Lesson Plans for SSEA

Pre-course: Give students math origin story writing prompt to learn a little bit about each student.

Very broadly speaking, this course has two goals:

1. Introduce students to linear algebra.
2. Introduce students to important skills needed to succeed in taking mathematical classes at Stanford.

Accordingly, on each day we list goals related to linear algebra, and goals related to skill building.

Ensure each class has a break in the middle of approximately 5 minutes (activities are often listed here as taking slightly more time than they actually do to allow for this). On days without homework, ask students to finish anything they didn't finish in class (this can be quite important on some days!). The descriptions of most activities are available on the website. The notes and activity columns here only contain material not already present on the website.

Day 1

Skill building goal: Set the tone–we're a warm and cozy classroom with friendly people! Introduce working together and convincing each other.
Math goal: Play with the notion of a vector.

	Activity	Notes
30	Getting cozy with each other. - Names (snowballing names activity, with instructor going last), pronouns, where are you from, and share any one other thing (a hobby or what you are looking forward to in SSEA, or anything else). - Goals for the course: What this course is about: Foundational (linear algebra is important!), the first two weeks of Math 51 (we'll be going slower!), fun math review, having the right attitude towards math, and problem solving. Mention that activities are not always connected to linear algebra. Explain that meta-skills are important, and that students should consciously try to focus on those too. (This is part of why the class will be useful even if students plan to take Math 51.) - Review syllabus and address if there is anything we want to add (expectations for instructors and students). - Review methods of contacting instructions..	- If you forget a name, just ask. Don't try to guess. (because you might guess incorrectly). - Reflection prompts don't have word limits. - Sections were randomly assigned.

	- Bring up office hour times. Stress their importance. Explain how they work (only need to attend for a while, can discuss homework or something else). It's also an assignment!	
20	String shapes activity	
60	Magic carpet activity	
10	Bring back together to wrap-up. Assign homework.	
HW	Watch the video about the [Honor Code]().	

Day 2

Skill building goal: Reflect on group work. Begin learning to present mathematics. Introduce important problem solving strategies, especially experimenting by trying simple examples and making guesses.

Math goal: Continue playing with the notion of a vector. Think about discrete linear combinations.

	Activity	Notes
60	Magic carpet activity continued	- Finish posters and do gallery walk, discuss, and work on part 2.
20	Honor code activity	
20	Good group work activity	
20	No more pennies activity	
HW	Give students good group work writing prompt	

Day 3

Skill building goal: Provide familiarity with various math resources and what to do in case you miss a lecture. Introduce the concept of a 'mathematical convention.'

Math goal: Introduce the definition of a vector and vector operations and transition from informal to more formal notions. Recap the concept of exponents.

	Activity	Notes
25	Math resources activity	
25	Reading practice activity	- Read section 1.3 (specifically the first page and half of the second page, i.e. pages 6 and half of 7.)
5	Middle of class break	
15	Write up a new solution to the magic carpet problem using the new terminology/notation.	- "Form new groups of three, where nobody in your group was also in your group earlier in the class." - Groups stand around the classroom using whiteboards.
10	Go over the reflections from the previous homework.	- Instructor prepares for this by reading reflections from students in their classes.
40	Root 2 and beyond activity	
HW	Give out homework 1	- Consider talking about discipline and how they can start to look at the problem set now, even though it is due next week.

Day 4

Skill building goal: Discuss problem solving strategies more explicitly.

Math goal: Introduce the concepts of magnitude, distance, and change-of-origin.

	Activity	Notes
15	Root 2 and beyond activity continued	

15	Discussion of homework and using resources	- Ask students in pairs to discuss
		  - What strategies and resources did you/ would you use for the homework?
		  - What lingering questions did you have? Try to come up with a specific question that will help

		clear that up.
20	Problem solving activity	
20	Reading practice activity	- Read example 1.6.3.
40	Maps and distances activity	
10	Mini lecture about convex combinations	

Day 5

Skill building goal: Focus on exploration as a process to discover definitions and theorems in mathematics.
Math goal: Introduce perpendicular vectors, dot product, and the cosine law.

	Activity	Notes
15	Review homework	- Ask students to discuss in small groups things they got stuck on or things they have questions about.
10	Perpendicularity and approximations activity	
35	Patterns in perpendicular vectors activity	- Introduce the word 'conjecture.'
40	Cosine law activity	
HW	Give students ask a 'dumb' question work writing prompt	

Day 6

Skill building goal: Familiarize students with various math words and introduce the concept of a proof.
Math goal: Explain the properties of dot product, and why the dot product being 0 is linked to perpendicularity.

	Activity	Notes

30	Math words matching game activity	- Each instructor can create their own definitions.
90	Dot product activity	

Day 7

Skill building goal: Provide practice with designing problems and making reference sheets. Understand any student concerns about the class.
Math goal: Review material studied in class so far.

	Activity	Notes
	Meet students one on one. Simultaneously, ask students to work on: Secret Santa activity 'Cheat' sheet activity Finish any incomplete activities.	
HW	Do the homework problem you received. Turn in the cheatsheet you worked on.	

Day 8

Skill building goal: Continue building a relationship with students by doing an activity linked to your own interests (different instructors do different activities).
Math goal: Introduce the concept of a plane.

	Activity	Notes
10	Discussion on comments from one-on-one meetings..	
80	VSM (Various sneaky mathematicians) activity	
30	Instructor's choice activity.	- Pranav did an ask-me-anything. - Shintaro did origami.
HW	Give out homework 2	

Day 9

Skill building goal: Continue providing practice with presenting mathematics.

Math goal: Continue discussing the concept of a plane.

	Activity	Notes
120	VSM activity continued	
HW	Give students ask mathematics in the world writing prompt	

Day 10

Skill building goal: Continue providing practice with presenting mathematics.

