Term 2, 2024/2025: Jan 2025 -- Apr 2025

Math 340 Introduction to Linear Programming

All the information is to be on Canvas.

We have two sections:

Section 201: Instructor: Rentian Yao (https://sites.google.com/view/rentianyao)
Email: Please use the Canvas email.
Tue Thu | 9:30 a.m. - 11:00 a.m.
Location of class: MATX-Floor 1-Room 1100

Section 202: Instructor: Young-Heon Kim (https://personal.math.ubc.ca/~yhkim/index.html)
Email: Please use the Canvas email.
Mon/Wed/Fri: 12:00--13:00
Location: BUCH-Floor 1-Room A103

About the Course

This course would be more properly called Linear Optimization, optimizing a linear objective function subject to linear constraints. The word `programming' is not used in the sense of computer programming. The word `programming' refers to the program of activities given by a solution.

Prerequisites: One of MATH 152, MATH 221, MATH 223.

- It is highly recommended that students have taken a multi-variable calculus course (e.g. Math 200, 253, etc.).
- Also, basic knowledge of mathematical proofs (e.g. Math 220) is highly recommended for taking this course.

Main Reference:

Linear Programming by Robert Vanderbei
(https://gw2jh3xr2c.search.serialssolutions.com/?sid=sersol&SS_jc=TC0002299077&title=Linear%20Programming%20Foundations%20and%20Extensions)
(electronic copy available to download through the UBC library!).
For your note, I am using the 5th edition, and will use it for referring the numbers of sections and exercise. Vanderbei's webpage:https://vanderbei.princeton.edu/LPbook/index.html

Supplementary:
Understanding and using linear programming by Jiří Matoušek , Bernd Gärtner
(https://gw2jh3xr2c.search.serialssolutions.com/?sid=sersol&SS_jc=TC0000320571&title=Understanding and using linear programming)
Electronic copy available to download through the UBC library.

Course topics (subject to changes):

- Basics of LP problems and computer packages. 2 weeks.
- Simplex method and related geometry. 2 weeks.
- Duality theory. 3 weeks.
- Matrix notation and sensitivity analysis. 2 weeks.
- Matrix games. 1 - 2 weeks.
- Optimal transport. 1 - 2 weeks.

Learning Goals:

- To be familiar with basic concepts of optimization
- To be able to translate practical (high dimensional) optimization problems into linear programming
- To understand the basic geometry of convex sets and its relation to linear programming
- To be able to compute solutions of linear programming by the simplex method and its variants
- To be able to manipulate matrix calculations to analyze linear optimization problems
- To understand and utilize duality to analyze linear optimization problems
- To be able to give mathematical proofs for simple statements regarding convex sets, optimization, simplex method, duality, etc.
- To be familiar with computer packages for doing mathematics

Expectations:

- Students are expected to attend all lectures and complete all assignments, quizzes, and exams to their full extent.
- Students should expect to spend between 6 and 10 hours per week outside of lectures. In the case a class meeting has to be missed, it is the student's responsibility to make up the missed material.

How to succeed in this course:

It is very important to learn mathematics by "doing". For example, it is not enough to read a worked out example from a book or lecture notes. It is not enough to understand each step in the solution. You have to struggle to work out examples or problems by yourself, without looking at the solutions. This way, you build up mathematical intuition on the subject.

Very useful advice on how to solve problems are in Polya (http://www.math.utah.edu/%7Epa/math/polya.html).

Grading

Your grade for the course will be computed as follows:

HW Assignments 30%. 10 weekly HWs. Only the best 9 HWs will be counted toward the course grade.

Midterm 5%. Self administered take home exam (2hr exam).

- Students write the exam simulating an in-class exam.
- Students mark their own exam and then submit the graded papers.
- The solutions and marking schemes will be provided by the instructor.
- **Students will get full official mark as long as they submit their self graded exam.** One of the points is to honestly assess one's own work.
- **Students who do not submit the graded exam will get zero mark.**
- We will still record the students' self mark, only to keep record of students' progress.

