Course Syllabus

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

Part I Course Overview

Course Title:	Convex Optimization
Course Code:	MA8022
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 aims to introduce students to the field of modern convex optimization, which generalizes least-squares, linear and quadratic programming, and semidefinite programming, and forms the basis of many methods for non-convex optimization. Students will learn to recognize and solve convex optimization problems that arise in applications, gain insight in algorithm analysis and design, and obtain a solid understanding of the theoretical foundations of the subject.

2. Course Intended Learning Outcomes (CILOs)

No.	CILOs#	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Understand the theoretical foundations of convex optimization	30%	✓		
2.	Develop familiarity with a range of algorithms for solving linear, quadratic, and semidefinite programming including its applicability and performance	30%	✓	✓	
3.	Recognize and formulate convex optimization problems as they arise in practise	20%	✓	✓	✓
4.	Implement a number of popular convex optimization algorithms	10%		✓	✓
5.	Use the software Julia to model and solve convex optimization problems	10%	✓	✓	✓
		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)

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4	5		
Lectures	Learning through teaching is primarily based on lectures, including software presentations.	✓	✓	✓	✓	✓		3 hrs/wk
Assignments	Learning through take-home assignments helps students understand the mathematical concepts in convex optimization, as well as modelling and solving	✓	✓	✓	✓	✓	✓	After-class

	concrete problems arising in applications of convex optimization.							

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.						Weighting*	Remarks
	1	2	3	4	5			
Continuous Assessment: 50%								
Hand-in assignments	✓	✓	✓	✓	✓		30%	Assignments will cover both theoretical and practical aspects of convex optimization; programming assignments will enable students to solve practical problems through their own implementations and through the use of available software
Mid-term test	✓	✓	✓				20%	Questions will primarily cover theoretical aspects of convex optimization and modelling aspects
Examination: 50% (duration: 3hrs)	✓	✓	✓				50%	Examination questions are designed to see how far the students have achieved the intended learning outcomes. Questions will primarily cover theoretical and modelling aspects.
							100%	

5. Assessment 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. Hand-in assignments	DEMONSTRATION of the understanding of the basic materials as well as the ability to implement basic algorithms and use implementations of more advanced algorithms in convex optimization	High	Significant	Basic	Not even reaching marginal levels
2. Mid-term test	DEMONSTRATION of the understanding of the theory of convex optimization and ability to recognize and formulate convex optimization problems	High	Significant	Basic	Not even reaching marginal levels
3. Examination	DEMONSTRATION of skills and versatility in convex optimization	High	Significant	Basic	Not even reaching marginal levels

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. Hand-in assignments	DEMONSTRATION of the understanding of the basic materials as well as the ability to implement basic algorithms and use implementations of more advanced algorithms in convex optimization	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Mid-term test	DEMONSTRATION of the understanding of the theory of convex optimization and ability to recognize and formulate convex optimization problems	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Examination	DEMONSTRATION of skills and versatility in convex optimization	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

Convex sets, convex functions, convex optimization problems (linear, quadratic, semidefinite, conic), optimality conditions, duality, theorems of alternative, first order (gradient) methods, second order (Newton/interior point) methods, semidefinite relaxations, convex regularization.

2. Reading List

2.1 Compulsory Readings

Convex optimization by Stephen Boyd and Lieven Vandenberghe. Cambridge University Press, Cambridge, 2004.

2.2 Additional Readings

1.	Lectures on modern convex optimization by Aharon Ben-Tal and Arkadi Nemirovski. SIAM, 2001.
2.	Numerical optimization, 2nd edition, by Jorge Nocedal and Stephen J. Wright. Springer, 2006