[MGMT 690 Convex optimization - Spring 2024]

- **Instructor**: Alex L. Wang, Krannert 463, wang5984@purdue.edu
- **Lectures**: TuTh 3:30-5pm RAWL 2077
- **Gradescope**: Link
- **Piazza**: Link
- **Office hours**: By appointment
- **Textbook**: Link
- **Optional texts**:
  - **LMCO**: Lectures on Modern Convex Optimization, Ben-Tal and Nemirovski
  - **LCO**: Lectures on Convex Optimization, Nesterov
  - **CC**: A Course in Convexity, Barvinok
  - **FOMO**: First-Order Methods in Optimization, Beck

Course description

MGMT 690 is an 8-week graduate course on the interplay between convexity and optimization. Through lectures, readings, and problem sets, students will develop an understanding and appreciation of key concepts relating convexity to optimization. Key topics include:

- Fundamentals of convex analysis
- Duality theory
- Conic optimization, including second-order cone programs and semidefinite programs
- First-order methods

Learning outcomes

By the end of this course, you will be able to:

- Accurately recall and rigorously define concepts related to convexity, duality, and semidefinite programming.
- Recognize and explain applications of course concepts in current optimization or optimization-adjacent research.
- Clearly and concisely communicate course concepts.

Prerequisites

Students will be expected to have a strong command of linear algebra and basic ideas from real analysis and topology (e.g., limits, compactness, continuity).

Grading

- *Problem sets (psets)*: There will be four psets each worth 25% of your final grade.
  - The psets will be released at the beginnings of weeks 1, 3, 5, and 7 and will be due at 11:59PM on Sunday of weeks 2, 4, and 6, and Thursday of week 8. (Spring break is not counted as one of the weeks.)

    - Each pset will have two portions: exercises and standard problems. Exercises will not be graded and do not have to be submitted. Standard problems are graded for correctness and completeness as normal.
    - Pset collaboration policy: You are allowed and encouraged to *discuss* psets in groups of up to 2 students but are required to complete and submit your psets individually. Please list all members of your group on your submission.
    - Late work policy: Each student is given two late passes that individually extend the deadline for any pset by one day. Late passes may be applied to any of the problem sets and can be "stacked".
- *Class participation*: Attendance and classroom participation is expected.

Course communications

Our official online meeting space will be Piazza. We will use this discussion board to post optional related readings, give additional commentary on course topics, and discuss any questions related to course material. Piazza will additionally be used for all course announcements or communications.

Schedule

Date	Topics	Optional reading
	Linear algebra and convex analysis background	
3/5	**Lec 1:** Linear algebra review	LMCO Appendix A
3/7	**Lec 2:** Elementary convex analysis I	CC 1.1–1.2, 2.1–2.8, 2.12
3/12	Spring break — no classes	
3/14	Spring break — no classes	
3/19	**Lec 3:** Elementary convex analysis II	CC 1.1–1.2, 2.1–2.8, 2.12
	Conic programming	
3/21	**Lec 4:** Conic programming I	LMCO 1.1, 1.2, 1.4
3/24	**Pset 1 due**	
3/26	**Lec 5:** Conic programming II	LMCO 1.4
	Conic programming applications	
3/28	**Lec 6:** SOCP representability	LMCO 2.1–2.3
4/2	**Lec 7:** SDP representability	LMCO 3.1, 3.2
4/4	**Lec 8:** SDP relaxations of intractable problems	CC 4.10–4.11; LMCO 3.3–3.4; Blekherman, Parrilo, and Thomas' textbook, Chapter 2.2; Hamza Fawzi's lecture notes, Lectures 10–13

Date	Topics	Optional reading
4/7	**Pset 2 due**	
	First-order methods for smooth minimization	
4/9	**Lec 9:** Subgradient descent, gradient descent, and accelerated gradient descent	LCO 3.1.5, 3.2.3
4/11	**Lec 10:** Subgradient descent, gradient descent, and accelerated gradient descent	LCO 2.1.1, 2.1.3, 2.1.5, 2.2; Ahn and Sra (2022) on PPM and AGD; Dmitriy Drusvyatskiy's lecture notes, Sections 5.3, 6.1, and 6.2
4/16	**Lec 11:** Oracle lower bounds	LCO 3.2.1, 2.1.2, 2.1.4
4/18	**Lec 12:** Convex conjugates and performance estimation programming	FOMO 4; Drori and Teboulle (2012) on PEP
4/21	**Pset 3 due**	
	Other topics in first-order methods	
4/23	**Lec 13:** Mirror descent	FOMO 9
4/25	**Lec 14:** Frank–Wolfe method	Sebastian Pokutta's blog on Frank–Wolfe and extensions, posts 2–4; Garber and Hazan (2015) on an extension of Frank–Wolfe
5/2	**Pset 4 due**	