

These slides, as well as all the information about the course, can be found at:
(shortcut: Google "Maira Chas")

<http://www.math.stonybrook.edu/~moira/courses/mat211-fall18/>

MAT 211 Introduction to Linear Algebra

About your instructor and this course

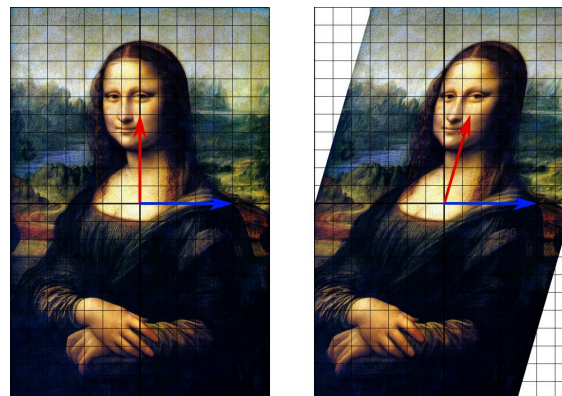


Image from Wikipedia

Space, cyberspace and time coordinates of your instructor

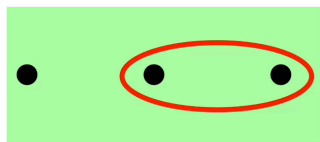


- ♦ Moira Chas, Associate professor
- ♦ Best way to contact me:
 - ♦ moira.chas at stonybrook.edu
- ♦ Website: <http://www.math.sunysb.edu/~moira/>
- ♦ Office: 3-119 Math Tower
- ♦ How to address me? Professor Chas is OK

I ♥
Math

Office hours:

- ♦ Mo 11am to 1pm in 3-119 Math Tower.
- ♦ We 11am to 12pm in P-143 Math Tower,
- ♦ and/or by appointment (email me!).



About this course

The more times any of us practice remembering something we are trying to learn, the more firmly we lodge it in our memories for the long term. James Lang

- ♦ In the first the last few minutes of some classes, we are going to work on a summary of the what already learned and/or what we are about to learn.
- ♦ Make groups of 3, 4 students.
 - ♦ Exchange ways of communication (email, phone number, smoke signals, whatever you are comfortable with).
 - ♦ Write down two or three sentences explaining what do you think linear algebra is

Inspired in an article by
Ignacio Salduendo

Why math?

- ❖ Math is useful: without math we wouldn't have GPS, subway, medicines...
- ❖ Math is beautiful and interesting (says me, the mathematician)
- ❖ Logical structure: It is developed from few initial concepts and clear arguments.
- ❖ Math keeps us honest.
- ❖ Math teaches us patience and grit
- ❖ "Education is what remains after one has forgotten what one has learned in school.." Einstein

411,296 views | Nov 12, 2014, 11:43am

Why math?

The 10 Skills Employers Most Want In 2015 Graduates



Susan Adams Forbes Staff
I'm a senior editor in charge of Forbes' education coverage.

1. Ability to work in a team structure
2. Ability to make decisions and solve problems
3. Ability to communicate verbally with people inside and outside an organization
4. Ability to plan, organize and prioritize work
5. Ability to obtain and process information
6. Ability to analyze quantitative data
7. Technical knowledge related to the job
8. Proficiency with computer software programs
9. Ability to create and/or edit written reports
10. Ability to sell and influence others

What is linear algebra about?

Poll locked. Responses not accepted.

- "Linear algebra is basically about graphing coordinates, vectors" "Linear Equations"
- "Studying lines without calculus" "plex things" "Matrices"
- "the study of points on a graph and how they are related to one another"
- "Linear algebra involves vectors and matrices on the coordinate plane. It shows data and how things move along the plane."
- "Dimensions" "Easy" "many maths" "Matrices"
- "Linear algebra is used to represent linear functions in the form of vectors and matrices. It is applied to models in different dimensions that help with"
- "Vectors" "dimensions" "*lines*" "Determinants" "vectors" "Vectors"
- "Tool to help analyze linear functions." "Visualizing"
- "linear algebra is the branch of math that studies vectors, 3D sp" "Analyzing planes"
- "Using functions in multiple dimensions to solv" "Math" "r" "Systems of equations"
- "Coordinates in Space" "Joing what calculus can but with algebrai" "Differential"

What is linear algebra about?