Participation and attitude 5%.

- This is calculated at the end of the semester as follows:
- All students will start with an INITIAL PARTICIPATION GRADE proportional to the rest of their course work. For example, a student with 57/95 will start with 3/5 participation mark.

- **To earn more grades than the initial participation grade** you should submit a one page essay discussing your learning experiences and how you have participated throughout the course. For example, you can explain what topic was most interesting to you and why, how the learning experiences have enhanced your mathematical understanding, as well as how you have participated classes/office hours/Piazza discussions. Then the instructor will determine the additional marks. **The essay is due Thursday, April 11.**
- **Under the decision of instructors, a small portion of the participation mark (maximum 1out of 5) might be assigned as a bonus mark, e.g. for participating in surveys/ evaluations.**

Final Exam 60%:

IMPORTANT: Students with failing term mark (that is, less than 17/35) will not be admitted to write the final exam and will fail the course.
All marks are subject to scaling.

Missing midterms: There are *no make-up midterms* in this course. Missing the midterm for a valid reason normally results in the weight of that midterm being transferred to the final exam.
Examples of valid reasons include illness and travel to play a scheduled game for a varsity team.
Examples of reasons that are not valid include conflicts with personal travel schedules or conflicts with work schedules or with other classes.

Please note that a student who misses the midterm and has otherwise not completed a substantial portion of the term work shall not be admitted to the final examination.

Missing the Final Exam: You will need to present your situation to the Dean's Office of your Faculty to be considered for a deferred exam. See the Calendar for detailed regulations (http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,41,94,0).
Your performance in a course up to the exam is taken into consideration in granting a deferred exam status (e.g. failing badly generally means you will not be granted a deferred exam). In Mathematics, generally students sit the next available exam for the course they are taking, which could be several months after the original exam was scheduled.
Note that your personal travel schedule is NOT a valid reason for missing a final exam and students who miss the MATH 340 exam for this reason will receive a grade of 0 on the exam and fail the course.
IT IS ESPECIALLY IMPORTANT that students know that IF THEY DO NOT FULFILL THE COURSE REQUIREMENTS DURING THE TERM (including not writing the midterm test(s) even if you agree to transfer the weight to the final) AND THEN MISS THE FINAL EXAMINATION, THEY MAY BE DEEMED INELIGIBLE FOR A DEFERRED FINAL.

Exams:

- **Midterm**: Take-home exam on **Tuesday, March 4. Self administered 2hr exam.** March 7 (Friday): graded take-home midterm exam submission due.
- **Final Exam: TBA.**

HW Assignments Schedule: All times are the Vancouver time.

There will be a total of 10 HW assignments throughout the term. The best 9 HWs will be counted towards the course grade:

- Jan 24 (Friday): HW 1 due
- Jan 31 (Friday): HW 2 due
- Feb 7 (Friday): HW 3 due
- Feb 14 (Friday): HW 4 due
- UBC break: Feb 17--21
- Feb 28 (Friday): HW 5 due
- March 4 (Tuesday): Take-home midterm exam.
- March 7 (Friday): graded take-home midterm exam submission due.
- March 7 (Friday) HW 6 due
- March 14 (Friday): HW 7 due
- March 21 (Friday): HW 8 due
- March 28 (Friday): HW 9 due
- April 4 (Friday): HW 10 due.

