Course Syllabus

Linear Algebra | M303 | Fall 2025

Instructor Information

- **Instructor Name:** Prof. Thomas Horine
- **Contact Info** can be found on the course **Home (https://iu.instructure.com/courses/2354790)** .
- **Office hours:**
  - During these hours, unless otherwise posted, I will be in my office (LF 102) and also available via my Zoom link.
  - **Time:**
    - **Monday, Wednesday 2:45pm - 4:00pm**
    - **Tuesday, Thursday 1:00pm - 2:00pm**
  - **I**f you need to schedule another time, ***please contact me via email***.

Course Information

Bulletin Description:

Introduction to the theory of real and complex vector spaces. Coordinate systems, linear dependence, bases. Linear transformations and matrix calculus. Determinants and rank.

Course Structure:

Your course consists of three units, with each unit further divided into weekly modules:

In the 16-week version of this course, each module will cover two to three sections of the textbook material.

Prerequisites:

M216 or M230

Required Texts and Materials

1.) The following textbook is provided as part of IU eTexts. You can access the textbook by following the IU eTexts link on the left side of the page. The fee to access this textbook has been included in your course fees. ***You do not need to purchase this textbook*.**

Elementary Linear Algebra, 12e Applications Version WileyPLUS Single Term12th Edition
ISBN: 978EEGRP43817

2.) ***A non-graphing scientific calculator is required***. The TI-30X IIS is particularly inexpensive and functional. **Note: Graphing calculators, calculators that perform numerical integration and differentiation (e.g. TI-36X Pro), and those that perform matrix operations are not allowed on any examination in this course.** It is your responsibility to bring an acceptable calculator to each exam session.

3.) A way to capture images of your written work. This is most usually done with a mobile phone, but a document camera is also an option. (Online students: Some document cameras can function as an external webcam, too!)

4.) A laptop or desktop computer, with broadband internet connection, speakers, and microphone.

5.) An **external webcam**. This is required for your testing. **You will not be able to use a built-in webcam for your testing.**

Course Learning Outcomes

It is important that you know **precise definitions of important concepts** in linear algebra. By the end of the semester, you should be able to **state** the following definitions:

- real vector space
- linear subspace of a real vector space
- linear transformation
- linear independent
- basis of a linear subspace
- inner product

You need to know **how to use these definitions** and **test whether or not they apply** to a given object. By the end of the semester, you should be able to **determine** if:

- a set of vectors is linearly independent
- a set of vectors is a basis for a vector space or a linear subspace of a vector space
- a set, with given operations of addition and scalar multiplication, is a vector space
- a subset of a vector space is a linear subspace
- a mapping from one vector space to another is a linear transformation

The matrix is the most fundamental tool in linear algebra, and its study forms the basis of our course. You should be **proficient in basic matrix arithmetic and computation**. By the end of the semester, you should be able to **carry out the appropriate computations** to:

- perform matrix arithmetic (addition, scalar multiplication, transpose, and matrix multiplication)

- apply elementary row operations to a matrix
- find the trace, determinant, and (when possible) the inverse of a square matrix
- compute bases for the row space, column space, and null space of a given matrix
- determine the (real) eigenvalues and eigenvectors of a square matrix and use these to perform diagonalization (or show that it is not possible)

Vectors are at first a special type of matrix, but then we discover they are in fact more general objects. We use these to perform many important analyses, but in particular, their relation to geometric concepts (distance, direction, angle) is useful. You should be **proficient in various vector operations**. By the end of the semester, you should be able to **carry out the appropriate computations** to:

- perform basic vector arithmetic (addition, scalar multiplication)
- find inner products of vectors (including dot products) in various spaces, and use these to solve problems involving distances, angles, and projections

Vectors live within sets called vector spaces. A basis is a special sort of set that we can use to build a vector space (or a subspace thereof), and a dimension is a number used to measure spaces. You must be **comfortable with a certain set of computations** involving these concepts. By the end of the semester, you should be able to **carry out the appropriate computations** to:

- find the coordinates of a vector relative to an ordered basis; find a vector given its coordinates relative to an ordered basis; compute and use transition matrices to translate coordinates between bases
- use the Gram-Schmidt process to convert a basis to an orthogonal or orthonormal basis
- find a basis for the orthogonal complement of a subspace
- find the dimension of a subspace or vector space