Poll locked. Responses not accepted.

- "Matrices and linear functions" "yur" "lots of maths"
- "Linear algebra involves the transformation of fubctions in vector spheres."
- "A way to relate functions using matrices" "Linear equations"
- "The study of matrices and vectors and sets without using" "Matrices" "lines"
- "An extension of calculus one and two and include somethi" "Dimension" "s."
- "Rerepresenting algebra in different ways"
- "Linear Algebra has to do with matrices vectors and linear transformations of coordinate space"
- "2D Planes" "Linear algebra is the study of math that focus' around the properties of lines"
- "Accurate" "Quantum" "Study of linear equations" ctor" "Charts"
- "Quadratic" tors" "Can anyone see th" "Vector space"
- iables" "Scalars vectors"
- "The study of graphs and vectors in different spaces"

What is linear algebra about?

 **Poll locked.** Responses not accepted.

The study of matrices and vectors and sets without using matrices

“An extension of calculus one and two and include something “Dimension” s.”

“Rerepresenting algebra in different ways”

“Linear Algebra has to do with matrices vectors and linear transformations of coordinate space”

“2D Planes” “Linear algebra is the study of math that focus' around the properties of lines”

“Accurate” “Quantum” “Study of linear equations” ctor” “Charts”

“Quadratic” tors” “Can anyone see th “Vector space”

ables” “Scalars vectors”

“The study of graphs and vectors in different spaces”

“Linear algebra is a unidimensional study of variables and related entities in the mathematical sphere”

“The analysis of the transformations of lines, built off of calculus, and an analysis at varying dimensions”

“lines and vectors” linear equations and ma “Math” “Math and lines”

“Abstract” “An area of study focusing on linear equations and linear functions”

Why linear algebra?

Besides many applications to different areas of mathematics, linear algebra is applied everywhere in the real world.

- ❖ In a large number of situations, one needs to solve an equation.
- ❖ The simplest equations to solve are the linear ones.
- ❖ Many problems have a linear approximation.

Tips to succeed in this course

Dedicate around 6-8 hours/wk to this course (outside the classroom). During these hours, your goal should be to **understand** the material. To do so,

- ❖ Work on written and WebAssign **HOMEWORK**
- ❖ **READ** the assigned sections of the textbook beforehand (**with paper and pencil handy**).

Every topic will be covered in class but some details will not be explained. You must must must **READ** the book

Tips to succeed in this course

- ❖ Do not leave the homework for the last minutes before the deadline.
- ❖ Attend the lectures, and when you do, *be completely* in the class. (This implies no use of electronics. Note: cell-phone is electronic)
- ❖ Come ready to work in class
- ❖ Get help if you need it, as soon as you need it (office hours, MLC)

Tips to succeed in this course

- ❖ Office hours: you do not need a concrete question, any confusion or uncertainty is justification.
- ❖ Get out of your comfort zone (in a productive way). Remember that most of us have been there: where not understanding a topic almost hurts... But if you work hard this changes.
- ❖ Ask questions (for instance What do you mean by a “blah”?)
- ❖ Answer questions
- ❖ The process of learning involves making mistakes. In other words, expect to make mistakes and do not judge yourself or others for them.

