THE CHINESE UNIVERSITY OF HONG KONG
DEPARTMENT OF SYSTEMS ENGINEERING AND ENGINEERING MANAGEMENT

COURSE OUTLINE

ENGG5501 Foundations of Optimization

https://blackboard.cuhk.edu.hk/ultra/courses/_230427_1/cl/outline

1. Course description

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.

2. Number of credit units: 3

3. Course timetable

2025-26	**Semester 1**		**Venue**
Lecture	Mondays:	1630 to 1815	ELB LT1
Lecture	Wednesdays:	1630 to 1815	MMW LT1

4. Course instructor

Name:	Professor Anthony Man-Cho So
Office Location:	ERB 604
Telephone:	3943-8477
Email Address:	manchoso@se.cuhk.edu.hk

5. Teaching assistants: (Name, Office, Email Address, Office hours)

	Name	Office	Email	Office Hours
1.	CHEN He	ERB 905	hchen@se.cuhk.edu.hk	Wed 1400-1600
2.	GUAN Jiewen	ERB 810B	jwguan@se.cuhk.edu.hk	Wed 1400-1600
3.	ZHAO Jianing	ERB 905	jnzhao@se.cuhk.edu.hk	Wed 1400-1600

6. Learning outcomes

Upon completion of the course, students should be able to

- formulate practical applications as various classes of optimization problems (e.g., linear program, quadratic program, semidefinite program);
- understand optimality conditions of optimization problems (conic optimization, general nonlinear optimization) and their implications;
- understand basic algorithmic approaches to optimization problems.

7. Use of course website

The course website https://www1.se.cuhk.edu.hk/~manchoso/2526/engg5501/ is available for the distribution of course-related announcements, documents, lecture notes, and homework.

8. Teaching mode and learning activities

Inside classroom (face-to-face)

- Lectures
  - The lectures cover the principles of the course topics according to the teaching plan.

Online

- Lecture recordings
- Reading materials
- Online exercises

9. Teaching schedule and content

Week	Date	Topics/Content	Remarks
1	September 1, 2025	Terminologies. Classes of optimization problems.	Lecture Note 1
	September 3, 2025	Formulating optimization problems.	Lecture Note 1
2	September 8, 2025	Linear, affine, convex combinations and sets.	Lecture Note 2
	September 10, 2025	Convex cones. Convexity-preserving operations.	Lecture Note 2
3	September 15, 2025	Projection onto convex sets.	Lecture Note 2
	September 17, 2025	Separation of convex sets.	Lecture Note 2
4	September 22, 2025	Convex functions. Convexity-preserving operations.	Lecture Note 2
	September 24, 2025	Convexity-preserving operations. Differentiable convex functions.	Lecture Note 2
5	September 29, 2025	Non-differentiable convex functions.	Lecture Note 2
	October 1, 2025	National Day.	
6	October 6, 2025	Linear programming: Existence of optimal solutions, Farkas Lemma.	Lecture Notes 3
	October 8, 2025	Linear programming: Farkas' Lemma. Duality theory.	Lecture Note 3

7	October 13, 2025	Linear relaxation. Vertex cover problem.	Lecture Note 4
	October 15, 2025	Midterm review.	
8	October 20, 2025	Midterm examination.	
	October 22, 2025	Introduction to conic programming.	Lecture Note 5
9	October 27, 2025	Conic programming: Examples. Farkas Lemma.	Lecture Note 5
	October 29, 2025	Chung Yeung Festival	
10	November 3, 2025	Conic programming: Farkas Lemma. Duality theory.	Lecture Note 5
	November 5, 2025	Robust optimization.	Lecture Note 6
11	November 10, 2025	Semidefinite relaxation of quadratic optimization problems.	Lecture Note 6
	November 12, 2025	Nonlinear programming: Optimality conditions for unconstrained and constrained problems.	Lecture Note 7
12	November 17, 2025	Nonlinear programming: Karush-Kuhn-Tucker theory.	Lecture Note 7
	November 19, 2025	Nonlinear programming: Karush-Kuhn-Tucker theory.	Lecture Note 7
13	November 24, 2025	Nonlinear programming: Lagrangian duality.	Lecture Note 7
	November 26, 2025	Nonlinear programming: Lagrangian duality.	Lecture Note 7

10. Assessment type, percentage, policies and rubrics

Assessment type	Weighting (%)	Remarks
▪ Homework	35	
▪ Midterm Examination	30	In-class
▪ Final Examination	35	In-class
	100	

Policy for Late submission:

- You may take up to two late days in total 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.

