



## SIE 545: Fundamentals of Optimization Fall 2023

**Time and Location:** Tuesday and Thursday, 11:00am-12:15pm, ENGR 301

**Course format:** In-Person

**Office Hours:** Tuesday and Thursday, 12:20 pm-1:20 pm, and by appointment

**Instructor:** Jianqiang Cheng, Associate professor, SIE

**Office Location:** ENGR 123    **Email:** jqcheng@arizona.edu

**Course Description:** This is a graduate level course on optimization, with an emphasis on the classical mathematical concepts, theories and techniques for linear and nonlinear optimization problems. The course will cover fundamental concepts in optimization, modeling nonlinear/linear problems, basic results in convex analysis, and optimality conditions for constrained and unconstrained problems, duality theory, and some algorithms.

**Prerequisite(s):** SIE 340 – Deterministic Operations Research, or equivalent. Knowledge of elementary calculus and matrix algebra.

**Credit Hours:** 3

**Textbook:** M.S. Bazaraa, H.D. Sherali, and C.M. Shetty, *Nonlinear Programming: Theory and Algorithms*, 3rd edition, Wiley & Sons Inc, New Jersey, 2006.

**Supplementary:** Boyd, Stephen, and Lieven Vandenberghe, *Convex optimization*, Cambridge university press, 2004.

**Course Website:** We'll be using D2L(<https://d2l.arizona.edu/>). All class materials, including homework assignments, lecture notes, supplementary readings, etc. will be distributed from D2L. I will also be sending emails

to the whole class throughout the semester using the classlist in D2L. You must check the announcements in D2L and your email at least twice a week.

### **Course Objectives:**

At the completion of this course, students will:

1. improve their ability to formulate real-world problems as optimization problems by some modeling and reformulation tricks, and recognize when problems they consider are nonlinear programming problems
2. extend knowledge and understanding of the mathematical foundations of optimization
3. be able to understand optimality conditions for both unconstrained and constrained nonlinear programming problems
4. be able to understand when and how to apply optimality conditions for solving particular problems
5. be able to apply some basic computational algorithms for nonlinear programs.

### **Course Outline (subject to change):**

1. Mathematical modeling (5 lectures)
2. Convex analysis:  
Convex sets (3 lectures)  
Convex functions and generalizations (4 lectures)
3. Optimality conditions and duality:  
Optimality conditions for unconstrained and constrained problems (6 lectures)  
Lagrangian duality and saddle point optimality conditions (4 lectures)
4. Algorithms (3 lectures)

### **Course Requirements:**

- **Lectures:** Students are expected to attend and participate in all lectures. Lecture materials will be posted in D2L, and you can print and take them to class to make notes. Some questions left in lectures will require you study by yourself.

- **Reading:** Reading materials from textbook or supplementary posted in D2L will be mentioned in the end of lecture notes. Students are responsible for completing these readings.
- **Homework assignments:** There will be about 5-6 problem sets due approximately every two weeks. The due date will be given in class and shown in D2L. Late homework will not be accepted, and all homework submissions should be electronically through D2L as **one readable** PDF-file (preferred: produced by LaTeX).
- **Exams (Closed book, Closed notes) :** There will be one midterm exam (with 75-minute limit) and one final exam (with 2-hour limit).
- **Grading distribution:**  
 Homework: About 5-6 sets (30%)  
 Midterm exam : (30%)  
 Final exam: (40%)
- **Final Grade:** A (90-100), B (80-89), C (70-79), D (60-69), E (< 60)

**Class Notes/Materials: Selling/Sharing** class notes and/or other course materials to other students or to a third party for resale is **NOT permitted** without the instructor's express written consent. Providing student email addresses to a third party is not permitted. Violations to this and other course rules are subject to **the Code of Academic Integrity** and may result in course sanctions. Additionally, students who use D2L or UA email to **sell or buy** these copyrighted materials are subject to Code of Conduct Violations for misuse of electronic resources provided by The University of Arizona. This conduct may also constitute copyright infringement.

**Recordings:** This course will be recorded via Panopto. For lecture recordings, which are used at the discretion of the instructor, students must access content in D2L only. Students may not modify content or re-use content for any purpose other than personal educational reasons. All recordings are subject to government and university regulations. Therefore, students accessing unauthorized recordings or using them in a manner inconsistent with UArizona values and educational policies (Code of Academic Integrity and the Student Code of Conduct) are also subject to civil action.

**Academic integrity policy:** Students are welcome to discuss class related materials, homework assignments with your classmates. However, students must write solutions individually and cite references, including discussions with classmates.

**Additional University Policies:**

- **Safety on Campus and in the Classroom:** For a list of emergency procedures for all types of incidents, please visit the website of the Critical Incident Response Team (CIRT): <https://cirt.arizona.edu/case-emergency/overview>
- **Accessibility and Accommodations:** At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, <https://drc.arizona.edu>) to establish reasonable accommodations.
- **Other University Policies:** <https://catalog.arizona.edu/syllabus-policies>.

You are encouraged to make recommendations to improve the class and my teaching skills.

**Note:** This syllabus is tentative and the instructor reserves the right to make modifications if appropriate.