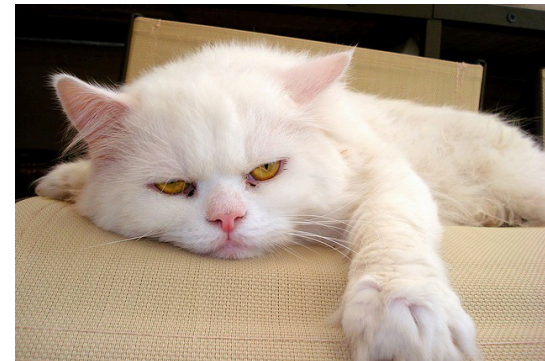
TABLE 1

Fixed mindset	Instead of	Try thinking	Growth mindset
	I am not good at this	What am I missing?	
	I am awesome at this	I am on the right track	
	I give up	This might take longer than I expected	
	This is too hard	I'll try to use some of the strategies we learned	
	I can't make it any better	I can improve if I keep trying	
	I am not a math person	I can train my brain to do math.	
	I am upset because I made a mistake	Mistakes help me learn better	
	The problem is that X is smarter than me	I'll try to learn how X does it.	
	It is good enough	How can I improve this?	
	My strategy didn't work.	What other strategy I can try?	
	This is too easy for me	Can I understand this more deeply?	

Unknown source

Constructive feedback is welcome by me, your instructor.

Administrative stuff



Homework Assignments

- ❖ HW 0: It is required!!
- ❖ You cannot learn math without working on problems.
- ❖ Expect to spend a few hours a week working on homework.
- ❖ Each graded problem is worth 5 points.
- ❖ **Grader:** Siqing Zhang, siqing.zhang“at”[stonybrook.edu](mailto:siqing.zhang@stonybrook.edu)
- ❖ **Grader office hours:**
 - ❖ Wed 3:00-4:00 p.m at S-240A Math Tower,
 - ❖ Wed 4:00-6:00 pm, Math Learning Center

Written Homework must contain

- ❖ The statement of the problem
- ❖ An answer that is emphasized, if appropriate.
- ❖ In most problems if there is no work shown, there is no credit. In other words, an answer with no justification is not admissible (even if it is the correct answer!)

Homework should be legible and written in complete English sentences.

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Grades policy

The goal of this course is to LEARN.
My job is to teach, grading is a tool to improve the learning.

- ❖ The final grade will be based on the midterms score (20% each) the final examination (40%) written homework and class participation (10%) and WebAssign homework (10%)
- ❖ The midterms and final will consist in problems similar to some of those of the homework.
- ❖ Class participation means being active and present in class, asking relevant questions and working on the proposed activities.
- ❖ Attendance will not be formally taken being really present (besides being beneficial for you) will count in your favor .

Is it allowed to work in teams?

- ❖ You may discuss the assignments in this course with classmates, before working in the write-up.
- ❖ Each student's submission must be his or her own work.
- ❖ It is not allowed to browse the Internet for solutions.

ACADEMIC DISHONESTY

- All work you submit for homework, final, or exams **MUST** be your own work.
- If you cheat or aid someone in cheating, you will automatically fail this course and be brought up on charges of academic dishonesty without warning.
- Cheat includes: presenting work of other as your own, copying other student work, facilitate that other student copies your work, use of notes, calculators and/or electronic devices during examinations.

Online Resources

- ✦ Course Website:
 - ✦ <http://www.math.stonybrook.edu/~moira/courses/mat211-fall18/>
 - ✦ Syllabus, homework schedule, exams dates, announcements.
 - ✦ <http://www.math.stonybrook.edu/~moira/courses/mat211-fall18/Material/>
 - ✦ Slides, and other materials (including the one you are reading)
- ✦ Blackboard:
 - ✦ Grades

Email communications

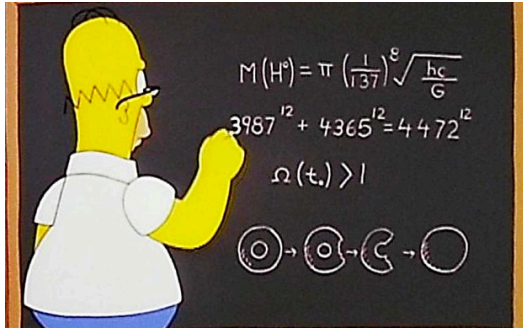
- During the semester, I will send a few emails. Please make sure that you check the Stony Brook email account regularly.
- Messages should be written in complete English sentences.
- I check my email about once a day, so expect my answer accordingly. I cannot answer complicated math question by email. This is office hours are for.