Policy for Absence from test examinations:

- ***Absence due to non-medical reasons***: submit absence request to course instructor at least 1 week in advance of the exam date, with supporting documents from the organizer involved.
- ***Absence due to*** medical reasons ***on exam day***: submit valid medical proof issued by registered medical doctor in Hong Kong to course instructor within 2 calendar days after the exam/test date.
- No make-up exam or special arrangements will be arranged if the above requirements are not met.
- Final decision will be made by the course instructor.

Grade Descriptors:

A

EXCELLENT - exceptionally good performance far exceeds expectation in all or most of the course learning outcomes. Demonstration of superior understanding of the subject matter, ability to analyze problems and apply extensive knowledge and skillful use of concepts and materials to derive proper solutions.

B

GOOD - good performance in all course learning outcomes and exceeds expectation in some. Demonstration of good understanding of the subject matter, ability to use proper concepts and materials to solve most of the problems encountered.

C

FAIR - adequate performance in all course learning outcomes. Demonstration of adequate understanding of the subject matter, ability to solve simple problems.

D

MARGINAL - performance barely meets the expectation in all or at least the essential course learning outcomes. Demonstration of partial understanding of the subject matter and ability to solve simple problems.

F

FAILURE - performance does not meet expectation in most of the course learning outcomes. Demonstration of serious deficiencies and shall retake the course.

11. Required and recommended readings

Required readings

1. Lecture notes available on course website (https://www1.se.cuhk.edu.hk/~manchoso/2526/engg5501/)

Recommended readings

1. Ben-Tal, Nemirovski: Lectures on Modern Convex Optimization: Analysis, Algorithms, and Engineering Applications, SIAM, 2001.
2. Boyd, Vandenberghe: Convex Optimization, Cambridge University Press, 2004.
3. Güler: Foundations of Optimization, Springer New York, 2010.
4. Luenberger, Ye: Linear and Nonlinear Programming (5th Edition), Springer Cham, 2021.
5. Nesterov: Lectures on Convex Optimization (2nd Edition), Springer Cham, 2018.

12. Feedback for evaluation

Students are encouraged to give comments and make suggestions using the following channels:

1. There are two course evaluations - one before the mid-term, and one at the end of the course. This is a formal channel for students to rate the teacher, the course, and the course tutors. Students can give specific comments or suggestions in addition to the

numeric ratings.
2. Students can provide feedbacks using informal channels, such as email, or simply by discussing with the tutors or the instructor directly.

13. Academic honesty and plagiarism

Attention is drawn to University policy and regulations on honesty in academic work, and to the disciplinary guidelines and procedures applicable to breaches of such policy and regulations. Details may be found at

http://www.cuhk.edu.hk/policy/academichonesty (CUHK)
https://www.erg.cuhk.edu.hk/erg/AcademicHonesty (Engineering Faculty)

With each assignment, students will be required to submit a signed **declaration** (Attachment) that they are aware of these policies, regulations, guidelines and procedures.

- In the case of group projects, all members of the group should be asked to sign the declaration, each of whom is responsible and liable to disciplinary actions, irrespective of whether he/she has signed the declaration and whether he/she has contributed, directly or indirectly, to the problematic contents.
- For assignments in the form of a computer-generated document that is principally text-based and submitted via VeriGuide, the statement, in the form of a receipt, will be issued by the system upon students' uploading of the soft copy of the assignment.
- Students are fully aware that their work may be investigated by AI content detection software to determine originality.
- Students are fully aware of the AI approach(es) adopted in the course. In the case where some AI tools are allowed, students have made proper acknowledgment and citations as suggested by the course teacher.

Assignments without a properly signed declaration will not be graded by teachers.

Only the final version of the assignment should be submitted via VeriGuide.

The submission of a piece of work, or a part of a piece of work, for more than one purpose (e.g. to satisfy the requirements in two different courses) without declaration to this effect shall be regarded as having committed undeclared multiple submissions. It is common and acceptable to reuse a turn of phrase or a sentence or two from one's own work; but wholesale reuse is problematic. In any case, agreement from the course teacher(s) concerned should be obtained prior to the submission of the piece of work.

