Faculty of Engineering
The University of Hong Kong

DASE7113 OPTIMIZATION METHODS FOR INTELLIGENT SYSTEMS

Course Outline

Course code:	DASE7113
Course title:	Optimization Methods for Intelligent Systems
Offered by (department):	DASE
Level:	MSc
Credit units:	6 credits
Pre-requisite course code:	Nil
Co-requisite course code:	Nil
Learning hours:	30
Student quota:	80
Course type:	Elective
Offer in academic year:	2026-27
Assessment (%):	Written examination (40) Coursework (60)

The intention of this document is for students undertaking the course to be well informed in terms of its learning expectations and also to help make their learning journey an enjoyable one.

The information presented in this document was correct at the time of printing.

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Course Description and Aims

The aims of this course are twofold:

(1) to introduce students to the essential concepts of optimization, including core optimization theory and widely used optimization algorithms.
(2) to equip students with the skills to apply optimization methods for solving real-world decision-making challenges, with an emphasis on problems arising in human-centric intelligent systems.

Teaching Staff

Contact details for the course co-ordinator and course teachers are shown below:

Course Teacher	
Name (Department)	**Contact Details**
Prof. J.Y. Li (DASE Department)	jiayangl@hku.hk

Course Learning Outcomes and Alignment with Programme Learning Outcomes

By the end of this course students should be able to demonstrate a threshold level of mastery of the following course learning outcomes. The appropriate Programme Learning Outcomes associated with each of the course learning outcomes are also presented.

MSc(IELM) Programme Learning Outcomes

I. Underpinning science and mathematics, etc.
- PO(1) A comprehensive understanding of the relevant scientific principles of the specialisation.
- PO(2) A critical awareness of current problems and/or new insights much of which is at, or informed by, the forefront of the specialisation.
- PO(3) An understanding of concepts relevant to the discipline, some from outside engineering, and the ability to critically evaluate and apply them effectively.

II. System analysis and design
- PO(4) The ability to use fundamental knowledge to investigate new and emerging system models and technologies.
- PO(5) The ability to apply appropriate models for solving problems in engineering systems and the ability to assess the limitations of particular cases.
- PO(6) The ability to collect and analyse research data and use appropriate engineering tools to tackle unfamiliar problems, such as those with uncertain or incomplete data or specifications, by the appropriate innovation, use or adaptation of engineering analytical methods.
- PO(7) The ability to apply original thought to the development of practical solutions for products, systems, processes or services.

III. Economic, social and environmental context
- PO(8) Knowledge and understanding of management and business practices, and their limitations, and how these may be applied appropriately, in the context of the particular specialisation.
- PO(9) The ability to make general evaluations of risks through some understanding of the basis of such risks.

IV. Engineering and management practices
- PO(10) A thorough understanding of current practices and their limitations, and some appreciation of likely new developments.
- PO(11) Advanced level knowledge and understanding of a wide range of industrial management and system operations.
- PO(12) The ability to apply industrial engineering techniques taking account of a range of commercial and industrial constraints.

Course Learning Outcomes	Relevant Programme Learning Outcomes
1. A solid understanding of the fundamentals of optimization theory.	1
2. The skill to solve unconstrained, constrained, and integer optimization problems using exact and intelligent algorithms.	3, 12
3. The ability to apply optimization techniques in the development of intelligent systems	4, 5, 6, 8

Course Teaching and Learning Activities and Alignment with Learning Outcomes

The teaching and learning activities in this course include lectures, assignments, tutorials, and laboratory sessions, all designed to support the achievement of the course learning outcomes.

- A series of formal lectures will cover key topics including optimization applications, optimization theory, and optimization algorithms.
- There will be two assignments. The first is an individual assignment designed to assess students' understanding of optimization theory and algorithms. The second is a group project, requiring students to apply optimization techniques (either learned in class or self-studied) to solve a real-world optimization problem.
- Tutorial sessions will be arranged to review mathematical foundations, provide guidance on the group project, and prepare students for the final exam.
- In-class laboratory sessions will provide hands-on experience with optimization algorithms through experiments and practical exercises.

Calendar Entry

Basics of optimization; Formulating real-world decision challenges as optimization problems; Convex optimization theory; Optimality conditions; Unconstrained optimization algorithms (gradient descent, Newton's method); Constrained optimization algorithms (linear and quadratic programming algorithms, Frank-Wolfe, projected gradient descent, sequential quadratic programming); intelligent and metaheuristic algorithms (simulated annealing, particle swarm, Tabu search, genetic algorithm, ant colony); Applications of optimization techniques in intelligent systems.

