Mathematics 2271—3 Linear Algebra

SYLLABUS - VERSION 5 - please discard all earlier versions!

Week	Date	Lecture	Topic	Textbook	Assignment
1	M 08/22/22	1	Introduction and Technicalities		hw 1 h.o.
1	T 08/23/22	2	Vectors and Linear Combinations	1.1	
1	W 08/24/22	3	Lengths and Dot Products	1.2	
1	F 08/26/22	4	Matrices	1.3	
2	M 08/29/22	5	Vectors and Linear Equations	2.1	hw 2 h.o.
2	T 08/30/22	6	The Idea of Elimination	2.2	
2	W 08/31/22	7	Elimination using Matrices	2.3	hw 1 due
2	F 09/02/22	8	Discussion		
3	M 09/05/22		**NO CLASS**		
3	T 09/06/22	9	Rules for Matrix Operations	2.4	hw 3 h.o.
3	W 09/07/22	10	Inverse Matrices	2.5	hw 2 due
3	F 09/09/22	11	Discussion		
4	M 09/12/22	12	Elimination = Factorization $A = LU$	2.6	
4	T 09/13/22	13	Transposes and Permutations	2.7	
4	W 09/14/22	14	Spaces of Vectors	3.1	hw 3 due
4	F 09/16/22	15	Discussion		
5	M 09/19/22	16	The Nullspace of A: Solving $Ax = 0$	3.2	hw 4 h.o.
5	T 09/20/22	17	Review		
5	W 09/21/22	18	Exam 1 on Chpt 1 and 2		Exam 1
5	F 09/23/22	19	Discussion		
6	M 09/26/22	20	The complete Solution of $Ax = b$	3.3	hw 5 h.o.
6	T 09/27/22	21	Independence, Basis, and Dimension	3.4	
6	W 09/28/22	22	Dimensions of the Four Subspaces	3.5	hw 4 due
6	F 09/30/22	23	Discussion		
7	M 10/03/22	24	Orthogonality of the Four Subspaces	4.1	hw 6 h.o.
7	T 10/04/22	25	Projections	4.2	
7	W 10/05/22	26	Least Squares Approximations	4.3	hw 5 due
7	F 10/07/22	27	Discussion		
8	M 10/10/22		**NO CLASS**		
8	T 10/11/22		**NO CLASS**		
8	W 10/12/22		**NO CLASS**		
8	F 10/14/22		**NO CLASS**		
9	M 10/17/22	28	Orthogonal Bases and Gram-Schmidt	4.4	
9	T 10/18/22	29	The Properties of Determinants	5.1	
9	W 10/19/22	30	Permutations and Cofactors	5.2	hw 6 due
9	F 10/21/22	31	Discussion		
10	M 10/24/22	32	Cramer's Rule, Inverses, and Volumes	5.3	hw 7 h.o.
10	T 10/25/22	33	Review		
10	W 10/26/22	34	Exam 2 on chapter 3 and 4		Exam 2
10	F 10/28/22	35	Discussion		
11	M 10/31/22	36	Interpolation and Determinants		
11	T 11/01/22	37	Introduction to Eigenvectors	6.1	
11	W 11/02/22	38	Diagonalizing a Matrix	6.2	hw 7 due
11	F 11/04/22	39	Discussion		
12	M 11/07/22	40	Systems of Differential Equations	6.3	
12	T 11/08/22	41	Symmetric Matrices	6.4	
12	W 11/09/22	42	Positive Definite Matrices	6.5	
12	F 11/11/22	43	Discussion		
13	M 11/14/22	44	Image Processing by Linear Algebra	7.1	
13	T 11/15/22	45	Review		
13	W 11/16/22	46	Exam 3 on Chapters 5 and 6		Exam 3
13	F 11/18/22	47	Discussion		

14	M 11/21/22	48	Bases and Matrices in the SVD	7.2	hw 8 h.o.
14	T 11/22/22	49	Applications of the SVD (replaces section 7.3)		
14	W 11/23/22	50	The Geometry of the SVD	7.4	
14	F 11/25/22		**NO CLASS**		
15	M 11/28/22	51	The Idea of a Linear Transform	8.1	
15	T 11/29/22	52	The Matrix of a Linear Transform	8.2	
15	W 11/30/22	53	The Search for a Good Basis	8.3	hw 8 due
15	F 12/02/22	54	Discussion		
16	M 12/05/22	55	The Google Page Rank Application		
16	T 12/06/22	56	Review		
16	W 12/07/22	57	More Review		

Notes

Tentative: **This syllabus is subject to change!** You will be notified of significant changes in class and via Canvas.

Linear Algebra: Linear Algebra is the mathematics of functions between **finite dimensional linear spaces**. The elements of those spaces are **vectors**, and the functions are **matrices**. That sounds pretty dry. But Linear Algebra is as central and fundamental to problem solving in Science and Engineering as is Calculus. That's why you need to learn about it. You will also see that it has a beautiful, rich, and *comprehensible* structure. I trust and hope that you will enjoy this class.

