
SYLLABUS CO 452 / 652 - WINTER 2023

We will be using D2L as our course website. Log on using your username and password (same as your UW email account). Various announcements such as the date of exams will be posted there. It is the responsibility of the students to check the web page regularly. This syllabus will get updated but the course page will have the latest version.

Read the syllabus, and check the course page regularly for updates.

1. Contact information

Here is the contact information for the instructor / course coordinator,

Name	Bertrand Guenin
Email	bguenin@uwaterloo.ca
Location	MC 5251

Here is the contact information for the teaching assistant,

Name	TBD
Email	TBD
Location	TBD

When to contact the instructor or the Teaching Assistant (TA)?

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, or discussed during Office Hours. Only contact the TA for questions pertaining to your assignment marks.

When sending us emails, use your UWaterloo email account, include CO 452/652 in subject line, and include your full name + UWaterloo student number in the email. We will answer most emails within 48 hours, from Monday to Friday. Note, for privacy reasons *we are unable to answer emails from personal accounts.*

2. Meeting coordinates

2.1 Lectures and office hours

In addition to the lectures we will have weekly office hours, starting from the second week of class. The schedule for the classes as well as the office hours is given below.

Type	Days	Time	Room
Lecture	Monday, Wednesday	1:00pm - 2:20pm	PHY 313
Office hours	Wednesday	3:00pm - 4:30pm	MC 5251

Note, office hours are subject to change based on the student's availability. This will be the proper venue to get support for assignments, and get help with understanding the course material.

2.2 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 <https://piazza.com/uwaterloo.ca/winter2023/co452652>. 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 TA 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 unenrol you if it is a private email.

We will monitor Piazza regularly Monday-Friday from 9am to 6pm. Occasionally, we may also answer questions over the weekend. Regularly, means twice a day. Therefore, when you post a question on Piazza *you should not expect an immediate answer*.

3. Course summary

3.1 Overview

An Integer Program (IP) is obtained by adding to a Linear Program (LP) the additional condition that some of the variables have to take integer values. IPs are extremely versatile and as a result have been widely deployed in business and industrial applications. Despite similarities between LPs and IPs, solving the former one can be done efficiently (i.e. in time polynomial in the size of the input), while no efficient algorithm is believed to exist to solve IPs. Nonetheless, every IP can be reduced to an LP, as the convex hull of the integer points in a (rational) polyhedron P is a polyhedron Q . The basic algorithmic framework for solving IPs consists of finding a suitable relaxation Q' of Q and solving the corresponding problem. If the optimal solution to the relaxation is also feasible to the original Integer Program we may stop as we have found an optimal solution. Otherwise we attempt to strengthen the relaxation Q' and repeat the process. A reason for the ongoing popularity of Integer Programming is the existence of effective and accessible software packages. In this course we will not address the use of such softwares, but rather focus on the robust (and beautiful) theoretical underpinnings. So this course will be a theoretical one, not one that is directly geared towards solving specific problems. However, it is my belief that understanding the fundamental mathematical concepts is necessary to be an effective user of any of the readily available softwares.

3.2 Topic list

- Formulations
- Generic cutting plane and branch and bound algorithms
- Reducing Integer Programming to Linear Programming
- Complexity: diophantine equations, linear inequalities, Integer Programming
- Farka's lemma, separation, and duality
- Cones, polytopes, and polyhedra
- Perfect formulations
- Cutting planes: split cuts, intersecting cuts, ...

3.3 Learning outcomes

Upon completion of the course the students will have the ability to formulate a multitude of problems as Integer Programs. They will also have a better understanding why some Integer Programs are bound to be challenging to solve and how to write an effective formulation. Revising and building on the theory of Linear Programming, students will learn the basics of polyhedral theory. Students will understand how this ties in to instances where Integer Programming reduces to Linear Programming. At the heart of commercial Integer Program solvers are cutting planes. Student will have a robust understanding of the theory of cutting planes.

3.4 Textbook

There are no course notes available. I will use a number of references most notably,

Integer Programming, by M. Conforti, G. Cornuéjols, G. Zambelli.

I requested that some copies of the book be on hold at the library.

3.5 CO 452 versus CO 652

We will have two distinct groups of students in this class, undergraduate students taking the course as CO 452 and graduate students taking the course as CO 652. The complexity of the material and the lectures will be aimed at the CO 652 students, i.e. taught at a level that is suitable for graduate students. The course will differ for these two groups of students when it comes to assessments and the marking scheme. CO 452 and CO 652 students will have a distinct final exam, and we will only expect the CO 452 students to complete a subset of the questions for each assignment. We will be more lenient for computing the final mark of the course for CO 452 students.

4. Assessments

4.1 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.

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.

