SDSC6011: OPTIMIZATION FOR DATA SCIENCE

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Optimization for Data Science

Subject Code
SDSC - Data Science
Course Number
6011

Academic Unit
Data Science (DS)

College/School
College of Computing (CC)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract
This course offers an introduction to optimization methods with applications in data science. A basic understanding of Calculus and Linear Algebra are assumed. We will introduce the theoretical foundation and the fundamental algorithms

for optimization and advanced optimization methods for practical problems arising in data science and machine learning applications. Course content includes convex analysis, Lagrangian duality theory, linear and nonlinear programming, conic programming, etc.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Explain methodologies and the underlying mathematical structures in optimization	20	x	x	
2	Apply basic concepts of mathematics to formulate an optimization problem	25	x	x	
3	Derive optimal solutions for optimization models	25	x	x	
4	Apply commonly used optimization algorithms	20	x	x	
5	Implement optimization programs to solve practical problems	10	x	x	x

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 real-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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Students will gain knowledge points of optimization methods covered in this course	1, 2, 3, 4	39 hours/semester

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Test	2, 3, 4, 5	40	
2	Assignments	1, 2, 3, 4	20	

Continuous Assessment (%)

60

Examination (%)

40

Examination Duration (Hours)

2

Assessment Rubrics (AR)

Assessment Task
Test (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
40%

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Assignments (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
20%

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
40%

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Test (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
40%

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate/basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Assignments (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
20%

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate/basic

Failure
(F) Not even reaching marginal levels

Assessment Task

Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
40%

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate/basic

Failure
(F) Not even reaching marginal levels

Part III Other Information

Keyword Syllabus
- Convex analysis
- Lagrangian duality theory
- Linear and conic programming
- Nonlinear programming
- Gradient descent, subgradient descent, proximal gradient descent
- Barrier methods
- Interior-point methods

Reading List

Compulsory Readings

	Title
1	Convex Optimization (3rd edition), Stephen Boyd and Lieven Vandenberghe © 2004 Cambridge University Press.
2	Lecture Notes

Additional Readings

	Title
1	Lectures on Modern Convex Optimization: Analysis, Algorithms, and Engineering Applications, Aharon Ben-Tal, Arkadi Nemirovski, © 2001 SIAM Press.
2	Linear and Nonlinear Programming (3rd edition), David G. Luenberger and Yinyu Ye © 2008 Springer