Syllabus CO 370 - Winter 2021

Because of Covid-19 this course is being run differently than during previous offerings. Therefore, it is critical that you be familiar with the course policies.

> Please read the syllabus. It is NOT run-of-the-mill stuff!!!.

1. Contact information

1.1 Instructor

Last name	First name	Email	Role
Guenin	Bertrand	bguenin@uwaterloo.ca	instructor - coordinator

When to contact the instructor?

Only for questions that are either of a personal nature or have no relevance to other students. Do NOT contact your instructor for questions about assignments, course material, or general organization. These questions should be posted on Piazza so that all students can benefit from the answers.

When writing to me, use your UWaterloo email account, include CO 370 in subject line, and include your full name + UWaterloo student number in the email. I will answer most emails within 48 hours, from Monday to Friday. Note, for privacy reasons *I am unable to answer emails from personal accounts.*

Advising hours

I am available to talk over Zoom every Monday from 9:30am to 11:30am (Waterloo local time). If you have an issue that you would like to discuss with me, send me an email and I will send you a Zoom invitation. Note, if Monday morning does not work because of the time zone you are currently residing in, I will arrange an alternate time for you. I am available to help feel free to reach out.

1.2 Tech support

Note that I am not in a position to solve technical issues with D2L, Piazza, or Crowdmark. Please try to use the resources below.

Desire to Learn (D2L)

Online help is available at:

> https://uwaterloo.ca/learn-help/students

If you do not find the answer to your question you can write to

> learnhelp@uwaterloo.ca

Include your full name, WatIAM user ID, student number, and course name and number. Technical support is available during regular business hours, Monday to Friday, 8:30 AM to 4:30 PM (Eastern Time).

Piazza

The answer to most common issues as well as how-to videos can be found at

> https://support.piazza.com/support/home

If you do not find the answer to your question you can try to contact the Piazza at,

> https://piazza.com/support/contact

To avoid issues, only use your UWaterloo email, never use multiple email addresses.

Crowdmark

Online help is available at

> https://crowdmark.com/help/

Check that your email inbox is not full. Note, you can login directly to Crowdmark and see all assignments posted. If all else fails and you are unable to access your assignment contact me.

2. Course overview

2.1 Summary

Operations Research (OR) is a multidisciplinary field, with researchers from such diverse areas as optimization, statistics, applied probability, computer science, combinatorics, finance, marketing, mechanical engineering, and supply chain management, and practitioners from industries such as airlines, manufacturing, retail, finance, health care, and defense. It is difficult to give a definition of the field that

everybody can agree on, but at the very least, Operations Research is the field of applying mathematical modeling tools for complex decision making in the real world. It is comprised of two main areas: optimization and stochastic processes. In this course, we focus on the optimization side of OR. The explosion of computational power in the past decades have given the field of OR a great boost, especially in its practical computational abilities. Personal desktops became cheap yet immensely powerful. The combination of this movement and the effect of 50 years of active research in OR gave rise to a wide range of OR tools, available as black-box software packages and many OR problems can now be solved on desktop computers.

2.2   Topics:

PART I: FORMULATIONS

- LP formulations:

    - examples
    - general techniques

- Flows:

    - max st-flow model & applications
    - min cost flow model & applications

- IP formulations:

    - examples
    - general techniques

- Integer Programs that reduce to Linear Programs

    - TU matrices
    - Applications to flows

- Cone programming

    - examples of cones
    - the model
    - Second Order cone programs

- Robust optimization

    - the model
    - modeling uncertainty as a ball

– modeling uncertainty as a hypercube

PART II: INTERPRETATIONS OF OPTIMAL SOLUTIONS

- Duality review

- Economic interpretation of dual variables

- Sensitivity analysis

    – optimal basis

    – changes to the right-hand-side

    – changes in the objective function

- Primal and dual Simplex

    – tableaus

    – Primal and Dual Simplex via tableaus

- Parametric Linear Programs

PART III: SOLVING OPTIMIZATION TECHNIQUES

- Large scale optimization

- cutting planes and dual Simplex

- cutting stock and column generation.