Course Content	Responsible Lecturer	Course Learning Outcomes
Basics of optimization (3 hours)		
A general introduction of optimization. A review of calculus, linear algebra, and convex analysis.	Prof. J.Y. Li	1
Optimization Applications (6 hours)		
Optimization problems in system engineering and data science.	Prof. J.Y. Li	3
Optimality conditions (4.5 hours)		
First- and second-order optimality conditions for unconstrained convex programs. KKT conditions for constrained convex programs.	Prof. J.Y. Li	1
Unconstrained optimization algorithms (3 hours)		
Gradient descent methods and Newton's methods.	Prof. J.Y. Li	2
Constrained optimization algorithms (6 hours)		
Linear and quadratic programming algorithms. The Frank-Wolfe method, the projected gradient descent method, and the sequential quadratic programming method. An introduction to constrained optimization software packages.	Prof. J.Y. Li	2
Intelligent optimization algorithms (4.5 hours)		
Particle swarm optimization, tabu search, and ant colony optimization. Simulated annealing, basin-hopping, and the DIRECT algorithm	Prof. J.Y. Li	2
Project presentation (3 hours)		
Student presentations on the application of optimization techniques to real-world problems in areas such as transportation, logistics, robotics, manufacturing, and service systems	Prof. J.Y. Li	1, 2, 3

Guidelines on Grading and Standards of Assessment

HKU has adopted standards-based assessment. The general course grade descriptors aim to provide descriptions on the normal expectations of student achieving particular grades.

Course Grade	Description
A	Exceptionally good performance demonstrating a superior understanding of the subject matter, a foundation of extensive knowledge, a skilful use of concepts and/or materials, and ability to analyse and evaluate problems.
B	Good performance demonstrating capacity to use the appropriate concepts, a good understanding of the subject matter, and an ability to handle the problems and materials encountered in the course.
C	Adequate performance demonstrating an adequate understanding of the subject matter, an ability to handle relatively simple problems, and adequate preparation for moving on to more advanced work in the field.
D	Minimally acceptable performance demonstrating at least partial familiarity with the subject matter and some capacity to deal with relatively simple problems, but also demonstrating deficiencies serious enough to make it inadvisable to proceed further in the field without additional work.
F	Unacceptable performance demonstrating unfamiliarity with the subject matter, and lack of capacity to deal with relatively simple problems, and also demonstrating deficiencies serious enough to make it advisable to retake the course.

Course Assessment Tasks and Alignment with Learning Outcomes

Assessment tasks in this course are described below, which includes weighting, assessment type, and alignment with course learning outcomes.

Weighting of in-course assessment and written examination

Assessment Type	Percentage of Total Assessment (%)	Description	Course Learning Outcomes
In-course Assessment	60	There will be 2 assignments, including (1) an individual assignment designed to assess students' understanding of optimization theory and algorithm; (2) a group project, requiring students to apply optimization techniques to solve a real-world optimization problem.	1,2,3
Written Examination	40	There will be a 2-hour final exam, aimed at measuring the overall subject knowledge that students have acquired.	1,2,3

Course and Assessment Policy

Late Submission
Submission of late assignments/essays will not be accepted under normal circumstances.

Missed laboratory / Missed quiz
There will be no 'make-up' for any missed quiz under normal circumstances.

Academic Conduct
The University Regulations on academic misconduct will be strictly enforced. Students are strongly recommended to refer to http://www.hku.hk/student/plagiarism/ for further details. In addition, students should familiarise themselves with http://lib.hku.hk/turnitin/.

Means / Processes for Student Feedback on Course

SETL
Students are asked to complete this evaluation (Student Evaluation of Teaching and Learning) of their learning experiences at the conclusion of the course. Questionnaire items relate to the overall evaluation of the course as well as an evaluation of teaching.

Other means of student feedback
The teacher will seek other student feedback and questions at the end of the lecture.

Date: June 2026 Completed by: Prof. J.Y. Li

Learning Resources

Required text / References
Relevant handouts will be provided in class. Students are also encouraged to read the following reference materials:

References
1. Boyd, Stephen P., and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.

Online Course material

Class notes and assignments will be posted on the Moodle.