MS3601: OPTIMIZATION METHODS

Effective Term
Semester A 2024/25

Part I Course Overview

Course Title
Optimization Methods

Subject Code
MS - Management Sciences
Course Number
3601

Academic Unit
Management Sciences (MS)

College/School
College of Business (CB)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
MA 2001 Multi-variable Calculus and Linear Algebra Or subject to instructor’ s approval

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract
This course introduces students to the theory, algorithms, and applications of optimization, particularly in linear programming, integer programming, and convex (quadratic) programming. Many real-world business problems can be

modelled as an optimization problem, and it is important to choose the most appropriate formulation to ensure that a solution can be obtained efficiently. Students will learn essential theoretical and algorithmic topics, such as the Simplex method, duality, cutting planes, and optimality conditions. Applications to finance will be emphasized. The course will introduce the use of software such as Gurobi with Python to solve large optimization problems.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Explain the fundamental concepts and principles underlying linear, integer, and convex (quadratic) programming.		x		
2	Demonstrate the ability to apply optimality conditions and solve optimization problems using appropriate methodologies, including linear, integer, and convex (quadratic) programming techniques.		x	x	
3	Formulate real-world business problems as optimization models and implement effective solutions.		x	x	x
4	Utilize industry-standard computer software, such as Gurobi with Python, to solve large-scale and complex optimization problems.		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 engage in lectures to discover the theory, algorithms, and applications of optimization. Students will work through examples to enhance understanding of the methodologies behind linear and convex optimization.	1, 2, 3, 4	3

2	Individual/Group Practice	Students will build optimization models for different types of business problems. Students will practice with computing optimal solutions using the algorithms introduced in lectures. Students will utilize Gurobi with Python to practice coding and using industry-standard software for large and complex optimization problems.	1, 2, 3, 4	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Assignments	1, 2, 3, 4	30	
2	Mid-term quiz (quizzes)	1, 2, 3	15	

Continuous Assessment (%)

45

Examination (%)

55

Examination Duration (Hours)

2

Assessment Rubrics (AR)

Assessment Task

Assignments

Criterion

Identify and build correct models for different applications; use appropriate techniques to solve simple optimization problems by hand; use software to solve and analyze larger problems.

Excellent (A+, A, A-)

Strong evidence of ability to understand key concepts and methodologies; consistent ability to analyze problems and apply the most appropriate solution techniques; superior grasp of subject matter; evidence of extensive knowledge base.

Good (B+, B, B-)

Evidence of ability to understand key concepts and methodologies; moderately consistent ability to analyze problems and apply appropriate solution techniques; reasonable grasp of subject matter.

Fair (C+, C, C-)

Some familiarity with key concepts and methodologies; some ability to analyze problems and apply solution techniques; some grasp of subject matter to demonstrate that student is profiting from the university experience.

Marginal (D)
Basic familiarity with key concepts; grasp of subject matter sufficient to enable the student to pursue further studies.

Failure (F)
Little or no evidence of familiarity with the subject matter.

Assessment Task
Mid-term quiz (quizzes)

Criterion
Understand introductory theories of optimization; apply correct algorithm and/or solution techniques for different types of problems; use appropriate techniques to solve simple optimization problems by hand.

Excellent (A+, A, A-)
Strong evidence of ability to understand key concepts and methodologies; consistent ability to analyze problems and apply the most appropriate solution techniques; superior grasp of subject matter; evidence of extensive knowledge base.

Good (B+, B, B-)
Evidence of ability to understand key concepts and methodologies; moderately consistent ability to analyze problems and apply appropriate solution techniques; reasonable grasp of subject matter.

Fair (C+, C, C-)
Some familiarity with key concepts and methodologies; some ability to analyze problems and apply solution techniques; some grasp of subject matter to demonstrate that student is profiting from the university experience.

Marginal (D)
Basic familiarity with key concepts; grasp of subject matter sufficient to enable the student to pursue further studies.

Failure (F)
Little or no evidence of familiarity with the subject matter.

Assessment Task
Exam

Criterion
Understand introductory theories of optimization; apply correct algorithm and/or solution techniques for different types of problems; use appropriate techniques to solve simple optimization problems by hand.

Excellent (A+, A, A-)
Strong evidence of ability to understand key concepts and methodologies; consistent ability to analyze problems and apply the most appropriate solution techniques; superior grasp of subject matter; evidence of extensive knowledge base.

Good (B+, B, B-)
Evidence of ability to understand key concepts and methodologies; moderately consistent ability to analyze problems and apply appropriate solution techniques; reasonable grasp of subject matter.

Fair (C+, C, C-)
Some familiarity with key concepts and methodologies; some ability to analyze problems and apply solution techniques; some grasp of subject matter to demonstrate that student is profiting from the university experience.

Marginal (D)

Basic familiarity with key concepts; grasp of subject matter sufficient to enable the student to pursue further studies.

Failure (F)
Little or no evidence of familiarity with the subject matter.

Part III Other Information

Keyword Syllabus

a. Linear programming: Simplex method, duality, sensitivity analysis
b. Integer programming: Branch-and-bound, cutting planes, complexity
c. Convex optimization: Convexity and properties, Lagrangian duality, optimality conditions, quadratic programming.
d. Applications: Product mix, foreign exchange, investment decisions, network flows, clustering, portfolio optimization

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	Guenin, B., Könemann, Un, J., & Tunçel, L. (2014). A Gentle Introduction to Optimization. Cambridge, UK: Cambridge University Press.
2	Cornuejols, G., Pen#a, J. F., & Tu#tu#ncu#, R. (2018). Optimization methods in finance (Second edition.). Cambridge, United Kingdom#; New York, NY: Cambridge University Press.
3	Boyd, S. P., & Vandenberghe, L. (2004). Convex optimization. Cambridge, UK#; New York: Cambridge.