Homework Assignments Policy:

- At the end of the semester, your lowest homework grade will be dropped. This policy is intended to cover situations where you may miss an assignment for whatever reason, without you needing to ask for a concession. Most academic concession requests for assignments will be addressed by this policy.
- Students may work together on the HW assignments but must write up their solutions **independently**. Copying is forbidden. Any 2 (or more) assignments with some virtually identical answers deemed the result of copying will be given 0 total credit, and there will be further consequences for such dishonest actions. The students are reminded of the plagiarism policies of UBC.
- We will be using Canvas for collecting the HWs.
- **Late homework is not accepted.**
- **Unreadable homework will get a zero mark.** You should write neatly and organize your material for a third party to be able to clearly understand.
- Work must be shown. Missed homework will count as a zero mark.
- The number of each homework problem should be clearly printed.
- It is probable that only a subset of those problems turned in would be graded, and you will not be informed (in advance) which ones these are. For example, if

your homework does not contain any of the problems to be graded (which will be known only after the due date), you will get zero mark. So, it would be better for you to do all the problems to be handed in. For selected problems, only some important steps and/or the final answer will be checked.

How to ask for change of marking: If you feel that a returned assessment is incorrectly marked, you can appeal that mark by submitting a regrade request statement to the instructor within one week of the return of the marked assignment. The statement should include a summary of what you think was incorrectly evaluated, with some justification of the claim. Your work will be re-evaluated in accordance with the established grading procedures, and re-marked if necessary. Note in unusual circumstances, if you mistakenly received a higher grade than earned, your final grade might decrease upon remarking.

Computing

For certain assignments and if you opt for the optional project, you will need to use software packages for computing linear programming problems.
Our default programming language is Python language via Jupyter Notebook, which is available available via the UBC syzygy server (https://ubc.syzygy.ca/jupyter/hub/) You can use this using your UBC CWL. There is Python library for linear programming, called PuLp. More details will be given later in the class.

- For learning python language, there are many sources; e.g. the online book https://automatetheboringstuff.com/
- Vanderbei (https://vanderbei.princeton.edu/LPbook/index.html) has an online pivoting tool that lets you choose entering and exiting variables and performs the pivot automatically. This is a good way to get an idea of how the simplex method will work on larger problems without having to do all of the algebra by hand.

Canvas email:

If you have course related questions for the instructor, then please use the Canvas email. Of course, visiting the office hours is a great way to communicate with the instructor. Please avoid using my math email address, unless urgent, to help me keep my math mailbox under the storage limit; using the Canvas email will also help your message to be not classified as a spam and missed.

Other general information:

About the use of generative AI (e.g. ChatGPT or similar) tools:
The use of generative AI tools, including ChatGPT and other similar tools, to complete or support the completion of any form of assignment or assessment in this course is **not** allowed, unless explicitly stated otherwise by the instructor in this course, and would be considered academic misconduct.

Academic Integrity:
Academic integrity, in short, means being an honest, diligent, and responsible scholar.

- **To what extent can students collaborate on homework or other assignments?**
  - You are encouraged to collaborate with fellow students to work on problems together. However, the final work should be in your own terms and your own writing, acknowledging all sources of information or help. This also means you should not cheat, copy, or mislead others about what is your work; nor should you help others to do the same.
- **What is permitted to be used during tests?**
  - Only pen/pencils/erasers.
- **How should I, as a student, resolve any uncertainty I may have about academic integrity and academic misconduct?**
  - Contact your instructor.

For more information, see https://academicintegrity.ubc.ca/resources/. Find information in Canvas Modules.

Academic concession

Question: How do I submit an academic concession?
Answer: Academic concessions for final assignments and exams are handled through your Faculty Advising Office. For in-term concessions, fill in and submit the form here to your instructor.

UBC Vancouver Senate's **Academic Concession Policy V-135 (http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,329,0,0).** Students are advised to read **this policy carefully.**

Accessibility resources at UBC:

Centre for Accessibility: https://students.ubc.ca/about-student-services/centre-for-accessibility/

Equity/Diversity/Inclusion:

Treat people with equal respect regardless of their gender, class, sexual orientation, ethnicity, appearance, religion, and so on, and regardless of their current level of mathematical ability. Be inclusive and considerate.
https://students.ubc.ca/campus-life/equity-diversity-inclusion-resources/

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