香港城市大學
City University of Hong Kong

City University of Hong Kong
Course Syllabus

offered by School of Data Science
with effect from Semester A 2024/25

Part I Course Overview

Course Title:	Online Learning and Optimization
Course Code:	SDSC8014
Course Duration:	One semester
Credit Units:	3
Level:	R8
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 covers the fundamentals and applications of online learning and optimization. Topics include online learning, online convex optimization, competitive analysis, regret analysis, online gradient descent, and online algorithms. Other selective topics include online optimization with prediction, robust optimization, online stochastic optimization, and online optimization with feedbacks. Applications in online learning and optimization in societal systems in the face of input uncertainty will be used to complement the theoretical developments. Students should know about convex optimization, linear algebra, and calculus.

2. Course Intended Learning Outcomes (CILOs)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes		
			A1	*A2*	*A3*
1.	Describe the fundamentals of key online optimization frameworks	20%	✓		
2.	Describe the basic theory and solution methodologies for online learning and key online optimization approaches	40%	✓		
3.	Compare and analyze different online optimization approaches	15%	✓	✓	
4.	Apply key online optimization frameworks to solve practical problems	25%	✓	✓	✓
		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. Learning and Teaching Activities (LTAs)

LTA	Brief Description	CILO No.					Hours/week (if applicable)
		1	2	3	4	5	
Lecture	Students will engage in formal lectures to gain knowledge about online learning and optimization	✓	✓	✓	✓		30 hours in total
Class-project	The students will identify and tackle practical problems in various engineering systems, ideally with online learning and optimization techniques learned from the course. The students will write a report and give two presentations. This learning activity will be mainly student-led but with the instructor's structural guidance.	✓	✓	✓	✓		9 hours for in-class check-point presentation and final presentation, as well as after-class project activities

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.					Weighting*	Remarks
	1	2	3	4	5		
Continuous Assessment: 100 %							
Paper Reading Review reports of selected papers will show how well the students can understand the concepts, fundamental theory, analysis, solution methods, and applications of online learning and optimization. This assessment will also train the students' ability for critical thinking and carrying out scientific reviews for academic works.	✓	✓	✓				25%
Test Questions are designed for the first part of the course to see how well the students have learned the basic concepts, fundamental theory, analysis, solution methods, and applications of online learning and optimization.	✓	✓	✓	✓			25%
Mini-Project The project provides students chances to demonstrate how well they have achieved their intended learning outcomes.	✓	✓	✓	✓			25%
Mini-Project Presentation The project provides students chances to demonstrate how well they have achieved their intended learning outcomes.	✓	✓	✓	✓			25%
						100%	

5. Assessment Rubrics

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Paper Reading	Ability to understand and the basic concepts, fundamental theory, analysis, solution methods, and applications of online learning and optimization.	High	Significant	Moderate to basic	Not even reaching marginal levels
2. Test	Ability to understand and apply the basic concepts, fundamental theory, analysis, solution methods, and applications of online learning and optimization.	High	Significant	Moderate to basic	Not even reaching marginal levels
3. Mini-Project Report	Ability to demonstrate the understanding of the basic concepts, fundamental theory, analysis, and solution methods of online optimization in practical problems.	High	Significant	Moderate to basic	Not even reaching marginal levels
4.Mini-Project Presentation	Ability to demonstrate how well the intended learning outcomes are achieved.	High	Significant	Moderate to basic	Not even reaching marginal levels

Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Paper Reading	Ability to understand and the basic concepts, fundamental theory, analysis, solution methods, and applications of online learning and optimization.	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Test	Ability to understand and apply the basic concepts, fundamental theory, analysis, solution methods, and applications of online learning and optimization.	High	Significant	Moderate	Basic	Not even reaching marginal levels

3. Mini-Project Report	Ability to demonstrate the understanding of the basic concepts, fundamental theory, analysis, and solution methods of online optimization in practical problems.	High	Significant	Moderate	Basic	Not even reaching marginal levels
4.Mini-Project Presentation	Ability to demonstrate how well the intended learning outcomes are achieved.	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

Online learning, online optimization, online algorithm, competitive analysis, regret analysis

2. Reading List

2.1 Compulsory Readings

1.	Elad Hazan (2016), "Introduction to Online Convex Optimization", Foundations and Trends® in Optimization: Vol. 2: No. 3-4, pp 157-325. http://dx.doi.org/10.1561/2400000013 (Selected chapters)
2.	Allan Borodin and Ran El-Yaniv (2015), "Online Computation and Competitive Analysis", Cambridge University Press New York, NY, USA (Selected chapters)

2.2 Additional Readings

1.	Niv Buchbinder and Joseph (Seffi) Naor (2009), "The Design of Competitive Online Algorithms via a Primal–Dual Approach", Foundations and Trends® in Theoretical Computer Science: Vol. 3: No. 2–3, pp 93-263. http://dx.doi.org/10.1561/0400000024
2.	Shai Shalev-Shwartz (2011), "Online Learning and Online Convex Optimization", Foundations and Trends® in Machine Learning, vol 4, no 2, pp 107–194, 2011.
3.	Sébastien Bubeck and Nicolò Cesa-Bianchi (2012), "Regret Analysis of Stochastic and Nonstochastic Multi-armed Bandit Problems", Foundations and Trends® in Machine Learning: Vol. 5: No. 1, pp 1-122. http://dx.doi.org/10.1561/2200000024