Our study of matrices and vectors is chiefly to aid us in solving other mathematical problems. You need to know how to **apply methods of linear algebra to appropriate problems**. By the end of the semester, you should be able to **carry out the appropriate computations** to:

- solve systems of linear equations
- solve least-squares approximation problems and calculate the error of the approximations
- find the standard matrix of a linear transformation

The use of computational software is essential in almost any application of linear algebra. You should be able to **use MATLAB to perform various tasks** related to the topics in this course. By the end of the semester, you should be able to **use MATLAB** to:

- perform standard linear algebra computations, including but not limited to matrix multiplication, row reduction, determinants, projections, linear transformations, and matrix inverses.
- display data graphically (e.g. basic 2- and 3-dimensional plots, the visualization of the range and nullspace of a 3x3 linear transformation, the orbits of a point under iterations of a 2x2 linear transformation)

Course Assessment & Grades

Grades

Grades will be posted in Canvas. When figuring your course grade, the follow scale will be used.

Grade Scale

Range	Grade	Range	Grade
$97 \leq x \leq 100+$	A+	$77 \leq x < 79.5$	C+
$92.5 \leq x < 97$	A	$72.5 \leq x < 77$	C
$89.5 \leq x < 92.5$	A-	$69.5 \leq x < 72.5$	C-
$87 \leq x < 89.5$	B+	$67 \leq x < 69.5$	D+
$82.5 \leq x < 87$	B	$62.5 \leq x < 67$	D
$79.5 \leq x < 82.5$	B-	$59.5 \leq x < 62.5$	D-
		$x < 59.5$	F

Assessments

Your performance in the course will be based upon the following components.

- **Lecture videos** have short quizzes embedded that test you on basic concepts covered in that video. Lecture videos/quizzes are due on the Friday of the relevant week. Late submissions will not be accepted. Version of the lecture videos without the quizzes are always available to students. **[5% of total grade]**
- **Weekly Assignments** will be given for each module. These are assignments within each module in Canvas that open up in WileyPlus. These are generally due on the following Tuesday. One larger set of questions does not require work uploaded, but then one smaller set of questions will require that work be uploaded. **[12.5% of total grade]**
- Several **labs**, to be completed using MATLAB computational software, will be assigned throughout the semester. The intent of these labs is twofold. First, they give you experience with a computational software package, skills that may be useful in many professional settings. Secondly, using this software allows us to see how linear algebra can be used to tackle application problems that would otherwise be infeasible. **[12.5% of total grade]**
- Each unit will have a corresponding **exam**, and there will be a **cumulative final exam**. These are graded on correctness, although partial credit can be a significant and important part of your grade. *I urge you to not underestimate the amount of partial credit you can get my writing down what you know.* The intent of these exams is to measure your ability to apply the procedures and problem-solving skills learned throughout the course in a controlled setting, without external aid. For online sections, these exams will be proctored using Honorlock. Note: Your exams will not

involve MATLAB material, nor will you have access to MATLAB for these exams. **[3 unit exams total 50% of total grade; final exam is 20% of total grade]**

Late Work

Late work is not accepted for weekly homework assignments or video lectures (PlayPosit quizzes). Submit what you have for partial credit, but remember that **work that is unorganized, unreadable, or insincere will not be graded**.

If a situation occurs where taking an exam on the day it is available is either impossible or presents a significant hardship, please let me know as soon as possible, especially if you are aware of the situation ahead of time. Many times, we can work something out. However, it is your responsibility to communicate the need for this accommodation in a timely manner.

Course Expectations

- You may contact me directly via e-mail or the Canvas messaging functionality. If you choose to use direct e-mail, **use your official IU email account**.
- For online sections, we do not have a literal attendance. My expectation, however, is that you will log in to work on this course 2-3 times per week.
- All assignments are submitted via Canvas/WileyPLUS. As such, due dates are not impacted by campus closings. If a specific problem affects your ability to complete or submit an assignment, it is your responsibility to contact me as soon as possible.
- Please proofread all assignments and communications in this course. Use standard English, proper grammar, and correct spelling, as these demonstrate professionalism, courtesy, and respect. This includes discussion posts made on the course website. While I do not expect perfection on this matter, I reserve the right to penalize students who consistently fail in this regard.
- In communications, please address me as Prof. Horine or Dr. Horine. One of your introductory assignments will include *your* informing *me* of how you prefer to be called. I will do my best to honor that.
- Humor and sarcasm do not always translate as well as you might like when using online communications. Keep this in mind when posting in discussions. I will delete any posting that I believe is inappropriate.
- Avoid offensive language. This includes, to an extent so obvious I hope it does need mentioning, any remarks that could reasonably be construed as racist, sexist, or otherwise bigoted. If you are not sure, that is a good sign you should not post it.
- Use **strong type** or *emphasis* to set apart the particularly important text. Using *starred text* is a good option when communicating via a mobile device. Please refrain from ALL CAPS.

