

CO 739: Analytic and Algorithmic Combinatorics (Winter 2021)

Instructor: Stephen Melczer (smelczer@uwaterloo.ca)

All content will be posted / coordinated on LEARN. This course will meet online only.

Schedule: Two pre-recorded lecture videos and one live ‘office hour’ session per week. Lecture videos will be uploaded each Monday. Office hours will be scheduled with students in the first week of class.

Description and Topics: This course presents an introduction to the theory of analytic combinatorics and computational techniques for enumeration. Topics will be tailored to student interest, and could include computer algebra tools for sequences and generating functions; rational, algebraic, D-finite, and differentially-algebraic functions, and their algebraic/analytic/arithmetic properties; effective analytic methods for asymptotics; algorithmic transcendence proofs and transcendence of constants vs functions; computability and complexity questions in enumeration and connections to formal languages; rigorous numerical analytic continuation of (generating) functions; limit theorems of combinatorial objects; analytic methods for multivariate generating functions.

References: The main reference for the course is the textbook

- [An Invitation to Analytic Combinatorics](#) by S. Melczer. Springer, 2021.

Additional references include

- [Generatingfunctionology](#) by H. Wilf. Academic Press, 1990.
- [Analytic Combinatorics](#) by P. Flajolet and B. Sedgewick. Cambridge University Press, 2009.

All references have free manuscripts at the above links.

Prerequisites: Students should be comfortable with the basics of real analysis (sequences and series) and ideally will have previous exposure to basic algebra (rings and fields) and complex analysis (analytic functions, Cauchy residue theorem). Short background lessons will be provided for students wanting to review (or needing to catch up on) some of the necessary background material. Interested students unsure of their background should email the instructor for more information. Students are not expected to have previous exposure to computer algebra.

Assessment: Students will be evaluated on three homework assignments (each 20% of final grade) and a final project (40% of final grade). For the final project students will write a report and make a short presentation to the class about a research paper related to their interests and the course content (other options, like a historical survey or coding project, are also possible). **You may discuss homework problems with your classmates, but you must write them up independently and explicitly acknowledge any discussions. Late assignments may be considered on a case-by-case basis, but only if you have contacted me before the deadline.** You may email your assignments directly to the instructor.

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. 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 offences (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 offences 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: The Faculty of Math encourages students to seek out mental health support if needed. On-campus Resources include

- Campus Wellness: <https://uwaterloo.ca/campus-wellness/>
- Counselling Services: [counselling.services@uwaterloo.ca/](mailto:counselling.services@uwaterloo.ca) (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 diverse 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.