The copyright of the teaching materials, including lecture notes, assignments and examination questions, etc., produced by staff members/ teachers of The Chinese University of Hong Kong (CUHK) belongs to CUHK. Students may download the teaching materials produced by the staff members/ teachers from the Learning Management Systems, e.g. Blackboard, adopted by CUHK for their own educational use, but shall not distribute/ share/ copy the materials to a third-party without seeking prior permission from the staff members/ teachers concerned.

14. Use of Generative Artificial Intelligence (AI) Tools in Teaching, Learning and Assessment

Approach adopted in this course is

Approach 3 - Use of AI tools is allowed with explicit acknowledgement and proper citation

In courses where students are allowed or expected to collaborate with or use AI tools for in-class learning activities or assignments, students should be reminded to make explicit acknowledgement of the use of these tools. Teachers may show students examples regarding how to acknowledge and make citations. Students should also be informed of the limitations and appropriate use of these tools.

Use of AI tools is allowed with explicit acknowledgement and proper citation

Students may use some AI tools in some class activities and assignments on the condition that they make explicit acknowledgement and proper citations of the input from AI tools.

Acknowledging support from AI tools
Students are required to acknowledge all functional uses of a generative AI tool and cite it when they paraphrase, quote, or incorporate into their own work any content (whether it is text, image, data, or other format) that was created by it.

i. An example of acknowledgement

I acknowledge the use of (name of AI tool – e.g. ChatGPT (https://chat.openai.com/) to (specify the support, e.g. plan my essay, generate some ideas for the content, ask for examples of data collection instruments, get the dates of historical events, etc.).

ii. An example of citation
OpenAI. (2023). *ChatGPT* (Mar 20 version). https://chat.openai.com/chat

(Students are reminded that due to the rapid developments of generative AI tools, some citation formats may be updated regularly.)

iii. An example of including texts generated by an AI tool in their work

"The following text was generated by an AI tool / language model (ChatGPT):"
[Insert the text generated by ChatGPT here.]

iv. An example of including texts generated by an AI tool and the prompts that were used to elicit the text from the AI tool

"[The prompt], as generated by an AI language model (ChatGPT):"
[Insert the text generated by ChatGPT in response to the prompt.]

Students are reminded to learn and use the AI tools responsibly and ethically and be aware of the limitations.

Students are reminded to clarify with the course teacher and obtain permission if necessary when in doubt.

15. Guideline on sharing lecture recordings

Attention is drawn to the following:
- The copyright of any lecture recordings shared in the course, whether they are produced by teachers, students, or peer note-takers, belongs to the University.
- Students should not share these recordings with others without obtaining prior written consent from the teacher(s).

Attachment

Declaration for written assignment

I am/we are submitting the assignment for:
□ an individual project or
□ a group project on behalf of all members of the group. It is hereby confirmed that the submission is authorized by all members of the group, and all members of the group are required to sign this declaration.

I/We declare that: (i) the assignment here submitted is original except for source material explicitly acknowledged/all members of the group have read and checked that all parts of the piece of work, irrespective of whether they are contributed by individual members or all members as a group, here submitted are original except for source material explicitly acknowledged; (ii) the piece of work, or a part of the piece of work has not been submitted for more than one purpose (e.g. to satisfy the requirements in two different courses) without declaration; and (iii) the submitted soft copy with details listed in the <Submission Details> is identical to the hard copy(ies), if any, which has(have) been / is(are) going to be submitted. I/We also acknowledge that I am/we are aware of the University's policy and regulations on honesty in academic work, and of the disciplinary guidelines and procedures applicable to breaches of such policy and regulations, as contained in the University website http://www.cuhk.edu.hk/policy/academichonesty/.

In the case of a group project, we are aware that all members of the group should be held responsible and liable to disciplinary actions, irrespective of whether he/she has signed the declaration and whether he/she has contributed, directly or indirectly, to the problematic content.

I/we declare that I/we have not distributed/ shared/ copied any teaching materials without the consent of the course teacher(s) to gain unfair academic advantage in the assignment/ course.

I/we declare that I/we have read and understood the University's policy on the use of AI for academic work. I/we confirm that I/we have complied with the instructions given by my/our course teacher(s) regarding the use of AI tools for this assignment and consent to the use of AI content detection software to review my/our submission.

I/We also understand that assignments without a properly signed declaration by the student concerned and in the case of a group project, by all members of the group concerned, will not be graded by the teacher(s).

__________________________ __________________________
Signature(s) Date

__________________________ __________________________
Name(s) Student ID(s)

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Course code Course title