City University of Hong Kong
Course Syllabus

offered by Department of Computer Science
with effect from Semester A 2022/23

Part I   Course Overview

Course Title:	Practical Optimization Algorithms and Techniques
Course Code:	CS5282
Course Duration:	One semester
Credit Units:	3 credits
Level:	P5
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	CS2310 Computer Programming or equivalent AND CS4335 Design and Analysis of Algorithms
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II   Course Details

1. **Abstract**

This course aims to offer practical techniques to solve hard optimization problems by the latest computing technology. These problems can be found in a variety of applications in ecommerce, networking, and cloud computing, such as combinatorial auction, group buying, network virtualization, and resource allocation. Upon completing the course, students will be familiar with applied optimization techniques and able to use optimization to formulate and solve large-scale problems.

The course includes two parts. In the first part, we introduce fundamentals of optimization formulation and the usage of modern Solvers (such as Cplex and Gurobi). In the second part, we investigate some typical optimization problems, in particular, in e-commerce and telecommunication, and study how to design tailor-made algorithms to solve them. Students will be required to do projects of implementing their designs.

2. **Course Intended Learning Outcomes (CILOs)**
    (CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Formulate optimization problems and interpret the optimization solutions.	20%	✓	✓	
2.	Use common optimization solvers.	20%	✓	✓	
3.	Identify the typical optimization problems in ecommerce, networking, and cloud computing.	10%	✓	✓	
4	Apply the formulation and practical techniques to solve some optimization problems in ecommerce, networking, and cloud computing.	30%	✓	✓	✓
5	Implement algorithms to solve some optimization problems in ecommerce, networking, and cloud computing.	20%	✓	✓	✓
		100%			

A1:   Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.
A2:   Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.
A3:   *Accomplishments*
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Teaching and Learning Activities (TLAs)
(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No. 1	2	3	4	5	Hours/week (if applicable)
Lecture	Explain the basic concepts of various optimization technologies and the optimization problems in e-commerce and telecommunication.	✓	✓	✓	✓	✓	2
Lab	Demonstrate the use of solvers, and let students practice the optimization technologies.	✓	✓	✓	✓	✓	1
Homework	Test students' understanding on the knowledge learned in lectures and train the students with independent thinking.	✓	✓	✓	✓	✓	0.5
Group project	Allow students to create practical and innovative optimization solutions to problems in ecommerce.		✓	✓	✓	✓	0.5

4. Assessment Tasks/Activities (ATs)
(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No. 1	2	3	4	5	Weighting	Remarks
Continuous Assessment: <u>50%</u>							
Homework	✓	✓	✓	✓	✓	10%	
Quiz	✓	✓	✓	✓	✓	15%	
Group project		✓	✓	✓	✓	25%	
Examination^: <u>50%</u> (duration: 2 hours)							
						100%	

^ For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

5. Assessment Rubrics
(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Homework	The ability to solve problems using the knowledge learned in lectures	The answer is correct and written in a clear manner.	The answer is mostly correct, with some minor mistakes.	The answer is large correct with some mistakes.	Below the marginal level
2. Quiz & Final Exam	The ability to solve problems using the knowledge learned in lectures	The answer is correct and written in a clear manner.	The answer is mostly correct, with some minor mistakes.	The answer is large correct with some mistakes.	Below the marginal level
3. Group project	The ability to innovatively solve practical problems in e-commerce and telecommunication	The topic of study is interesting. The analysis is thorough and creative, with a research component. The presentation is clear.	The topic of study is interesting. The analysis is mostly thorough. The presentation is clear.	The topic of study is conventional, and the study does not require to take efforts. The analysis is superficial. The presentation is alright.	Below the marginal level

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Homework	The ability to solve problems using the knowledge learned in lectures	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Quiz & Final Exam	The ability to solve problems using the knowledge learned in lectures	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Group project	The ability to innovatively solve practical problems in e-commerce and telecommunication	High	Significant	Moderate	Basic	Not even reaching marginal levels

Part III   Other Information (more details can be provided separately in the teaching plan)

1.   **Keyword Syllabus**
      (An indication of the key topics of the course.)

      Fundamentals of linear programming, combinatorial optimization, optimization solvers, heuristics, algorithm design, combinatorial auction, logistics, group buying, sharing economy, game theory

      Syllabus

      An overview of various optimization technologies and optimization problems will be presented during the lectures, with discussion of the following issues and the related techniques/algorithms:

      1.   Basic concepts of optimization formulation, solution and interpretation.

      2.   Usage of common optimization solvers.

      3.   Optimizations problems that exist in ecommerce and telecommunication, and practical solution approaches.

      4.   Implementation of optimization to solve problems.

2.   **Reading List**
2.1   **Compulsory Readings**
      (Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

2.2   **Additional Readings**
      (Additional references for students to learn to expand their knowledge about the subject.)

| 1. | Saul I. Gass (2010). *Linear Programming: Methods and Applications*. Dover Publications, 5th edition. |
| 2. | Gurobi Reference Manual, http://www.gurobi.com |