Course Technology Accessibility Statements and Privacy Policies

This course uses a variety of technology. Accessibility is supported in different ways in each environment. Please see the following links for more specific information.

- **Canvas Accessibility Statement (https://www.canvaslms.com/accessibility)**
- **Kaltura Accessibility Statement (http://corp.kaltura.com/Products/Features/Video-Discovery-and-Accessibility)**
- **Honorlock Accessibility Statement (https://honorlock.com/accessibility-statement/)**

Privacy is an important concern for online classrooms. Please see the following links for privacy statements from our main technology partners.

- **Canvas Privacy Statement (https://www.canvaslms.com/policies/privacy)**
- **Kaltura Privacy Statement (http://corp.kaltura.com/privacy-policy)**
- **Honorlock Privacy Statement (https://honorlock.com/student-privacy-statement/)**

Academic Support Services for Online Students

IU Online provides quick and easy access to tools, tips, and IU resources to help you succeed in your online courses, including:

- Math and Writing Support: Direct access to IU-trained math mentors and writing consultants
- Libraries and Research: Online access to IU library resources and research librarians
- Technology: A full suite of software, collaboration tools, cloud storage, and training

For more information, visit: **IU Online Academic Support (https://expand.iu.edu/courses/iu-online-academic-support)**

Technical Support

- Students encountering any technology problems (lost password, Canvas access, etc.) have several options:
  - Call (812) 941-2447 (extension 2447 from campus phones)
  - E-mail helpdesk@ius.edu
- Students can also find answers to frequently asked technology questions in the **IU Knowledge Base (https://kb.iu.edu/index.html)** .
- Get no-cost access to hundreds of software programs and applications through **IUware (https://iuware.iu.edu/Windows)** and **IUanyWare (https://uits.iu.edu/iuanyware)** . All you need is your IU email address. Use IUware to install software directly onto your hard drive. Use IUanyWare to stream 400+ apps on your desktop or through the mobile app with your IU login. Contact the **UITS Support Center (https://kb.iu.edu/d/abxl)** to learn more.

University Policies

Accommodations

Every attempt will be made to accommodate qualified students with disabilities (e.g. mental health, learning, chronic health, physical, hearing, vision neurological, etc.) You must have established your eligibility for support services through the appropriate office that services students with disabilities. Note that services are confidential, may take time to put into place and are not retroactive; Captions and alternate media for print materials may take three or more weeks to get produced. **Please contact your campus office as soon as possible if accommodations are needed. Find your campus office serving students with disabilities (http://ada.iu.edu/students/index.shtml)** .

Intellectual Dishonesty

All work should be your original product unless explicitly noted otherwise. Any materials you reference or take from others should be properly cited. Cheating, plagiarism, or fabrication in any form will not be tolerated, regardless of any justification. For more detailed information see the **Student Responsibilities section of the Code of Student Rights, Responsibilities, and Conduct (http://studentcode.iu.edu/responsibilities/index.html)** . Academic misconduct will not be tolerated. The minimum consequence is failing the assignment. In a case of a more serious offense, a student may fail the course. **Students should NOT present work from other courses in this class (i.e., using pieces of previous papers you have done is considered plagiarism).**

Title IX Sexual Misconduct

As your instructor, one of my responsibilities is to help create a safe learning environment on our campus. Title IX and our own Sexual Misconduct policy prohibit sexual misconduct. If you have experienced sexual misconduct, or know someone who has, the University can help. I encourage you to visit **Stop Sexual Violence website Mental Health Counselor on campus. (http://stopsexualviolence.iu.edu/)** to learn more. If you are seeking help and would like to speak to someone confidentially, you can make an appointment with a

It is also important that you know that federal regulations and University policy require me to promptly convey any information about potential sexual misconduct known to me to our Deputy Title IX Coordinator or IU's Title IX Coordinator. In that event, they will work with a small number of others on campus to ensure that appropriate measures are taken and resources are made available to the student who may have been harmed. Protecting a student's privacy is of utmost concern, and all involved will only share information with those that need to know to ensure the University can respond and assist.

