CE282: Linear Algebra

Department of Computer Engineering
Sharif University of Technology
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Objective

To make the undergraduate students acquainted with the fundamental concepts of linear algebra and its application in computer science and engineering.

Course Description

This course covers matrix theory and linear algebra, emphasizing topics useful in other disciplines. Linear algebra is a branch of mathematics that studies systems of linear equations and the properties of matrices. The concepts of linear algebra are extremely useful in image processing, computer vision, data science, machine learning, bio-informatics, social networks, and neuroscience. Due to its broad range of applications, linear algebra is one of the most widely taught subjects in college-level mathematics.

References

Our main reference which we recommend you to read is [3]. We are extremely grateful to the authors of [1, 2, 4, 5] for the benefit we got from them in compiling the program of this lesson.

[1] Stephen Boyd and Lieven Vandenberghe. *Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares*. Cambridge University Press, 2018.

[2] Nathaniel Johnston. *Advanced Linear and Matrix Algebra*. Springer Nature, 2021.

[3] David C. Lay, Steven R. Lay, and Judi J. McDonald. *Linear Algebra and Its Applications*. Pearson, 2016.

[4] Gilbert Strang. *Introduction to Linear Algebra*. Wellesley-Cambridge Press, 2016.

[5] Gilbert Strang. *Linear Algebra and Learning From Data*. Wellesley-Cambridge Press, 2019.

Classes

The classes will be held in person on Sunday and Tuesday from 10:30 AM to 12:00 PM in Education Tower Class 205. In special circumstances, virtual classes will be held on `https://vc.sharif.edu/ch/rabiee`. Schedule of the classes is available in the appendix. If a class is canceled by students, that class may be considered as completed in the continuation of the curriculum.

TA Classes

TA classes will be held in person on Tuesdays from 12:00 PM to 1:15 PM approximately every other weeks. Schedule of TA classes is available in the appendix.

- Problem solving classes: Classes to solve additional questions will be held approximately every other week during the semester.
- Exams Exclusive classes: In particular, for each of the midterm and the final exam, a TA class will be held so that students can prepare adequately for the exam.
- Python workshops: For those students who are not familiar with Python and its related libraries, four workshop classes will be held to learn Python, NumPy, visualization libraries, and PyTorch.

Exams

Students' learning will be assessed by a midterm and a final exam. These exams will be held on the following dates and students are required to participate in them. Note that the final exam is comprehensive.

- **Midterm Exam**: 1401/02/21 9:00 AM
- **Final Exam**: 1401/03/23 9:00 AM (As Schedule in Edu, Comprehensive)

Homework Assignments

Six series of homework assignments will be released in this course. The first five series of assignments include a theoretical part and a practical part with grades of 1.40 points and 0.32 points, respectively. The last series only includes a theoretical part with grade of 1.40 points. Assignments will be released on Tuesday midnight every two weeks. Students will have 12 days for the theoretical part and 14 days for the practical part to submit answers in the Quera. Regarding *the late submission policy*, students are allowed to submit answers of the theoretical part and practical part with 5 days of delay. 15 days of delay will be ignored in way to minimize your loss. After that, 0.5% of the assignment grade will be subtracted for each hour of delay. Consider that grading of the theoretical part and practical part of an assignment is separated and delay in each of them will be calculated separately. For example, one day of delay in the practical part and two days of delay in the theoretical part of an assignment will be considered as three days in ignoring that 15 days and subtracting that 0.5%. In other words, you can consider the theoretical and practical parts as two separate assignments in grading. Delays will be calculated on a scale of hours. It's obvious that *submission after related TA class to that assignment is forbidden.*

Grading

Please note that grades will be calculated out of 22.

- **Homework Assignments**: 10 points, first five series with 1.40 points for theoretical questions and 0.32 points for practical questions, last series with 1.40 for theoretical questions.
- **Final Project**: 1 point
- **Midterm Exam**: 5 points, 1401/02/21 9:00 AM
- **Final Exam**: 6 points, 1401/03/23 9:00 AM (As Schedule in Edu, Comprehensive)

Statement on Collaboration, Academic Honesty, and Plagiarism

We encourage working together whenever possible on homework, working problems in tutorials, and discussing and interpreting reading assignments. Talking about the course material is a great way to learn. Regarding homework, the following is a fruitful (and acceptable) form of collaboration; discuss with your classmates possible approaches to solving the problems, and then have each one fill in the details and write her/his own solution *independently*. At the top of each homework you turn in, we expect you to briefly list all sources of information you used, except known course materials like Text Book, Lectures, etc. A brief note such as "Did homework with ABC and ACB in study group" or "Looked at old solution for Problem 4" would be sufficient. Besides the morality issues, it will help TAs on grading your hand outs. There will be a zero tolerance policy for Cheating/Copying HW's. The first time you are caught, you will receive a -100% of grade for the task at hand. If you are caught for a second time, you will fail the course. Refer to the Education Committee's statement on homework etiquette.