Math goal: Introduce the definitions of parametric, equational, 3 point, and point-normal forms, and transition from informal to more formal notions. Provide practice with converting between different forms of a plane.

	Activity	Notes
20	Review VSM activity	- Use the words parametric and equational when talking about the planes.
40	Reading practice	- Read descriptions of different forms of the plane from the textbook (specifically pages 48 and 49.) - Use the 'jigsaw' technique, ask students how what they are reading is related to problems they did, and ask them then to think about the pros and cons of the various descriptions they've now seen..
50	Converting between descriptions of planes activity	

Day 11

Skill building goal: Provide opportunities to cooperate outside of a small group. Introduce the idea that it suffices to find a single example to prove a statement false.

Math goal: Continue providing practice with converting between different forms of a plane. Help identify common errors made while performing algebraic manipulations, and help identify a strategy to reduce errors.

	Activity	Notes

30	Converting between descriptions of planes activity continued	
50	Planes telephone activity	
40	True or false activity	

Day 12

Skill building goal: Reflect on preparing for lecture, and strategies to learn effectively from lecture. Provide a taste of mathematical research. Continue practice with problem solving strategies.
Math goal: Begin discussing the ideas of span, subspace and dimension.

	Activity	Notes
20	Review material from previous class	
20	Preparing for lecture activity.	
20	Introduce chapter 4.	
60	Egyptian fractions activity	
HW	Skim read all of chapter 4, to prepare for the upcoming lecture. 15 minutes is enough!	

Day 13

Skill building goal: Reflect on what attending lecture is like. Continue discussion of the idea that they are formal and informal ways to talk about ideas.
Math goal: Discuss the ideas of span, subspace and dimension more formally, and discuss their relationship to informal notions considered earlier.

	Activity	Notes
50	Lecture on chapter 4	
10	Moving back to individual classrooms	
20	Lecture debrief	- What was asking questions like?

		- How easy/ hard was it to pay attention? - How easy/ hard was it to look at the board?
20	Discussion of how concepts introduced in lecture are related to the Magic Carpet and VSM activities	
HW	Give out homework 3	

Day 14

Skill building goal: Provide experience of what attending section is like.

Math goal: Learn to find spanning sets from equations determining a subspace. Provide practice with checking whether a vector is in a subspace (and see how tedious it is). Continue appreciating the relationship between new concepts and informal notions considered earlier. Introduce the concept of a basis.

	Activity	Notes
60	Attending section activity	
45	Spanning sets activity	
15	Mini lecture about the definition of a basis as a spanning set with no redundancies. The dimension is the number of vectors in the basis.	

Day 15

Skill building goal: Provide an example of a mathematical game. Continue providing practice with presenting mathematics.

Math goal: Continue discussing the concept of a basis. Provide practice with checking whether a set of vectors has a redundancy. Introduce orthogonal bases and their importance.

	Activity	Notes

20	Mini lecture about basis continued. Suppose we already have one basis. How can we check if some other set is a basis? We need to check the following:
	   - It is spanning.
	   - It has no redundancies.
	This is typically difficult to do, so even if we can remove one of these conditions, we already have an improvement! Blackbox theorem 1: If you have dim(V) vectors with	

	no redundancy, they form a basis of V. So we've simplified things at least a bit to checking:
	   - There are dim(V) vectors.
	   - It has no redundancies.	

30	Basis ladder activity	- Make sure R^n has dimension n–the standard basis is easily seen to be both spanning and have no redundancies. - Discussion: it's still pretty tedious! Is there an easier way to guarantee that a set is a basis? Yes! Orthogonality. - Blackbox theorem 2: a collection of orthogonal vectors have no redundancies.
70	Practice with bases activity	

Day 16

Skill building goal: Continue discussion of the idea that they are formal and informal ways to talk about ideas.

Math goal: Introduce projections, focussing on projections onto a line. Provide intuitive and formal ways of understanding what a projection is.

	Activity	Notes
50	Practice with bases activity continued	
20	Projections using a toy train activity	
50	The nearest vector interpretation and the projection formula activity	

Day 17

Skill building goal: Provide opportunities to cooperate outside of a small group.

Math goal: Discuss projection onto a subspace, focussing on projecting a vector in R^3 onto a plane.

	Activity	Notes
50	The nearest vector interpretation and the projection formula activity continued	

40	Projection onto planes telephone activity	

30	Instructor's choice activity	- Pranav asked students to work on submitting reflections.
		- Shintaro did origami with the '7 intersecting planes model':
		   - Each student folds two or three modules (paper is pre-cut, as required).
		   - Each student writes their name and/or a message on one of the papers before folding it. (Once folded, the message disappears).
		   - The instructor collects the modules and brings them back to class the next day, but all folded up!
		- Megan did high-level review of what was done in class so far.

Day 18

Skill building goal: Understand how mathematical concepts apply in the real world.
Math goal: Review the material of the class.

	Activity	Notes
30	Discussion of applications of projections onto a subspace through a presentation	
15	Very quick recap of concepts covered in class Topics: - Properties of vectors (add/scale, length, distance between vectors) - Perpendicular vectors and dot product - Plane representations + translations between them - Spans, subspaces, dimension - Bases and Orthogonal bases - Projections	
75	Making a presentation activity: - Students in groups of 4-ish make 12-ish minute presentations on one of the	Some potential strategies students could use: - Slides

	6 topics. Bonus points for making it interactive.	- Embed recordings - Do a problem - Do an example or application - Connect different concepts we covered.

Day 19

Skill building goal: Provide a sense of accomplishment.
Math goal: Review the material of the class.

	Activity	Notes
10	Preparation for presentations	
90	Student presentations	
15	Skills recap activity	