non-square generalizations
5. To understand and compute Singular Value Decomposition
6. To understand and compute the core concept of rank and its variations
7. To understand and compute Gaussian elimination and other strategies for finding solutions or approximate solutions to systems of linear equations
7. To understand and compute bases, change of bases, spanning and linear independence, kernel and image sets
8. To understand and compute the diagonalization of a matrix, both with Singular Value Decomposition, and Eigenvalue - Eigenvector constructions.

Honors Topics:

- 9.* To understand and compute interpolating polynomials and Fourier fitting and analysis
- 10.*To understand and compute the Gram-Schmidt process in relation to Singular Value Decomposition
- 11.*To understand and compute the diagonalization of a matrix when Eigenvalues are repeated and/or complex.
- 12.*To understand and compute the relationship of matrix diagonalization and dynamical systems of differential equations
- 13.*To understand and compute the Spectral Theorem
- 14.*To develop mathematical technical writing skills, culminating in a term paper on an approved topic

Syllabus Topics Outline for DMAT 336 - Honors Computational Linear Algebra

1. Getting Started
 - 1.1 Email and Chat
 - 1.2 Learning About the Course
 - 1.3 Required Hardware
 - 1.4 Software Fundamentals
2. Vectors
 - 2.1. Geometry of Vectors

- 2.2. Perpendicular Frames
- 2.3. Curves in 2D: Change of Frames/Basis
- 2.4. Dot Products
- 2.5. Cross Products
- 2.6. Ellipses and Ellipsoids
- 2.7. Area and Volume

3. Matrices
 - 3.1 Basics
 - 3.2 Transforming Curves
 - 3.3 Matrix Arithmetic
 - 3.4 Translations and Rotations
 - 3.5 Shears
 - 3.6 Linear Transformations
 - 3.7 Inverses
 - 3.8 Determinants
 - 3.9 Transposes
 - 3.10 Matrix Decomposition: Singular Value Decomposition
 - 3.11 Rank
 - 3.12 Projections
 - 3.13 Higher Dimensions

4. Linear Systems
 - 4.1 Conversion to Matrix Notation
 - 4.2 Gaussian Elimination
 - 4.3 Vector Spaces and Subspaces
 - 4.4 Numerical Considerations
 - 4.5 Applications: Least Square Fit
 - 4.6 Spanning Sets; Basis
 - 4.7 Linear Independence
 - 4.8 Pseudo Inverses
 - 4.9 Approximate Solutions
 - 4.10 Null Space and Image Space
 - 4.11* Interpolating Polynomials and Trigonometric Functions: Fourier Fit
 - 4.11* Undetermined Coefficients in Differential Equations Systems

5. Eigenvalues and Eigenvectors
 - 5.1 Diagonalization of a Matrix
 - 5.2 Eigenvalues
 - 5.3 Eigenvectors
 - 5.4 Exponential of a Matrix

- 6.* Honors Topics
 - 6.1* Gram-Schmidt Process and Singular Value Decomposition
 - 6.2* 4D Projections

6.3* Non-Real Eigenvalue and Eigenvectors

6.4* Applications to Dynamical Systems

6.5* Spectral Theorem

7.* Mathematical Writing

7.1* Cogent writing

7.2* Mathematical Presentation

7.3* Term Paper Topic and Research