Code of Student Rights, Responsibilities, and Conduct

Students are expected to adhere to the Code of Student Rights, Responsibilities, and Conduct at all times. Any inappropriate behavior, disruptive conduct (e.g., engaging in a hostile or disrespectful commentary on the site, or discussing irrelevant evidence) or non-compliance with faculty directions can result in a charge of Academic and/or Personal Misconduct, the consequence of which could be a variety of sanctions either from the instructor or the Dean of Students. For more information see **The Code of Student Rights, Responsibilities, and Conduct (http://studentcode.iu.edu/)** .

Syllabus Revision

The instructor reserves the right to revise or adjust the course syllabus.

Fair Use Policy

Copying or recording synchronous classes and asynchronous course materials without the express prior approval of Prof. Horine is prohibited. All copies and recordings remain the property of Indiana University and Prof. Horine. IU and Prof. Horine reserve the right to retrieve, inspect, or destroy the copies and recordings after their intended use. These policies are not intended to affect the rights of students with disabilities under applicable law or IU policies.

Course Schedule

In the table, the link for each week takes you to that week's overview page. Textbook section links take you to the videos page for that section. Exam links take you to the info page for that exam.

Our weeks are defined as going from Monday to Friday. However, I allow exam due dates to go through to the Saturday of the corresponding week.

Semester Schedule

Week #	Dates (M -- F)	Textbook Sections Covered
1	8/25 -- 8/29	1.1 - Introduction to Systems of Linear Equations 1.2 - Gaussian Elimination 1.3 - Matrices and Matrix Operations

2	9/1 -- 9/5 Monday = Labor Day (campus holiday)	1.4 - Inverses; Algebraic Properties of Matrices 1.5 - Elementary Matrices; A Method for Finding A−1A^{-1}
3	9/8 -- 9/12	1.8 - Introduction to Linear Transformations 2.1 - Determinants by Cofactor Expansion 2.2 - Evaluating Determinants by Row Reduction
4	9/15 -- 9/19	3.1 - Vectors in $\mathbf{2}$-Space, $\mathbf{3}$-Space, and n-Space 3.2 - Norm, Dot Product, and Distance in $\mathbb{R}^n$ 3.3 - Orthogonality
5	9/22 -- 9/26	Exam 1 Review **Exam 1 (https://iu.instructure.com/courses/2354790/quizzes/4509033)**
6	9/29 -- 10/3	4.1 - Real Vector Spaces 4.2 - Subspaces 4.3 - Spanning Sets
7	10/6 -- 10/10	4.4 - Linear Independence 4.5 - Coordinates and Basis 4.6 - Dimension
8	10/13 -- 10/17	4.7 - Change of Basis 4.8 - Row Space, Column Space, and Null Space 4.9 - Rank, Nullity, and Fundamental Matrix Spaces
9	10/20 -- 10/24	4.10 - Basic Linear Transformations in $\mathbb{R}^2$ and $\mathbb{R}^3$

	Monday & Tuesday = Fall Break	
10	10/27 -- 10/31	Exam 2 Review **Exam 2 (https://iu.instructure.com/courses/2354790/quizzes/4509028)**
11	11/3 -- 11/7	5.1 - Eigenvalues and Eigenvectors 5.2 - Diagonalization
12	11/10 -- 11/14	6.1 - Inner Products 6.2 - Angle and Orthogonality in Inner Product Spaces
13	11/17 -- 11/21	6.3 - Gram-Schmidt Process; QR-decomposition 6.4 - Best Approximation; Least Squares
14	11/24 -- 11/28	**Catch-Up and Review**

	Wednesday thru Friday = Thanksgiving Break	
15	12/1 -- 12/5	**Exam 3 (https://iu.instructure.com/courses/2354790/quizzes/4509031)**
16	12/8 -- 12/12	**Final Exam Prep**
F	12/15 -- 12/19	**Final Exam (https://iu.instructure.com/courses/2354790/quizzes/4509032) (cumulative)**