IE 521 (Convex Optimization) – Fall 2025

Syllabus

Instructor: Behrouz Touri

Quick Links

- Main platform: Canvas and all this information is available there too.
- Homework submissions: through Gradescope (the link is available through Canvas)

Times and Places

- Course lecture: Mondays and Wednesdays, 1:00–2:20 PM, **103 Transportation Building**.
- Instructor office hours: Wednesdays, 3:00–4:30 PM (location CSL 161), or by appointment.
- TA office hours: Thursdays, 10:30 AM–12:00 PM (room TBD).

Course Folks

- **Instructor**: Behrouz Touri
  Email: touri1@illinois.edu
- **TA**: Vincent Leon
  Email: leon18@illinois.edu

Course Description

The goal of this course is to build both the foundations to understand modern convex optimization from both a theoretical and applied perspective. Students will be expected to be both capable of rigorous mathematical arguments as well as implementation and programming.

Topics covered include:

- Fundamental concepts in optimization (e.g. optimality conditions, equivalence of optimizations)
- Fundamental concepts in convex analysis (e.g. separating hyperplanes, Legendre-Fenchel conjugates)
- Lagrangian duality
- Optimization methods and implementation (e.g. gradient descent, Newton method, interior point, cutting planes, and operator splitting methods)

Course Expectations

This course will be theoretical and rigorous. You will be expected to give valid and detailed mathematical proofs with clear exposition. Some homework assignments may require programming in Python or MATLAB.

The overall goal is to build intuition and fundamental understanding that will allow you to **develop and analyze new algorithms**, not just implement existing ones.

Course Structure

The course materials will include lecture notes, recommended readings, and references.

Assignment-wise, there will be **homeworks, two midterm exams, and a final project**. There will not be a final exam.

Grading

- Homework: 10%
- Midterm 1: 30%
- Midterm 2: 40%
- Final Project: 20%

Grades will be maintained on Gradescope.

Homework

- Administered and submitted via Gradescope.
- No late homeworks accepted.
- Lowest homework grade will be dropped.

Midterm Exams

Two in-class midterm exams will be given. The exams are closed book and notes, only one cheat sheet is allowed. No digital devices/electronics allowed. Midterm dates: Midterm 1: Wed Oct 8th, and Midterm 2: Wed Nov 19th, During the class time (in-person)

Final Project

At the end of the semester, we will have a **final project worth 20% of the grade** with two deliverables:

1. A 10-minute presentation (+2–3 minutes for questions).
2. A written report of at least 5 pages.

This final project can either be **novel research you are working on**, or **a review of a handful of related papers**, providing an overview of existing results and their context within its field.

If your final project overlaps with your thesis research, please make sure your thesis advisor is aware and approves.

Regardless of whether your project covers your own research or the work of others, your presentation and report should address:

1. Identifying Contributions

- What is new in the works being presented?
- What was the research context prior to this work?
- What is the main focus of the work (theoretical vs applied)?

2. Impact

- What can we do now with these results that we could not before?
- For theoretical works: what are the most useful implications of the results?
- For applied works: what real-world consequences exist, and what societal/economic issues might be impacted?

3. Technical Content

- For theoretical works: present the main proof ideas, explain beyond the paper's text, and demonstrate deep understanding.
- For applied works: clearly state the problem (formally and informally), describe methodology, explain why tools were chosen, and highlight difficulties in application.

You are expected to:

- Attend and engage with your peers' presentations.
- Be prepared to answer detailed questions about your topic.
- Demonstrate strong understanding, as if preparing for a qualifying exam.

Textbooks/References

- Boyd and Vandenberghe, *Convex Optimization*, available online: link.
- Bertsekas, Nedich, and Ozdaglar, *Convex Analysis and Optimization*
- Nesterov, *Lectures on Convex Optimization*, available online through campus wifi/internet: link.
- Rockafellar, *Convex Analysis*
- Bauschke and Combettes, *Convex Analysis and Monotone Operator Theory in Hilbert Spaces*

Additional notes will be provided throughout the semester.

Academic Integrity

All students are subject to the university's academic integrity policies. A quick reference guide, as well as links to the official student code, can be found at: https://provost.illinois.edu/policies/policies/academic-integrity/students-quick-reference-guide-to-academic-integrity/

We are here to help: attend the office hours, ask questions in the class, make appointments, etc. but not cheat.

The cheating policy for this course is: Any cheating at any portion of the course, results in 0 point for the entire category. For example, cheating on Problem 1 of Homework 1, results in 0% out of 10% Homework portion of the course.

College-Wide Syllabi Information

The following text is standardized across all syllabi in the Grainger College of Engineering. This class stands behind and upholds the following statements and values therein.

Sexual Misconduct Reporting Obligation

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here:

wecare.illinois.edu/resources/students/#confidential Other information about resources and reporting is available here: wecare.illinois.edu.

Academic Integrity

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: http://studentcode.illinois.edu/.

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy: https://studentcode.illinois.edu/article1/part4/1-401/. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Religious Observances

Illinois law requires the University to reasonably accommodate its students' religious beliefs, observances, and practices in regard to admissions, class attendance, and the scheduling of examinations and work requirements. You should examine this syllabus at the beginning of the semester for potential conflicts between course deadlines and any of your religious observances. If a conflict exists, you should notify your instructor of the conflict and follow the procedure at https://odos.illinois.edu/community-of-care/resources/students/religious-observances/ to request appropriate accommodations. This should be done in the first two weeks of classes.

Disability-Related Accommodations

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail disability@illinois.edu or go to `https://www.disability.illinois.edu`. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available that can help diagnosis a previously undiagnosed disability. You may access these by visiting the DRES website and selecting "Request an Academic Screening" at the bottom of the page.

Family Educational Rights and Privacy Act (FERPA)

Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See https://registrar.illinois.edu/academic-records/ferpa/ for more information on FERPA.

Anti-Racism and Inclusivity Statement for Inclusion in Course Syllabi

The intent is to raise student and instructor awareness of the ongoing threat of bias and racism and of the need to take personal responsibility in creating an inclusive learning environment.

The Grainger College of Engineering is committed to the creation of an anti-racist, inclusive community that welcomes diversity along a number of dimensions, including, but not limited to, race, ethnicity and national origins, gender and gender identity, sexuality, disability status, class, age, or religious beliefs. The College recognizes that we are learning together in the midst of the Black Lives Matter movement, that Black, Hispanic, and Indigenous voices and contributions have largely either been excluded from, or not recognized in, science and engineering, and that both overt racism and micro-aggressions threaten the well-being of our students and our university community.

The effectiveness of this course is dependent upon each of us to create a safe and encouraging learning environment that allows for the open exchange of ideas while also ensuring equitable opportunities and respect for all of us. Everyone is expected to help establish and maintain an environment where students, staff, and faculty can contribute without fear of personal ridicule, or intolerant or offensive language. If you witness or experience racism, discrimination, micro-aggressions, or other offensive behavior, you are encouraged to bring this to the attention of the course director if you feel comfortable. You can also report these behaviors to the Bias Assessment and Response Team (BART) (`https://bart.illinois.edu/`). Based on your report, BART members will follow up and reach out to students to make sure they have the support they need to be healthy and safe. If the reported behavior also violates university policy, staff in the Office for Student Conflict Resolution may respond as well and will take appropriate action.