Book and WebAssign

Textbook: Linear Algebra: A Modern Introduction 4th Edition, by David Poole.

WebAssign is required (more about this in a few minutes)

Calculators are not allowed in the exams



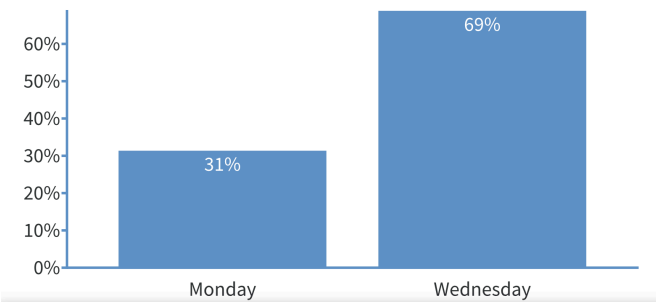
Course Policies

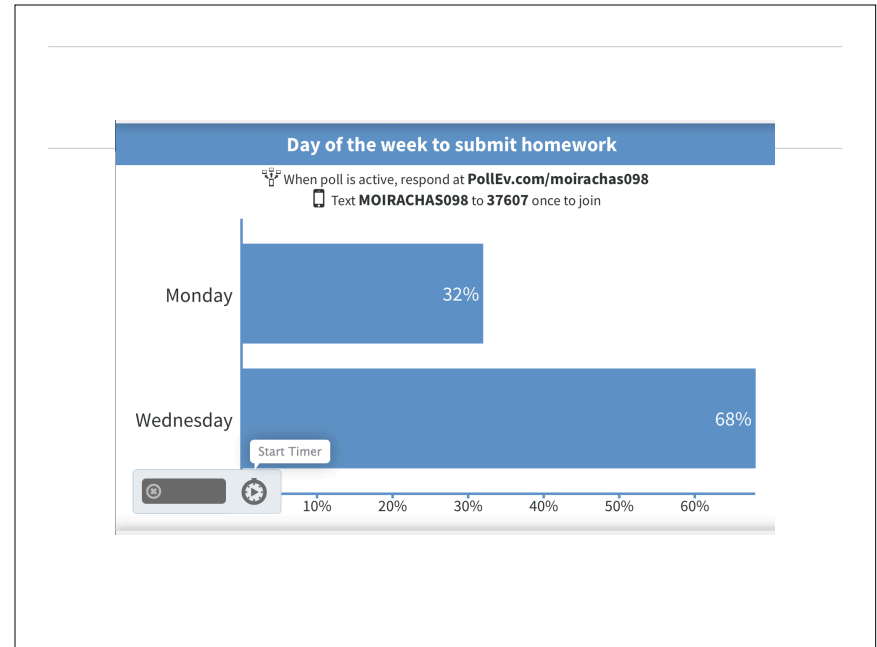
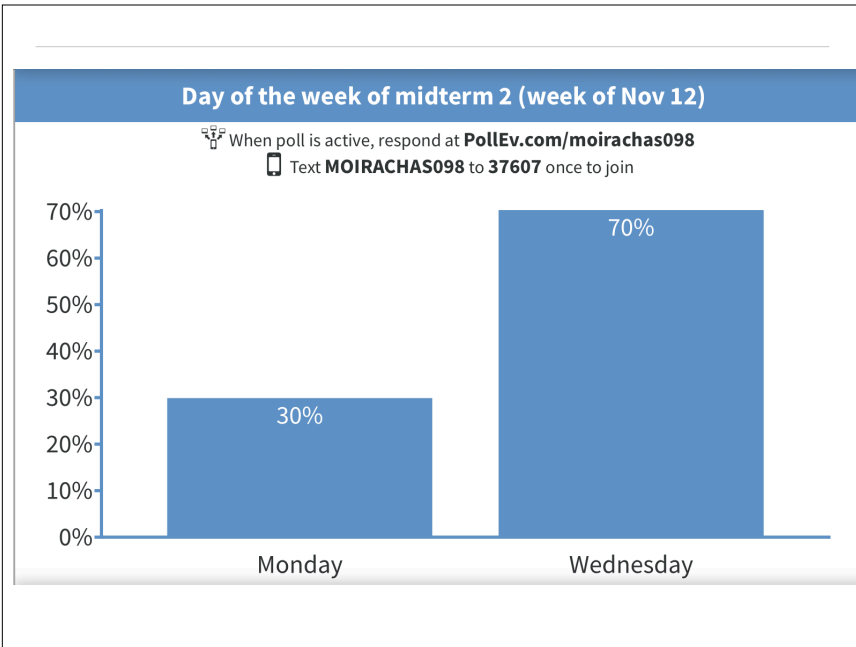