Assignments will be due at 11:59pm EDT (Eastern Daylight Time) on the due day. You will have two weeks to complete the assignment and there should be ample time to work out any logistical issues. Crowdmark lets you upload assignments as many times 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.

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 your assignment remarked proceed as follows,

- Step 1. Write a concise message to the Teaching Assistant explaining why you think you received an erroneous mark.
- Step 2. Wait for 48 hours, if you do not hear from the Teaching Assistant by then, send a follow up message and copy me on the message.

4.2 Final exam

We will have an in person final exam that will be scheduled by the registrar's office. We do not have the date yet, but it will be scheduled during the official final exam period (between April 13th and April 28th). There will be two distinct versions of the final, one for CO 452 students and one for CO 652.

4.3 Week by week schedule

Week	Starts Monday	Activity	Begin Date	Due Date	Note
1	January 9				Classes start Monday
2	January 16	HW 1	January 20	February 3	Office hours start
3	January 23				
4	January 30	HW 2	February 3	February 17	
5	February 6				
6	February 13	HW 3	February 17	March 10	
READING WEEK (NO NEW MATERIAL)					
7	February 27				
8	March 6	HW4	March 10	March 24	
9	March 13				
10	March 20	HW 5	March 24	April 7	
11	March 27				
12	April 3				
13	April 10				Classes end Monday
FINAL EXAM			TBA	TBA	

4.4 Grade breakdown

Your final mark will be computed as follows:

Assignments	5 × 12%
Final exam	40%
Total	100%

5. Policies

5.1 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. If you have not already completed the online Academic Integrity Tutorial you should do so as soon as possible.

Assignments will count for 60% 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.

5.2 What is forbidden

Here is a list of behaviours that CONSTITUTE CHEATING,

- a. discussing the assessment with other students,
- b. getting any outside help on an assessment by anyone,
- c. using any resources not provided by the instructor to help you with an assessment.

For (b) “anyone” could mean for instance: a student that already completed CO 452/652, 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.

5.3 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).

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

5.4 Absences and INC

Students are *strongly advised* to attend all lectures and to take advantage of the office hours. If you are unable to come to class you can self-declare an absence or illness via Quest. The process is slightly different for undergraduates and graduate students.

- Quest link for undergraduates students
- Quest link for graduate students

In those cases contact your instructor as soon as you realize there will be a problem, and preferably within 48 hours, but no more than 72 hours. I will try to accommodate students as best possible. In case of a short period of absence and a strong performance in the course we should be able to shift the weight to the remaining assessments and the final.

To receive an INC we will require that

- you completed at least 3/5 assignments, and
- you obtained an average of at least 60% on these assignments

6. Additional support

6.1 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.

6.2 AccessAbility Services

AccessAbility Services, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodation to lessen the impact of your disability, please register with AccessAbility Services.

6.3 Mental Health Support

The Faculty of Math encourages students to seek out mental health support if needed.

ON-CAMPUS RESOURCES:

- Campus Wellness <https://uwaterloo.ca/campus-wellness/>
- Counselling Services: counselling.services@uwaterloo.ca 519-888-4567 ext 32655
- MATES: one-to-one peer support program offered by Waterloo Undergraduate Student Association (WUSA) and Counselling Services: mates@wusa.ca
- Health Services: located across the creek from the Student Life Centre, 519-888-4096.

OFF-CAMPUS RESOURCES:

- Good2Talk (24/7): Free confidential help line for post-secondary students. Phone: 1-866-925-5454 (Ontario and Nova Scotia only)
- Here 24/7: Mental Health and Crisis Service Team. Phone: 1-844-437-3247 (Waterloo Region only)
- OK2BME: set of support services for lesbian, gay, bisexual, transgender or questioning teens. Phone: 519-884-0000 extension 213 (Waterloo Region only)
- EMPOWER ME 1-833-628-5589 for Cdn./USA other countries see: http://studentcare.ca/rte/en/IHaveAPlan_WUSA_EmpowerMe_EmpowerMe
- EMPOWER ME in China: China North 108007142831 / China South 108001402851

7. Diversity and Territorial acknowledgment

It is our intent that students from all diverse backgrounds and perspectives be well served by this course, and that students' learning needs be addressed both in and out of class. We recognize the immense value of the diversity in identities, perspectives, and contributions that students bring, and the benefit it has on our educational environment. Your suggestions are encouraged and appreciated. Please let us know ways to improve the effectiveness of the course for you personally or for other students or student groups. In particular:

- We will gladly honour your request to address you by an alternate/preferred name or gender pronoun. Please advise us of this preference early in the term so we may make appropriate changes to our records.
- We will honour your religious holidays and celebrations. Please inform of us these at the start of the course.
- We will follow AccessAbility Services guidelines and protocols on how to best support students with different learning needs.

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.