Math 2271 This class, Math 2271, covers the same material as Math 2270. It serves as a prerequisite wherever Math 2270 does. It differs from Math 2270 in several aspects: we use a different textbook, there is more emphasis on concepts and connections as opposed to computations, we may go into greater depth in some topics, and the class is smaller than the usual 2270 sections. The class is designed for students who are particularly well motivated, and keen to get a deeper insight into Linear Algebra.

Instructor: Peter Alfeld, JWB 127, 801-581-6851, pa@math.utah.edu. You may wonder how to address me. It makes me feel young when people your age address me by my first name, and you are very welcome to do so. However, if you are more comfortable calling me professor or Mr. Alfeld, or just professor, that's fine too.

Canvas: A large amount of additional information will be available on canvas.

Where and When: The University is operating under the assumption that most classes, including ours, will take place in physical classrooms, as they did prior to the pandemic. Thus we will meet MTWF 12:55-1:45pm in LCB 323. If if becomes necessary to meet online we will have a smooth transition to that mode.

Office Hours: I will usually be available after class until at least 2:30pm for consultations inside or outside my office JWB 127. I'll give you advance notice of any exceptions, the first one being Tuesday, 8/23. I am also very responsive to email, and we can set up appointments as well.

Notes: I will put printed notes online before class, and we will annotate them together during class. After class I will put the annotated notes online as well.

Grading: 8 home works (5% each), 3 exams (10% each), and one final exam (30%).

Fixed Scale: Grading is according to the following fixed scale.

$\geq 90\%$	$\geq 85\%$	$\geq 80\%$	$\geq 75\%$	$\geq 70\%$	$\geq 65\%$	$\geq 60\%$	$\geq 55\%$	$\geq 50\%$	$\geq 45\%$	$\geq 40\%$	**else**
A	**A−**	**B+**	**B**	**B−**	**C+**	**C**	**C−**	**D+**	**D**	**D−**	**E**

Textbook: Gilbert Strang, Introduction to Linear Algebra, Fifth Edition, Wellesley-Cambridge Press, 2016, ISBN 978-1-7331466-5-4. We will work through the first eight chapters of the textbook.

Organization Every Wednesday (except the first and last Wednesday, and the Wednesday before Thanksgiving) we will either have a home work due, or we will have a midterm exam. I expect to be able to grade these assignments on Thursday and hand them back on Friday. Fridays (except the first Friday) are called "Discussions" on the schedule. On those Friday we will talk about the graded assignments, I will answer questions, I will ask you questions, and we will tie up loose ends. During the regular lectures I will cover new material. The primary purpose of the schedule on the first two pages of the syllabus is to let you know what section we will cover on that day. I strongly recommend that you read those sections in the textbook before class. Doing so will make it much easier for you to to follow during class, and overall you will save time and deepen your understanding. You are very welcome to ask questions during class as well. The exams will take place after the last home work covering the subject of the exam has closed. Therefore, the exams will lag our class discussion. Chapters 7 and 8 will not be covered by a midterm exam. All Chapters will be covered, about evenly, by the final exam.

Home Works To get the most out of this class you should work as many of the problems in the textbook as you can. Those problems often are often quite unusual, with a twist, and sometimes challenging. The home work assignments will consist mostly of problems from the textbook. I will grade them and they will count towards your grade at the end of the semester. However, you should work more of the book exercises than those in the home works. If you get stuck on any of them feel free to talk with me.

Home works open on Mondays and close 9 days later on Wednesdays. The idea is that you finish each home work during the week that it opened. The weekend, and the following Monday and Tuesdays, are for catch up if you need it. Home works will typically cover the material from the week preceding the home work and perhaps the Monday and Tuesday after the home work first opens. Home works will be handed out as hard copies in class, and you hand back hard copies of your answers in class on the due date. You may talk with your class mates about the home works—indeed I recommend you do—but you do need to write your own answers to each questions and hand those in on the due date.

Mid Term Exams: There will be three midterm exams, each covering two chapters. They will be closed books and notes, no calculators or other electronic devices.

Final Exam: The final exam will be a comprehensive written exam in our regular classroom on

Tuesday, December 13, 2022, 1:00-3:00pm.

The format will be the same as the midterms, except the exam will be twice as long.

One Point Contest: I want the official materials for this class to be perfect. Therefore, if you find a mathematical or factual error in the home work assignments or answers, the exams, or the exam answers, and bring it to my attention before I can fix it, you will get one extra point towards your final grade. Thus to get an A in this class you only have to find 90 mistakes that I made during the semester. I appreciate if you bring other mistakes, like grammatical or spelling errors, to my attention, but there are no points for those.

Makeups Since you have the four day grace period at the end of each home work period makeups for home works will be possible only in exceptional circumstances. If you need to miss a midterm exam for a good reason let me know beforehand, or no more than a week after the exam, and you will receive the same score on the missed exam as you will on the final. Makeups for the final will be possible only in very exceptional circumstances, and will be oral.