ENGG 5501: Foundations of Optimization	2021–22 First Term

Handout A: Information Sheet

Instructor: Anthony Man–Cho So — September 6, 2021

1 General Information

- Instructor: Professor Anthony Man–Cho So
  - Office: ERB 604
  - Office Hours: By appointment
  - Email: `manchoso@se.cuhk.edu.hk`
- Teaching Assistants:

Name	Email
Yuen Man Pun	`ympun@se.cuhk.edu.hk`
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  - Office: ERB 905
  - Office Hours: Thursdays 2:30pm — 4:00pm
- Class Time & Location:
  - Mondays 12:30pm — 2:15pm, in ERB LT
  - Thursdays 12:30pm — 2:15pm, in YIA LT3
- Class Website: `http://www.se.cuhk.edu.hk/~manchoso/2122/engg5501`
- Online Q&A Forum: `http://piazza.com/cuhk.edu.hk/fall2021/engg5501`

2 Course Objectives

In this course we will develop the basic machinery for formulating and analyzing various optimization problems. Topics include convex analysis, linear and conic linear programming, nonlinear programming, optimality conditions, Lagrangian duality theory, and basics of optimization algorithms. Applications from different fields, such as combinatorial optimization, communications, computational economics and finance, machine learning, and signal and image processing, will be used to complement the theoretical developments. No prior optimization background is required for this class. However, students should have workable knowledge in multivariable calculus, real analysis, linear algebra and matrix theory.

3 Course Outline

Part I: **Introduction**
Problem Formulation
Classes of Optimization Problems

Part II: **Theory**
Elements of Convex Analysis
Conic Linear Programming and Nonlinear Programming — Optimality Conditions and Duality Theory

Part III: **Algorithms**
First–Order Methods for Unconstrained and Constrained Optimization

Part IV: **Selected Applications**
Combinatorial Optimization
Communications
Computational Economics and Finance
Machine Learning
Signal and Image Processing

4 Grading

- Homework (35%): There will be about 5 homeworks during the term. Typically, they are due two weeks after being assigned. You may take up to two late days during the term. However, once you have used up the late days, **no more late homeworks will be accepted unless prior arrangement has been made with the instructor**.

  You are allowed, and even encouraged, to discuss the homeworks with your classmates. However, **you must write up the solutions on your own**. Plagiarism and other anti–scholarly behavior will be dealt with severely. In particular, **you should never copy from previous years' homework solutions**. Further information on academic honesty can be found at

  – `http://www.cuhk.edu.hk/policy/academichonesty/`
  – `https://www.erg.cuhk.edu.hk/erg/sites/default/files/Guidelines_to_Academic_Honesty.pdf`

- Midterm Examination (30%): There will be a midterm examination, tentatively scheduled in the seventh week of the course. The date, format, and scope of the examination will be announced later.

- Final Examination (35%): There will be a final examination. The date, format, and scope of the examination will be announced later.

5 Reference Material

There is no required textbook for this class. Lecture notes will be posted on the course website. Below is a list of material for further reading:

[1] M. S. Bazaraa, H. D. Sherali, and C. M. Shetty. *Nonlinear Programming: Theory and Algorithms*. Wiley–Interscience Series in Discrete Mathematics and Optimization. John Wiley & Sons, Inc., New York, second edition, 1993.

[2] A. Ben-Tal and A. Nemirovski. *Lectures on Modern Convex Optimization: Analysis, Algorithms, and Engineering Applications*, volume 2 of *MPS–SIAM Series on Optimization*. Society for Industrial and Applied Mathematics, Philadelphia, Pennsylvania, 2001.

[3] D. P. Bertsekas. *Nonlinear Programming.* Athena Scientific, Belmont, Massachusetts, second edition, 1999.

[4] D. Bertsimas and J. N. Tsitsiklis. *Introduction to Linear Optimization.* Athena Scientific, Belmont, Massachusetts, 1997.

[5] S. Boyd and L. Vandenberghe. *Convex Optimization.* Cambridge University Press, Cambridge, 2004. Available online at `http://www.stanford.edu/~boyd/cvxbook/`.

[6] M. Grötschel, L. Lovász, and A. Schrijver. *Geometric Algorithms and Combinatorial Optimization*, volume 2 of *Algorithms and Combinatorics.* Springer–Verlag, Berlin/Heidelberg, second corrected edition, 1993.

[7] O. Güler. *Foundations of Optimization*, volume 258 of *Graduate Texts in Mathematics.* Springer Science+Business Media LLC, New York, 2010.

[8] J.-B. Hiriart-Urruty and C. Lemaréchal. *Fundamentals of Convex Analysis.* Grundlehren Text Editions. Springer–Verlag, Berlin/Heidelberg, 2001.

[9] D. G. Luenberger and Y. Ye. *Linear and Nonlinear Programming*, volume 228 of *International Series in Operations Research and Management Science.* Springer International Publishing AG Switzerland, Cham, Switzerland, fourth edition, 2016.

[10] O. L. Mangasarian. *Nonlinear Programming.* McGraw–Hill, Inc., New York, 1969.

[11] S. G. Nash and A. Sofer. *Linear and Nonlinear Programming.* The McGraw–Hill Companies, Inc., New York, 1996.

[12] Yu. Nesterov. *Introductory Lectures on Convex Optimization: A Basic Course.* Kluwer Academic Publishers, Boston, 2004.

[13] J. Nocedal and S. J. Wright. *Numerical Optimization.* Springer Series in Operations Research and Financial Engineering. Springer Science+Business Media LLC, New York, second edition, 2006.

[14] R. T. Rockafellar. *Convex Analysis.* Princeton Landmarks in Mathematics and Physics. Princeton University Press, Princeton, New Jersey, 1997.

[15] A. Ruszczyński. *Nonlinear Optimization.* Princeton University Press, Princeton, New Jersey, 2006.