Feedback

We would be grateful if you could send us your valuable feedback. You can contact instructors or even TAs via email. You can also use this google form (`https://forms.gle/ajiQ9v4XxxUEXepQ6`) to send your feedback anonymously to instructors.

Course Pages

- Jabrekh, `https://jabrekh.github.io/`: This is the main page of our course and all exercises, slides and course resources will be placed in it.
- Quera, `https://quera.org/course/13072/`: Delivery of exercises and announcements will be done entirely through Quera. Make sure you enter an email on Quera that you check regularly. Your questions from the exercises will also be answered in Quera.

Class Schedule

Date	Title	Instructor	Description	Assignments
1401/11/16	S01	Ramezani	Introduction	HW1
1401/11/18	S02	Ramezani	Vector Space (Introduction and Operations)	
1401/11/23	S03	Ramezani	Vector Space (Field and subspace)	
1401/11/25	S04	Ramezani	LInear Equations	
1401/11/30	S05	Ramezani	Scaler-valued Functions (Linear and Affine)	HW2
1401/12/02	S06	Ramezani	Independence (Linear and Affine)	
1401/12/07	S07	Ramezani	Inner Product and Orthogonality	
1401/12/09	S08	Ramezani	Euclidian Norm and Inequalities	
1401/12/14	S09	Ramezani	Norm Space	
1401/12/16	S10	Ramezani	Matrix Properties	HW3
1401/12/21	S11	Ramezani	Transformations	
1401/12/23	S12	Ramezani	Surjection and Injection - Change of Basis	
1401/12/25	S13	Ramezani	Dimension and Rank (Online)	
1402/01/15	S14	Ramezani	Inverse	
1402/01/20	S15	Ramezani	QR Decomposition and Pseudo inverse	HW4
1402/01/22	S16	Ramezani	Deterninant	
1402/01/27	S17	Ramezani	Eigenvalue and Eigenvector	
1402/01/29	S18	Ramezani	Decomposition and Matrix Factorization	
1402/02/03	*National Holiday*		*Eid Al-Fitr*	
1402/02/05	S19	Ramezani	Symmetric Matrices and Quaratic Form	HW5
1402/02/10	S20	Ramezani	Singualr Value, Singular Vector, and SVD	
1402/02/12	S21	Ramezani	Least Square	
1402/02/17	S22	Rabiee	Least Square Regression	
1402/02/19	S23	Rabiee	Diagnonalization and Jordan Form	
1402/02/21	*Midterm Exam*		*9:00 AM*	
1402/02/24	S24	Rabiee	Matrix Inner Product and Norm	HW6
1402/02/26	*National Holiday*		*Martyrdom of Imam Jafar Sadiq*	
1402/02/31	*Survey Start*		*Educational Calendar*	
1402/02/31	S25	Rabiee	Combinations	
1402/03/02	S26	Ramezani	Tensor Derivatives	
1402/03/07	S27	Ramezani	Best Low Rank Matrix and PCA	
1402/03/08	*Withdraw Deadline*		*Educational Calendar*	
1402/03/09	S28	Ramezani	Graph and Networks	
1402/03/16	Makeup Session	N/A	Makeup Session	
1402/03/23	*Final Exam*		*9:00 AM, Comprehensive*	
1402/04/15	*Grade Submission*		*Educational Calendar*	

Important: Note that this schedule is tentative and may be affected by unforeseen circumstances.

TA Classes Schedule

Date	Title
1401/11/18	Python
1401/11/25	TA Problem Solving
1401/12/02	Python / NumPy
1401/12/09	TA Problem Solving
1401/12/16	NumPy
1401/12/23	TA Problem Solving
1402/01/15	PyTorch (Part 1)
1402/01/22	TA Problem Solving
1402/01/29	*No Class*
1402/02/05	TA Problem Solving
1402/02/12	*No Class*
1402/02/19	Exam Exclusive
1402/02/26	PyTorch (Part 2)
1402/03/02	TA Problem Solving
1402/03/09	*No Class*
1402/03/16	Exam Exclusive

Important: Note that this schedule is tentative and may be affected by unforeseen circumstances.

Homework Assignments and the Final Project Schedule

Assignment	Release	Submission	Code Submission	Solution Release
1	1401/11/25	1401/12/06	1401/12/08	1401/12/14
2	1401/12/09	1401/12/20	1401/12/22	1401/12/28
3	1402/01/15	1402/01/26	1402/01/28	1402/02/03
4	1402/01/29	1402/02/09	1402/02/11	1402/02/17
5	1402/02/12	1402/02/30	1402/03/01	1402/03/07
6	1402/03/02	1402/03/13	–	1402/03/19
Final Project	1402/03/02	–	1402/04/09	–

Important: Note that this schedule is tentative and may be affected by unforeseen circumstances.