

Course Outline
Optimization Theory (MATH4230)

2018/2019, Second Term: 7 January 2019 (Mon) 18 April 2019 (Thu)

No Teaching Days:

Feb. 4-9 (Mon-Sat, Lunar New Year Vacation), 1-6 April 2019 (Reading week)

Course Homepage:

<http://www.math.cuhk.edu.hk/course/1819/math4230>

Lectures:

Tue 2:30pm - 4:15pm, LSB LT4

Wed 1:30pm - 2:15pm, LSB LT4

Tutorial:

Wed 12:30pm - 1:15pm, LSB LT4

Teacher:

Professor Tiejong Zeng

Tutor:

Wong Hok Shing, hswong@math.cuhk.edu.hk

Course Description:

Unconstrained and equality optimization models, constrained problems, optimality conditions for constrained extrema, convex sets and functions, duality in nonlinear convex programming, descent methods, conjugate direction methods and quasi-Newton methods. Students taking this course are expected to have knowledge in advanced calculus.

Subject Content in Outline:

1. Introduction to optimization, example problems
2. Convexity
 - a. convex sets
 - b. closest point problem and its dual
 - c. convex functions
 - d. Fenchel duality
3. Unconstrained optimization
 - a. basic theory
 - b. gradient descent
 - c. accelerated first-order methods
 - d. Newtons method
 - e. quasi-Newton methods
4. Constrained optimization

- a. geometric optimality conditions
 - b. KKT conditions
 - c. Lagrange duality with examples
 - d. interior point methods
 - e. ADMM
5. Modeling
- a. applications in engineering, statistics, and machine learning
 - b. convex relaxations
6. Non-smooth optimization
- a. subgradients and basic theory
 - b. subgradient method
 - c. proximal methods
 - d. proximal gradient (forward-backward splitting)

Course prerequisite:

Most fundamental: advanced calculus and linear algebra.

The course is focused on both optimization methods and theoretical analysis. The students should be very solid in mathematical analysis, and have a very good feeling and understanding of numerical methods and rigorous mathematical reasoning. It is advised to take at Year 3 or 4.

Grade policies:

Tutorial attendance & good efforts or top 15% in both the mid- and final exams:
10%;

(tutorial assignments are counted only if they are submitted before 6:30pm Monday next after the tutorial class)

Mid-Exam/Project: **35%**; Final Exam: **55%**.

Mid-exam date:

Attention: Venue may be different from the currently used classroom.

Textbooks: mainly based on

1. **S. Boyd and L. Vandenberghe**, *Convex Optimization*, Cambridge University Press, 2004.
2. **D. Bertsekas, A. Nedic, A. Ozdaglar**, *Convex Analysis and Optimization* Athena Scientific, 2003.
3. **D. Bertsekas**, *Convex Optimization Theory*, Athena Scientific, 2009.

References:

1. **A. Ben-Tal and A. Nemirovski**, *Lectures on Modern Convex Optimization* (SIAM).
2. **J. M. Borwein and A. S. Lewis**, *Convex Analysis and Nonlinear Optimization* (Springer).

3. **J.B. Hiriart-Urruty and C. Lemarechal**, *Convex Analysis and Minimization Algorithms* (Springer).
4. **D. Luenberger and Y. Ye**, *Linear and Nonlinear Programming* (Springer).
5. **Y. Nesterov**, *Introductory Lectures on Convex Optimization: A Basic Course* (Kluwer).
6. **J. Nocedal and S. Wright**, *Numerical Optimization* (Springer).

Academic Honesty:

<http://www.cuhk.edu.hk/policy/academichonesty/>