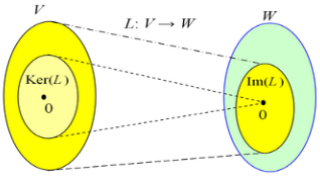
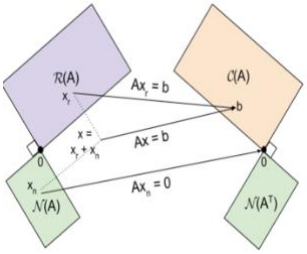
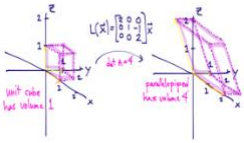
Linear Algebra (APMA 3080-004-005)
Fall 2020









Why Linear Algebra?
When you take a digital photo with your phone or transform the image in Photoshop, when you play a video game or watch a movie with digital effects, when you do a web search or make a phone call, you are using technologies that build upon linear algebra. Linear algebra provides concepts that are crucial to many areas, including graphics, image processing, cryptography, machine learning, computer vision, optimization, graph algorithms, quantum computation, computational biology, information retrieval and web search.

Course Description
In this class, you will learn the concepts and methods of linear algebra, like manipulating matrices, solving systems of linear equations, solving eigenvalues/eigenvectors, converting a basis to an orthogonal basis, making projections onto variety of inner product subspaces, connecting variety of vector spaces by linear transformations, etc. Meanwhile, we will work together to help you develop a good study habits that are necessary for success as an engineering student and beyond.

COURSE OBJECTIVES:

- Describe the basic linear algebra concepts such as matrix, determinant, vector/coordinate vector, span, linear/not-linear independency, vector space/inner product space, basis/orthogonal basis, projections.
- Apply matrix as a tool to analyze systems of equations and perform least-square approximations to linear regression models.
- Determine structures of vector space/inner product space, e.g. basis, dimension, etc.
- Connect different vectors space by linear transformations
- Determine eigenvalue/eigenvectors and diagonalize matrices.
- Communicate linear algebra orally and in the written work.
- Acquire knowledge by learning independently and by collaboration.

How is your work evaluated?

- In-class activities (15%)
- Webwork (5%)
- Written Homework (10%)
- Final Exam (30%)
- 2 Midterms (20% each)

In-Class Activities Worksheet(15%)

The lecturing part of this class is asynchronous. You will watch the relevant videos I make for the corresponding sections according to the weekly schedule. However, in order that you can benefit from collaborating, Friday's

class is synchronous so it is mandatory to attend it virtually. You will do in-class activity worksheet as groups on Friday each week, and a TA will be in class ready to help you. The ICA worksheet will be due midnight Friday each week via Gradescope. Working on the worksheets not only gives you more hands-on learning experiences than a traditional lecture, but also provides the opportunities for you to communicate your thinking process to others, which is desirable as an engineer.

Homework

You've probably heard this enough time that it's lost meaning, but math is not a spectator sport. This means that you need to practice math to learn it. You cannot learn it just by watching someone else do it. Thus, homework is an essential part of this class.

- **WeBWorK (5%):** A weekly WebWork homework will be due at midnight each Wednesday and automatically graded online. These assignments can be found at https://webwork.its.virginia.edu/webwork2/Fall20-APMA3080/. Although there are no official restrictions on the resources you can use, you'll learn the most by carefully working through each problem from start to finish with as little assistance as possible. You could treat them as written paper homework, solve them on your notebook/scratch paper, then type the answer to WebWork. Since the purpose of the homework is to gain a better understanding of the material, students may discuss the homework problems with TAs, instructors or other students, but must solve for solutions on their own. Copying another student's homework is a violation of academic integrity

- **Reading:** A helpful way to learn is to preview. Learning ability is highly related with reading ability. To develop such ability for you, you will need to read the relevant section in the textbook or via Collab before watching videos. Lecturing won't replace your reading, neither will develop you a good study habit. You need to read to manipulate every variation of problems in your homework/worksheets/exams. I will upload the relevant material into UVACollab in advance. If I forget due to a certain reason, please remind me.

- **Written Homework (10%):** Each week, there will be a written homework to finish, due at midnight Wednesday via Gradescope. Optional: you can do one project listed in the table at the end to replace the lowest written homework grade.

Midterms (20% each)

Midterm 1: after the 4th week, Monday Sept 21st (50+5mins) – chapters 1,2 and 3
Midterm 2: end of the 9th week, Friday Oct 23st (50+5mins) - chapters 4.5 and 6

Final Exam (30%)

12/08/2020. Cumulative all of the materials. The final exam can't be taken early according to UVA policy, please make your plans accordingly.

Words of Advice & Encouragement

Mathematics can be challenging, but it can also be very rewarding. Its most important to remind yourself that there is a light (not a train) at the end of this tunnel. The learning of math is often a sequence of small failures that ultimately results in bigger successes. But you must learn to live with numerous setbacks and not get frustrated. And this is true for you, for me, and many others.

Do not worry about your difficulties in Mathematics. I can assure you mine are still greater -Albert Einstein.

So how do we get through the many stumbles and starts to ultimately succeed? **We practice!** Math isn't a spectator sport: you must get your hands dirty, working problems. But you must work hard and smart: when you finish working a problem, the work has only begun. Now ask yourself some crucial questions: (1) Do I truly understand the method? (2) How can I verify my work if I don't know the correct answer? (3) What is the significance of this problem? (4) Do I understand what the problem means, and can I describe the meaning in words? (5) Can I make connections to other topics were studied so far? Don't obsess with getting the right answer, but do obsess with understanding the process, and you will excel (and enjoy) mathematics. We also need to eliminate "cramming" from our vocabulary. Consider musicians and athletes: do they cram all day once a week? No, they typically practice every day. So consider yourself as a mathlete: barring serious injury, you should also be working on math every day. Keeping up with the course will save you lots of time and distress.

