

CO 330: Combinatorial Enumeration

Fall 2022 Course Outline

Instructor: Stephen Melczer

TAs: TBD

Class time: Mondays, Wednesdays, and Fridays from 11:30 – 12:20 in **RCH 305**

Course notes: Distributed on <https://enumeration.ca> (with extra resources on LEARN, you don't need to buy any materials)

This course is scheduled to run **in-person only** (with modifications to be made if necessary to account for any changing health situations).

Overview.

This course is about **combinatorial enumeration**: the counting of discrete objects using combinatorial techniques. Combinatorics lies in the intersection of pure mathematics, applied mathematics, and computer science, and this course will showcase the intriguing interactions between these areas. Part of the fun and the usefulness of combinatorial enumeration comes from the nice classes of combinatorial objects that we'll study – which find application in areas from the analysis of algorithms to properties of DNA sequences – and our approach to these concrete problems will lead us to study general techniques for combinatorial sequences. We always strive for *effective methods*, meaning methods that are explicit enough that they can be implemented on a computer.

Assessments.

The grade breakdown will be

- 30% six assignments
- 30% one midterm (October 21 in class)
- 40% final exam

To pass the course you must pass both the test portion and the assignment portion of the assessments.

Exams. The midterm exam will be written in-person during normal class time on Friday October 21 (the Friday after reading week). The final exam will be scheduled by the registrar and take place in-person during the final exam period (date/time/location will be announced during the term).

Assignments. We will be using the **Crowdmark** system for submitting assignments online. You will receive a Crowdmark link for each assignment, and you must submit your solutions on Crowdmark. You must submit each question in the corresponding box, or it will not be graded. Do not hand in your assignment in person, or it will not be graded. You may write your solutions by hand and upload pictures, or type up your solutions using Latex (remember to separate each question when you upload your answers). **You are strongly encouraged to submit your assignments on Crowdmark well before their deadlines. Late assignments can be submitted up to 12 hours after the deadline with a 50% penalty subtracted from your mark on that assignment.**

Assignments are to be done individually. You may discuss the assignments in small groups, however **you must write up the solutions on your own**. This means that you may not write up your solutions while you are with a group, and you should not consult any notes you have taken during your group discussions while writing up your solutions. You must **explicitly** acknowledge any discussions with other students by listing their names at the start of your solution (write this for every problem discussed with others).

Many assignment questions are proof questions and you will be evaluated on the logic and presentation of your ideas. Aim to present your proofs at a level that would be understood by an average

student in the class who has not thought about the problem yet. You may not use electronic resources for help with assignment questions directly. For example, you may read internet materials to review the Lagrange inversion formula, however, you may not directly search for an assignment question on this (or any other) topic and should immediately stop reading anything you think will solve one of the assignment questions. You are not allowed to use solutions obtained from previous offerings of this course. Any submitted assignments that are suspected of cheating will be reported to the integrity officer of the Faculty of Mathematics.

Piazza. Students are encouraged to help each other understand assignment questions and course materials using the forum at piazza.com. We will be using Piazza as a discussion board, and your mathematical questions about course content should be posted there. Guidelines for usage and details about access will be provided early in the term.

Schedule and material.

Course resources and announcements will be posted on LEARN. Here is a **tentative** schedule with topics that we plan to cover. The breakdown of topics between weeks may change slightly as we go through the course.

Week	Start	Topics (Tentative)	Assignments (Tuesdays)
Week 1	Sept 7	combinatorial classes and GFs	A1 Released <i>Wednesday</i>
Week 2	Sept 12	manipulating GFs and specifications	
Week 3	Sept 19	Lagrange Implicit Function Theorem	A1 Due and A2 Released
Week 4	Sept 26	lattice paths and bivariate GFs	
Week 5	Oct 3	q -analogues	A2 Due and A3 Released
<i>Reading Week October 10 – 15</i>			
Week 6	Oct 17	partitions + midterm review	A3 Due Midterm Friday Oct 21
Week 7	Oct 24	more partitions	A4 Released
Week 8	Oct 31	labelled objects and exponential GFs	
Week 9	Nov 7	more on exponential GFs	A4 Due and A5 Released
Week 10	Nov 14	random generation	
Week 11	Nov 21	techniques for asymptotics	A5 Due and A6 Released
Week 12	Nov 28	more on asymptotics	
Week 13	Dec 5	final class (summary + exam details)	A6 Due

First class is **Wednesday** September 7. Final class is **Monday** December 5. Assignments are due by 10pm. Assignments are posted and due on Tuesdays, except for Assignment 1 which is posted on a Wednesday.

Computer Software: I will be using the (free and open source) computer algebra software Sage to illustrate some examples during lectures. Although it is not necessary to learn Sage for the course, I will release the code used to generate these examples and playing around with it yourself can greatly help your understanding. See <https://melczer.ca/330/> or LEARN for information on installing Sage and a basic tutorial on how to use it.

Administrative policy

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. **You must do individual work on your own, and you must not do other people’s individual work or seek out other people to do yours. You must not upload course material to sharing sites such as chegg nor seek out information there.** Check the [Office of Academic Integrity](#) for more information.

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read [Policy 70, Student Petitions and Grievances, Section 4](#). When in doubt, please be certain to contact the department’s administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for his/her actions (check the [Office of Academic Integrity](#) for more information). A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about “rules” for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offenses and types of penalties, students should refer to [Policy 71, Student Discipline](#). For typical penalties, check [Guidelines for the Assessment of Penalties](#).

Appeals: A decision made or penalty imposed under [Policy 70, Student Petitions and Grievances](#) (other than a petition) or [Policy 71, Student Discipline](#) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to [Policy 72, Student Appeals](#).

Note for students with disabilities: [AccessAbility Services](#), located in Needles Hall, Room 1401, 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 accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

Mental Health Support: I encourage you to seek out mental health support if needed. On-campus Resources include

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

Off-campus Resources include

- Good2Talk (24/7): Free confidential help line for post-secondary students (phone 1-866-925-5454)
- Here 24/7: Mental Health and Crisis Service Team (phone 1-844-437-3247)
- OK2BME: set of support services for lesbian, gay, bisexual, transgender or questioning teens in Waterloo (phone 519-884-0000 extension 213)

Diversity: It is my intent that students from all backgrounds and perspectives be well served by this course, and that students’ learning needs be addressed both in and out of class. I 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 me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In particular:

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