There are no dumb questions

Day of the week of the midterm 1 (on the week that starts of Oct 1st)

When poll is active, respond at [PollEv.com/moirachas098](https://poll.ev.com/moirachas098)
Text **MOIRACHAS098** to **37607** once to join



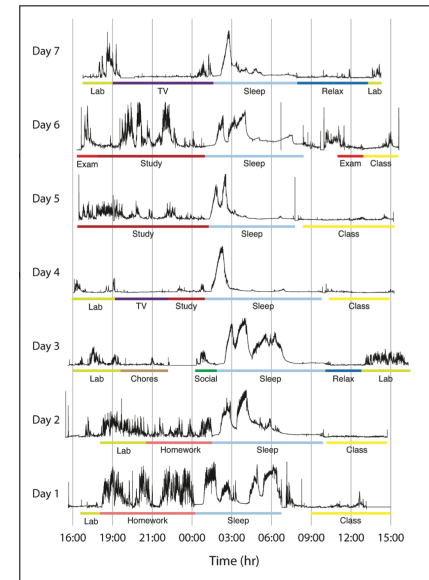


A quotation (sometimes attributed to Mark Twain)

“Lecturing is that mysterious process by means of which the contents of the note-book of the professor are transferred to the note-book of the student without passing through the mind of either.”

Table by Eric Mazur

Let's make brain waves in this lecture.



An overview of the topics

scalar ($\in \mathbb{R}$)

vectors
 add
 subtract
 multiply by scalar
 algebraically
 geometrically
 special vecs δ
 dot product
 in \mathbb{R}^n length, angle

matrices

add
 subtract
 multiply by scalar
 special matrices \rightarrow row echelon form
 product of matrices
 inverse \rightarrow how to find it
 invertible matrix
 determinant
 Factorization of Matrices $\left\{ \begin{array}{l} LU \\ QR \end{array} \right.$
 diagonalizable
 similar matrices
 Eigenvalues, eigenvectors
 Perron-Frobenius Thm
 rank

vector spaces dim'n
 basis
 $V, \mathbb{R}, \mathbb{R}^2$

subspaces (lines, planes, ...)

orthogonality
 algebraically
 geometrically
 orthonormal basis
 orthogonal complement
 projection
 orthogonal decomposition
 Gram-Schmidt method

linear transformations

algebraically
 geometrically
 from \mathbb{R}^n to \mathbb{R}^n : description
 from \mathbb{R}^n to \mathbb{R}^m : these kinds
 scaling
 rotate
 shear
 inverse
 composition
 matrix

systems of linear equations

Different ways of saying
 when a system has a
 unique sol'n.
 algebraically
 geometrically
 When do they have sol'n
 "How many" solutions?

What is a vector?

Poll locked. Responses not accepted.

