

ISE 530 Optimization Methods for Analytics

Last edit: September 28, 2023

Course topics by week: overview

- Wk 1:** Introduction. Modeling and the optimization paradigm. Local and global minima. Convexity. Geometry of optimization problems.
- Wk 2:** Modeling with linear programming. Reformulation tricks (absolute value, min-max). Standard form of an LP and reduction to standard form. The simplex algorithm in tableau form.
- Wk 3:** Using Pyomo. The simplex algorithm in matrix form.
- Wk 4:** Sensitivity analysis. Alternative optima.
- Wk 5:** Dual of a linear program, relationship to sensitivity analysis. Weak and strong duality theorem.
- Wk 6:** Two-player zero-sum games. First and second order optimality conditions.
- Wk 7:** Line search.
- Wk 8:** Midterm exam.
- Wk 9:** Unconstrained optimization: steepest descent and Newton's method. Constrained nonlinear optimization.
- Wk 10:** KKT conditions. Examples with KKT conditions. Networks and formulations on networks.
- Wk 11:** Max-flow / min-cut. Maximum matching. The min-cost flow problem.
- Wk 12:** Network simplex algorithm.
- Wk 13:** Integer programming formulations. Modeling with binary variables. LP relaxation.
- Wk 14:** Branch-and-bound. Cutting planes: knapsack covers, Gomory fractional cuts.
- Wk 15:** Exam review.

Timetable

Classes for the course are on Tuesday and Thursday, 4PM-5:50PM.

Textbook references by week

The main textbook is *Optimization methods in finance*, by Cornuejols and Tütüncü. It is available online here: <https://www.andrew.cmu.edu/user/gc0v/webpub/book.pdf>.

The secondary textbook is *Applied Mathematical Programming*, by Bradley, Hax and Magnanti. It is available online here: <http://web.mit.edu/15.053/www/AppliedMathematicalProgramming.pdf>. It is abbreviated “AMP” below. We use it for network optimization models and algorithms.

Wk 1: Chapter 1 (only 1.1 for assessment purposes; the rest of the chapter is useful for personal knowledge, in particular read 1.3 to get exposed to more optimization models), appendix A.

Wk 2: Sections 2.1, 2.4.3, 2.4.4. Appendix D.

Wk 3: Pyomo material referenced in class. Sections 2.4.1, 2.4.2.

Wk 4: Sections 3.1, 3.3. (Skip “Dedication.”)

Wk 5: Sections 2.2, 2.3. (By now we have covered all of Chapter 2.)

Wk 6: No textbook reference: refer to the slides and the discussion in class.

Wk 7: Sections 5.1, 5.3.

Wk 8: No textbook reference (midterm).

Wk 9: Sections 5.4, 5.5.

Wk 10: Section 7.1. AMP (Applied Mathematical Programming, see above) Section 8.1 and 8.2.

Wk 11: AMP Appendix C.

Wk 12: AMP Section 8.7. (AMP Section 8.8 useful, but optional: only the material discussed in class will be tested.)

Wk 13: Sections 11.1, 11.2.

Wk 14: Section 11.3.

Assessment methods and schedule

Wk 3: Problem Set 1 due, covering Wk 1–2.

Wk 5: Problem Set 2 due, covering Wk 3–4.

Wk 7: Problem Set 3 due, covering Wk 5–6.

Wk 8: Midterm Exam on Tuesday October 10 during class, covering Wk 1–6.

Wk 10: Problem Set 4 due, covering Wk 7–9.

Wk 12: Problem Set 5 due, covering Wk 11–12.

Wk 14: Problem Set 6 due, covering Wk 13–14.

Wk 16: Final Exam (exam week) on December 7, between 4:30-6:30PM, covering Wk 7–15. The schedule and location of the exam are determined by the university, see <https://classes.usc.edu/term-20233/finals/> and <https://arr.usc.edu/faculty-staff/classroom-scheduling/final-examinations-rooms/>.

The final course grade is computed as follows:

- 25%: Homework (6 problem sets, *lowest one is dropped*, each of the remaining 5 is worth 5% each).
- 30%: Midterm exam.
- 35%: Final exam.
- 10%: Class participation.

Homework policy

- All homework assignments are due by 11:59:00pm on the date indicated on the problem set.
- Homework assignments must be submitted via Blackboard. Only one pdf file should be submitted for each homework assignment. Students can submit PDFs generated with your favorite method: Latex-generated PDFs, converted from Word/Libreoffice, or even scanned images converted to PDF.
- Late homework submissions are not accepted under any circumstances.
- There will be biweekly homework assignments. The lowest scored homework assignment will not be considered in your final grade
- Working with other students on homework assignments is allowed, including discussing the answers and working together to find a solution strategy. However, each student must write and submit their own personal work.