MATH 441

Discrete Optimization Problems *Course Outline 2024W2*

MATH 441 is a project-based course which emphasizes mathematical research, communication, collaboration, computation and reflection. Students collaborate on group projects which explore real-world applications of linear programming, combinatorial optimization and convex optimization.

Learning Goals

- Formulate well-defined optimization problems based on real-world phenomena
- Describe and contrast algorithms for solving optimization problems
- Describe and contrast the computational complexity of optimization problems
- Use mathematical software to compute solutions of optimization problems
- Communicate solutions of optimization problems to a mathematical audience

Instructors

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Lectures

Monday/Wednesday/Friday	11am–12pm	LSK 121

- Many lectures are reserved for student work on optimization projects and instructor feedback

Prerequisites

MATH 340 Introduction to Linear Programming is *required*. It will also be *very* helpful if students have completed MATH 200, 210 and 307. See the UBC Course Descriptions.

Important Dates

January 6	First lecture
February 17–21	Reading break (no lectures)
April 7	Last day of class

- See UBC Academic Calendar 2024/2025

Participation

Class attendance is optional but strongly encouraged. Mathematics is best learned in conversation with others. Furthermore, instructors will not provide reference letters in the future for graduate school or otherwise for students who do not regularly participate in class.

Schedule

Hours	*Units*
3	**Overview.** Mathematical modelling process, classification of optimization problems, Python and Jupyter, survey of peer-reviewed journals in applied mathematics, how to read and write mathematical documents.
12	**Linear Programming.** Linear objective functions and constraints, standard form, simplex method, duality theory. Applications: transportation, network flows, production, consumption. Python packages: SciPy, PuLP.
12	**Combinatorial Optimization.** Integer programming, network analysis, greedy algorithms. Applications: routing, scheduling, packing, cutting, assignment, covering, games. Python packages: NetworkX, Google OR-Tools.
10	**Convex Optimization.** Convex objective functions and constraints, interior point methods, KKT systems. Applications: portfolio optimization, geometric optimization, L1 optimization. Python packages: CVXPY.
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Assessments

Journal Article Summary	10%
Linear Programming Project	30%
Combinatorial Optimization Project	30%
Convex Optimization Project	30%

- Journal Article Summary is completed in pairs
- Projects are completed in groups of 3 or 4 students
- Students formulate optimization problems in collaboration with instructors, construct and analyze mathematical models, compute solutions with mathematical software and present results in a technical document similar to an article published in a peer-reviewed journal in applied mathematics

Collaborative Grading

We will implement a *collaborative grading* process for assessments:

- Groups submit documents by due date
- Instructors review documents and provide written feedback but no grades
- Groups review feedback and, if they choose, revise and resubmit their work
- Each group schedules an in-person meeting to determine their grade in collaboration with instructors following a rubric
- Grades are assigned at the discretion of instructors

What's the point?! The focus is on *your learning* and not the "right answers". You are free to explore ideas that you find interesting and to demonstrate your mathematical skills. Meetings in the collaborative grading process are informal conversations where students reflect on their own learning, shares their experience with instructors and participate in the grading process.

GenAI Policy

Generative artificial intelligence (GenAI) includes tools such as ChatGPT, Gemini, Copilot, Claude, etc. Students may use GenAI as a study aid and search tool however:

- Students must submit their own work. Do not submit any text, code or images created by GenAI. Do not submit any work that is paraphrasing output created by GenAI.
- Do not cite GenAI or its output as a source. Find primary sources such as published books and peer-reviewed research articles and cite those sources properly.

Violating the GenAI policy is academic misconduct. See UBC Academic Integrity and UBC Academic Misconduct for more information.

See UBC Guidance on Learning with GenAI for more information, and ask your instructors if you have further questions.

Student Resources

Science Advising	Health and Wellbeing	Centre for Accessibility
Academic Concession	Academic Integrity	Counselling Services

University Policies

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available on the UBC Senate website.