Top

14	A quantity that has magnitude and direction
8	A fancy arrow
6	A villian from despicable me
4	A quantity that has magnitude and direction
3	A value that has both magnitude and direction
1	Something with both magnitude and direction
1	it is a point that only travels in one direction
1	A quantity with magnitude and direction

Learning objectives

- ❖ solve systems of linear equations using Gauss-Jordan elimination;
- ❖ perform operations (addition, multiplication, inversion) with matrices;
- ❖ understand the idea of vector spaces, be able to recognize them, and compute their dimension;
- ❖ decide whether a function between vector spaces is a linear transformation, or an isomorphism;
- ❖ understand linear transformations from a geometric point of view, and decide whether a transformation is orthogonal;
- ❖ compute the kernel and image of a linear transformation;
- ❖ compute determinants;
- ❖ compute eigenvalues and eigenvectors of a matrix and use them (if possible) to diagonalize the matrix.

MAT 211

Lecture 2

We will use activities from
the book

Linear Algebra:
A Guided Discovery Approach

Feryal Alayont
Steven Schlicker

(a) On the same set of axes, plot the points that correspond to 5-6 scalar multiples of the vector $\begin{bmatrix} 1 \\ 2 \end{bmatrix}$. Make sure to use variety of scalar multiples covering possibilities with $c > 0$, $c < 0$, $c > 1$, $0 < c < 1$, $-1 < c < 0$. If we consider the collection of all possible scalar multiples of this vector, what do we obtain?

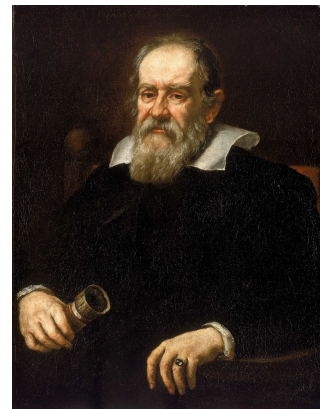
(b) What would the collection of all scalar multiples of the vector $\begin{bmatrix} 0 \\ 0 \end{bmatrix}$ form in the plane?

(c) What would the collection of all scalar multiples of the vector $\begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$ form in the three-dimensional space?

Let $\mathbf{u} = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$ and $\mathbf{v} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$ in \mathbb{R}^2 . We are interested in finding all vectors that can be formed as a sum of scalar multiples of \mathbf{u} and \mathbf{v} .

- (a) On the same set of axes, plot the points that correspond to the vectors \mathbf{u} , \mathbf{v} , $\mathbf{u} + \mathbf{v}$, $1.5\mathbf{u}$, $2\mathbf{v}$, $-\mathbf{u}$, $-\mathbf{v}$, $-\mathbf{u} + 2\mathbf{v}$. Plot other random sums of scalar multiples of \mathbf{u} and \mathbf{v} using several scalar multiples (including those less than 1 or negative) (that is, find other vectors of the form $a\mathbf{u} + b\mathbf{v}$ where a and b are any scalars.).
- (b) If we considered sums of all scalar multiples of \mathbf{u} , \mathbf{v} , which vectors will we obtain? Can we obtain any vector in \mathbb{R}^2 in this form?

Philosophy is written in that great book which ever lies before our eyes – I mean the universe – but we cannot understand it if we do not first learn the language and grasp the symbols, in which it is written.



This book is written in the mathematical language, and the symbols are triangles, circles and other geometrical figures, without whose help it is impossible to comprehend a single word of it; without which one wanders in vain through a dark labyrinth.

Galileo Galilei

10 Growth Mindset Statements

FIXED MINDSET



What can I say to myself?

GROWTH MINDSET



INSTEAD OF:

TRY THINKING:

I'm not good at this.

I'm awesome at this.

I give up.

This is too hard.

I can't make this any better.

I just can't do Math.

I made a mistake.

She's so smart. I will never be that smart.

It's good enough.

Plan "A" didn't work.

1 What am I missing?

2 I'm on the right track.

3 I'll use some of the strategies we've learned.

4 This may take some time and effort.

5 I can always improve so I'll keep trying.

6 I'm going to train my brain in Math.

7 Mistakes help me to learn better.

8 I'm going to figure out how she does it.

9 Is it really my best work?

10 Good thing the alphabet has 25 more letters!

(Original source unknown)

@sylvia Duckworth