2.3 Week by week schedule

Week	Starts Monday	Activity	Begin Date	Due Date
1	January 11			
2	January 18	HW 1	January 20	January 29
3	January 25			
4	February 1	HW 2	February 3	February 12
5	February 8			
READING WEEK (NO NEW MATERIAL)				
6	February 22	Midterm	February 24	February 24
7	March 1	HW 3	March 3	March 12
8	March 8			
9	March 15	HW 4	March 17	March 26
10	March 22			
11	March 29	HW5	March 31	April 9
12	April 5			
CLASS ENDS, APRIL 14TH				
FINAL EXAM			TBA	TBA

2.4 Milestones

After completing the class, you are expected to master the following tasks and concepts:

- write formulations (LP, IP, NLP, and Flow Problems),
- Totally Unimodular matrices and Network Flows,
- cone programming,
- robust optimization,
- interpretation of dual variables in Linear Programs,
- sensitivity analysis,
- Primal and Dual Simplex,
- parametric LPs,
- Cutting Plane Algorithms and the dual Simplex,
- the Column Generation procedure.

3. Available resources

The following resources will be available to you,

1. online classes,

2. the course notes,

3. the Piazza forum,

4. office hours,

5. assignments and solutions, and

6. video tutorials.

Next we discuss each of these resources in more details.

3.1 Online classes

The online classes are all available at the start of the course. The material covered in these lectures is similar in scope to the material that is covered during a typical off-line course. Because of the differences in delivery, online material tends to be more dense than in-class material, so a 20 minute online lecture will cover the same amount of material as 40 minutes in class. Much of the material in the online lectures are available in the course notes with two notable exceptions: cone programming and robust optimization.

3.2 Course notes

The course notes for CO 370 are mandatory. I will expect that you have access to it. You can order the course notes through the UW book store. Note, that we will also make the course notes available on the D2L platform, so unless you want a hard copy it is not necessary for you to purchase it from the UW book store.

3.3 Piazza

We will use Piazza for discussion. If you enrolled early in the course you should already be enrolled in the Piazza discussion board. Otherwise you can sign yourself up at

We will use Piazza to discuss course material, assignments, and organizational issues. This will be your main point of contact with instructors and teaching assistants. Please be respectful and polite. As you will receive credit for each assignment *do not give away answers.* You can help fellow students by clearing ambiguity, or pointing to the appropriate material in the course, however. If you are unsure if your post on Piazza gives away too much of an assignment's answer, *please post it as a private post*, i.e. visible to the instructor

and the TAs only. We may then choose to make the post public if it is appropriate. You can freely discuss the material in the lectures and the textbook.

> Only use your UWaterloo email account to sign up on Piazza. We want to limit access to Piazza to students enrolled in the course and may unenroll you if it is a private email.

3.4 Office hours

You will have access to online office hours each week. You can ask questions pertaining to the course material or the assignments. The schedule is as follows:

- From Jan 19 to April 13 (no office hour the first week and Reading Week).
- Every Tuesday/Thursday 10:00-11:30 and 2:00:3:30 (Waterloo local time).

We are using Zoom, you can download the app at `https://zoom.us/download`.

There are two ways to join a meeting.

- follow the following link:

- login using the meeting ID + password (use if link does not work).

> To avoid Zoom bombing (i.e. internet trolls crashing the tutorial) do not post invites.

3.5 Assignments

There will be 5 assignments. Check the week by week schedule for posting and due dates. Assignments will be mailed out to you via Crowdmark. In the unlikely event you do not receive your assignment follow these instructions. Note, we will post assignments on D2L as well so in all cases you will be able to get started immediately.

Group assignments

Assignments 1 and 3 will be *group assignments*. For these assignments, you will be randomly divided into groups of three students. You will be expected to work together and will upload one solution for each group. Note, I expect everyone in the group to contribute equally to the assignment. If you feel that one of your group member is unwilling to work on the assignment please contact me.

Deadlines and logistical issues

> The assignment is due at 11:59pm EDT (Eastern Daylight Time) on the due day.
>
> This is a HARD DEADLINE.
>
> Late assignments will receive NO CREDIT regardless of the reason why.

In particular, technical issues, such as being unable to load assignments are not considered a valid excuse! You will have 9 days to complete the assignment and there should be ample time to work out any logistical issues. Crowdmark lets you upload assignments as many time as you wish. Thus we suggest the following strategy,

- Upload the assignment after you complete each question.
- Do not try to submit your assignment close to the deadline.

In *exceptional circumstances* you can email us the assignment and if we receive it before the deadline we will credit the work. One reason for the hard deadline is that we wish to post solutions to assignments as soon as possible, i.e. right after the submission deadline. Another reason is for work to be graded on time. If you are outside the Waterloo time zone and require assistance with converting your time, please try the Ontario, Canada Time Converter.

Academic Integrity

> Because each assignment counts for a significant percentage of your final mark there will be strict rules governing access to material and help, and severe penalties for violating these. See Academic Integrity.