Resources:

TEXT: *Linear Algebra with Applications, Second Edition, by Jeff Holt (reference book but not required, since I will provide all lecture notes).* We will cover Chapters 1-10 as outlined in the table at the end.

Gradescope: Create an account at Gradescope.com using your UVA email address. There is no charge. Y
Tablet or Printer/Scanner: You must either have a tablet with pen annotation capability by which you can annotate pdf files, or you must have a printer and a scanner or scanner app by which you can scan multiple pages as a single pdf file.
UVaCollab: The class UVaCollab site will contain the lecture notes, worksheets and test solutions, and other supplementary material.
APMA Workshop: The virtual APMA Workshop will be available for you to consult with a GTA for extra help. The hours for the workshop will be posted on UVaCollab.

Instructor: Meiqin Li
Small Hall 112D
(434) 243-7701
ml2vq@virginia.edu

Office hours:
There will be opportunities for extra help in several forms:

(i) **Prof.Li's Office Hours (from 8/27):** Tuesday, Wednesday, Thursday 1:00-2:30pm (access via Collab->announcement)

(ii) **GTA Office Hours** (access via Collab->announcement)

Monday: 3:30 – 4:30pm (Smriti)
Tuesday: 1 - 4pm (Heze) and 4-5pm (Smriti)
Wednesday: 1 - 3pm (Heze) and 4-5pm(Smriti)

(iii) **UTA Office Hours** (access via Collab->online meetings)
Kyle (from 8/27): Wednesday, Thursday 8:30-9:30pm
Matthew: (from 8/28) Monday, Friday 8:30-9:30pm.

Regrading
If you believe that a mistake has been made in scoring graded work, you may request regrading up to 7 days

after the graded work has been returned in class. After 7 days, your score is final. The 7-day clock begins when the graded work is made available, even if you are not present to receive it. Regrade requests are submitted through Gradescope.

Honor Code:
I trust every student in this course to fully comply with all of the provisions of the University's Honor Code. By enrolling in this course, you have agreed to abide by and uphold the Honor System of the University of Virginia, as well as the following policies specific to this course:
You may give and receive assistance with homework but your submitted answers should reflect your own work. Classroom work will be collaborative.
Calculators may be used to check your answers for homework or classroom work, but not to do your work unless expressly permitted.
Tests will be pledged. No calculators, notes, nor any other aids may be used for tests and quizzes.
Materials provided for this course are for your use for this course only and not to be shared with anyone outside of the course.

Accommodations for Disabilities:
The University of Virginia strives to provide accessibility to all students. If you require an accommodation to fully access this course, please contact the Student Disability Access Center (SDAC) at (434) 243-5180 or sdac@virginia.edu. If you are unsure if you require an accommodation, or to learn more about their services, you may contact the SDAC at the number above or by visiting their website at http://studenthealth.virginia.edu/student-disability-access-center/faculty-staff.

Religious Accommodations:
It is the University's long-standing policy and practice to reasonably accommodate students so that they do not experience an adverse academic consequence when sincerely held religious beliefs or observances conflict with academic requirements.

Students who wish to request academic accommodation for a religious observance should submit their request in writing directly to me by email as far in advance as possible. Students and instructors who have questions or concerns about academic accommodations for religious observance or religious beliefs may contact the University's Office for Equal Opportunity and Civil Rights (EOCR) at UVAEOCR@virginia.edu or 434-924-3200.

Accommodations do not relieve you of the responsibility for completion of any part of the coursework missed as the result of a religious observance.

Week	**Lecture Scheduled**	
Week # 1 Aug 26, 28	1.1: Lines and linear equations 1.2: Linear systems and matrices 1.4: Application: (mention) Curve fitting	
Week # 2 Aug 31, Sept 2-4	2.1: Vectors 2.2: Span	
Week # 3 Sept 7-11	2.3: Linear independence 3.1: Linear transformations 3.2: Matrix Algebra (as Hw)	

Week # 4 Sept 14-18	3.3: Inverses 4.1: Introduction to subspaces	Project 3.4: LU factorization OR 3.5: Markov chains
Week # 5 Sept 21-25	4.2: Basis and dimension 4.3: Row and column spaces	9/21(Monday): Midterm 1, Chapters 1, 2, 3,
Week # 6 Sept 28 - Oct 2	(4.3: Row and column spaces) 4.4 Change of basis (& coordinate vector)	
Week # 7 Oct 5-9	5.1: The determinant function 5.2: Properties of the determinant	
Week # 8 Oct 12-16	6.1: Eigenvalues and eigenvectors 6.2: Diagonalization	
Week # 9 Oct 19-23	7.1: Vector spaces and subspaces	10/23(Friday): Midterm 2, Chapters 4, 5, 6
Week # 10 Oct 26- 30	7.2: Span and linear independence 7.3: Basis and dimension	
Week # 11 Nov 2-6	8.1: Dot products and orthogonal sets 8.2: Projection and the Gram-Schmidt Process	
Week # 12 Nov 9-13	8.5 Least Squares Regression 9.1: Definition and properties of linear Transformations	Student project 8.3: Diagonalizing symmetric matrices
Week # 13 Nov 16-20	9.2: Isomorphism 9.3: The matrix of a linear transformation	
Week # 14 Nov 23,25	10.1: Inner products	

Final Exam 12/08/2020 7:00pm-10:00pm: Cumulative all of the materials. The final exam can't be taken early according to UVA policy, please make your plans accordingly.