City University of Hong Kong
Course Syllabus

offered by School of Data Science
with effect from Semester A 2019/20

Part I Course Overview

Course Title:	Optimization for Data Science
Course Code:	SDSC6011
Course Duration:	One Semester
Credit Units:	3
Level:	P6
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
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 offers an introduction to optimization methods with applications in data science. We will introduce the theoretical foundation and the fundamental algorithms for optimization and advanced optimization methods for large-scale problems arising in data science and machine learning applications. Course content includes linear and nonlinear programming, conic programming, convex analysis, Lagrangian duality theory, augmented Lagrangian methods, stochastic gradient descent. Students write their own implementation of the algorithms in a programming language and explore their performance on realistic data sets.

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.	Understand methodologies and the underlying mathematical structures in optimization	20%	✓		
2.	Apply basic concepts of mathematics to formulate an optimization problem	20%	✓		
3.	Mathematically characterize optimal solutions for optimization models	20%	✓	✓	
4.	Apply commonly used optimization algorithms	20%	✓	✓	
5.	Implement optimization programs to solve practical problems	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.						Hours/week (if applicable)
		1	2	3	4	5		
Lecture	Introduce key knowledge points of optimization methods covered in this course	✓	✓	✓	✓			26 hours/sem
Laboratory work	Assist students to develop the ability of implementing optimization algorithms through lab activities		✓	✓	✓	✓		13 hours/sem

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting	Remarks
	1	2	3	4	5			
Continuous Assessment: 60 %								
Project/Test		✓	✓	✓	✓		40%	
Assignments	✓	✓	✓	✓			20%	
Examination: 40 % (duration: 2 hours)								
Examination	✓	✓	✓	✓	✓		40%	
							100%	

5. Assessment Rubrics

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

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Project/Test	40%	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Assignments	20%	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Examination	40%	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.)

- Convex analysis
- Linear and conic programming
- Nonlinear programming
- Lagrangian duality theory
- Augmented Lagrangian methods
- Proximal and stochastic gradient descent

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.)

1.	Aharon Ben-Tal, Arkadi Nemirovski: Lectures on Modern Convex Optimization: Analysis, Algorithms, and Engineering Applications, SIAM, 2001.
2.	Lecture Notes

2.2 Additional Readings

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

1.	Leon Bottou, Frank Curtis, and Jorge Nocedal. Optimization Methods for Large-Scale Machine Learning, SIAM Review, 60, 223-311.