Remarking requests

Once you receive your marked assignment, you will have *one week* to request any remarking. We will NOT revise the marking after that. To get get your assignment remarked proceed as follows for *each question*,

1. Find the email of the TA that marked the question,

2. Write a concise message explaining why you think you received an erroneous mark,

3. Wait for 48 hours, if you do not hear from the TA by then, send a follow up message.

For (1) the information will be available on D2L where assignments are posted.

3.6   Video tutorials

Completion of the assignments will be critical to your understanding of the course and to your final grade. It is often a challenge for students to know how to get started. To

address this challenge we will release with each assignment a short video to provide tips to get going. You will be expected to watch the video tutorial.

4. Mark and policies

4.1 Breakdown

Your final mark will be computed as follows:

Assignments	$5 \times 11\%$
Midterm exam	20%
Final exam	25%
Total	100%

4.2 Policies

Late enrolment

If you enroll in the course after the start of the course and missed the first assignment the assignments will still count for 55% but we will distribute the weight between the remaining assignments, namely each of the remaining four assignments will count for $\frac{1}{4}55 = 13.75\%$.

Illnesses and INC

If you are sick contact your instructor as soon as you realize there will be a problem, and preferably within 48 hours, but no more than 72 hours. Follow the instructions at, `https://uwaterloo.ca/math/vif-submission` to submit your Verification of Illness Form (VIF) electronically. We will accommodate sick students as best possible. In case of a short period of illness and a strong performance in the course we should be able to simply shift the weight to the remaining assessments and exams.

> To receive an INC we will require that
> - you completed at least 3/5 assignments
> - you obtained an average of at least 60% on these assignments
> - you wrote and passed the midterm exam.

5. Academic Integrity

In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect, and responsibility.

This has never been more true than in these times of crisis. If you have not already completed the online Academic Integrity Tutorial you should do so as soon as possible.

Assignments will count for 55% of your final mark. As result you should *treat each assignment as an exam*. In particular, you are expected to complete the work you submit on your own. In the following by "assessment" we mean an assignment or the final exam.

5.1   What is forbidden

Here is a list of behaviours that CONSTITUTE CHEATING,

a. discussing the assessment with other students[1] anywhere but Piazza,

b. getting any outside help on an assessment by anyone,

c. using any resources not provided by the instructors to help you with an assessment,

d. joining/setting up a discussion board other than Piazza for the purpose discussing or sharing CO 370 related material.

For (b) "anyone" could mean for instance: a student that already completed CO 370, or a paid tutor. Note that helping someone by sharing your assignment is also considered cheating. For (c) this means for instance that you are not allowed to download old solutions to assignments, or consult outside textbooks, notes, research papers, etc... with the aim of finding a solution to a question on an assessment. For (d) this means that you are not allowed to create a whatsapp/facebook group or use any similar platform.

5.2   What is acceptable

Here is list of behaviour that are perfectly proper,

a. discussing *course material* with anyone,

b. using outside resources to help you understand the *course material*,

c. asking on Piazza for clarification on an assessment (we encourage you to do so),

d. talking to anyone in your group for a group assignment,

e. asking anything to the TAs during office hours.

We will refer any suspicious activity to the Associate Dean following the guidelines of Policy 71. Disciplinary actions can range from, a letter of reprimand, all the way, to expulsion from the University.

6.   AccessAbility Services

AccessAbility Services, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic

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[1]unless it is a group assignment and that student is in your group

integrity of the curriculum. If you require academic accommodation to lessen the impact of your disability, *please register with AccessAbility Services.*

Although the doors of AccessAbility Services and the Exam Centre are temporarily closed, its staff remains available and committed to students. AAS will continue to support students with assistive technology, learning strategy support, and accommodation consulting to ensure you are supported in the online space. Find out more about AccessAbility Services modified services.

https://uwaterloo.ca/accessability-services/

7. Copyright Information

All rights, including copyright, images, slides, audio, and video components, of the content of this course are owned by the course instructor, the C&0 Department, and the University of Waterloo. By accessing this course, you agree that you may only download the content for your own personal, non-commercial use. You are not permitted to copy, broadcast, download, store (in any medium), transmit, show or play in public, adapt, or change in any way the content of these web pages for any other purpose whatsoever.

8. Territorial Acknowledgement

We acknowledge that we live and work on the traditional territory of the Attawandaron (Neutral), Anishinaabeg, and Haudenosaunee peoples. The University of Waterloo is situated on the Haldimand Tract, the land promised to the Six Nations that includes ten kilometres on each side of the Grand River.