Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

Expected Implementation in Academic Year	AY2022-2023
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Yan Zhenzhen
Course Author Email	yanzz@ntu.edu.sg
Course Title	Basic Optimization
Course Code	MH3701
Academic Units	4
Contact Hours	59
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	MH1201 OR MH2800 OR MH2802
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

This is a first course in mathematical optimization. It builds the basic knowledge and skills in the theory and techniques of analysing and solving simple optimization models. With these foundations, you will be able to deepen your understanding of more complex optimization models, and their applications to various disciplines in subsequent mathematical optimization and operations research courses.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Solve instances of linear programs with the simplex method.
ILO 2	Explain and relate the geometry, the algebra, and the tabular form of the simplex method
ILO 3	Solve instances of minimum-cost flow problems with the network simplex method.
ILO 4	Explain the algebra of the network simplex method.
ILO 5	Explain the optimality of a solution to a linear program, and the infeasibility of a linear program, using linear programming duality.
ILO 6	Conduct sensitivity and post-optimality analysis on linear programs.
ILO 7	Solve instances of nonlinear programs via their Karush-Kuhn-Tucker conditions.

Course Content

Geometric simplex method
Algebraic simplex method in tabular form
Implementing the simplex method
Revised simplex method
Fundamental Theorem of the network simplex method
The network simplex method
Linear programming duality
Sensitivity and post-optimality analysis
Lagrange duality and the Karush-Kuhn-Tucker conditions

Reading and References (if applicable)

1. Frederick S. Hillier and Gerald J. Lieberman, “Introduction to Operations Research”,McGraw-Hill, ISBN 0073376299

2. Robert J. Vanderbei, “Linear Programming: Foundations and Extensions”, Springer, ISBN1461476291

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Geometric simplex method	1	Lecture notes Chapter 1		
2	Geometric simplex method	1	Lecture notes Chapter 2		
3	Algebraic simplex method in tabular form	1, 2	Lecture notes Chapter 2		
4	Algebraic simplex method in tabular form	1, 2	Lecture notes Chapter 2		
5	Implementing the simplex method	1	Lecture notes Chapter 3		
6	Revised simplex method	1	Lecture notes Chapter 3		
7	Fundamental Theorem of the network simplex method	3, 4	Lecture notes Chapter 4		
8	The network simplex method	3	Lecture notes Chapter 4,		Test
9	Linear programming duality	5	Lecture notes Chapter 6		
10	Linear programming duality	5	Lecture notes Chapter 6		
11	Sensitivity and post-optimality analysis	6	Lecture notes Chapter 7		

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
12	Lagrange duality and the Karush-Kuhn-Tucker conditions	7	Lecture notes Chapter 8		
13	Lagrange duality and the Karush-Kuhn-Tucker conditions	7	Lecture notes Chapter 8		

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	You will learn algorithms to solve linear programs and understand the rationality of the algorithms in lectures. You will also learn the duality theory of linear programs and understand how to analyze the sensitivity of each component of a linear program during the lecture.
Tutorials	You will participate in problem-solving tutorial sessions, where problems are designed based on the theories and solution techniques covered in the lecture.
Laboratories	You will learn how to model real-world optimization problems as linear programs, and solve instances of these models in the lab sessions. The optimization problem will be introduced and the linear programming model explained at the beginning of the lab session. You will then have hands-on experience in extracting the problem data from a randomly selected problem to build a linear programming model, and solve it using a solver of your choice.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Others(Laboratories - Multiple Choice Questions)	1, 2, 6	1.a,c,d, 2.a	5		Individual	Holistic	Relational
2	Continuous Assessment (CA): Others(Multiple Choice Questions)	1, 2, 5, 6	1.a, c	20		Individual	Holistic	Relational
3	Continuous Assessment (CA): Others(Mid-semester Quiz - Short Answer Questions)	1, 2, 3, 4, 5, 6,7	1.a,b,c, 2.b, 3.a, 4.a	25		Individual	Analytic	Extended Abstract
4	Summative Assessment (EXAM): Final exam(Short Answer Questions)	1, 2, 3, 4, 5, 6,7	1. a,b,c, 2.b, 3.a, 4.a	50		Individual	Analytic	Extended Abstract

Description of Assessment Components (if applicable)

These are the relevant SPMS-MAS Graduate Attributes.
1. Competence
a. Independently process and interpret mathematical theories and methodologies, and apply them to solve problems
b. Formulate mathematical statements precisely using rigorous mathematical language
c. Discover patterns by abstraction from examples
d. Use computer technology to solve problems, and to communicate mathematical ideas
2. Creativity
a. Critically assess the applicability of mathematical tools in the workplace
b. Build on the connection between subfields of mathematics to tackle new problems
3. Communication
a. Present mathematics ideas logically and coherently at the appropriate level for the intended audience

4. Civic-mindedness
a. Develop and communicate mathematical ideas and concepts relevant in everyday life for the benefits of society

Formative Feedback

1. Online quizzes:
Your performance in an online quiz will be immediately given upon submission of your answers. The feedback includes your performance on each question, possible misconceptions that may lead you to wrong answers, and how the question can be answered.

2. In-class test:
Comments on your answers to the questions will be written on your test scripts and returned to you upon grading.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Critical Thinking	Intermediate
Curiosity	Intermediate
Adaptability	Intermediate

Course Policy

Policy (Academic Integrity)

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values. As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

You are expected to attend all lectures, tutorials, and lab classes punctually, and complete allscheduled lab assignments, online quizzes, and in-class tests by due dates. You are expected to take responsibility to follow up with course notes, quizzes, lab assignments, and course related announcements for assessments you have missed. You are expected to participate in all tutorial discussions and activities.

Policy (Absenteeism)

A missed test will be given a mark of zero, unless prior permission is given by the course coordinator, or a leave of absence is approved by the School. If you miss an in-class test, you must inform the course coordinator via email (yanzz@ntu.edu.sg) within 2 working days of the test.

Policy (Others, if applicable)

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:

- If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
- If you feel like your performance in the class is being impacted by your experiences outside of class;
- If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

Please speak to your teaching team, our school pastoral officer or a peer or senior (either in-person or via email) about how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or a faculty member.

Online Compulsory Lab Assignments and Quizzes:
You are required to complete online compulsory lab assignments and quizzes on due dates. You have unlimited attempts. The highest score will be considered in the course assessment.

Appendix 1: Assessment Rubrics

Rubric for Laboratories: Multiple Choice Questions (5%)

As scored by online system

Rubric for Technology-enhanced Learning: Multiple Choice Questions (20%)

As scored by online system

Rubric for Mid-semester Quiz: Short Answer Questions (25%)

Point-based marking

Rubric for Examination: Short Answer Questions (50%)

Point-based marking