

CO 430/630 — Algebraic Enumeration

Winter 2021

Instructor: Prof. Kevin Purbhoo

Office: Not very relevant

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Course webpage: Through LEARN

Office hours: TBA

Topics:

- **Formal power series and formal laurent series:** Algebraic properties, Lagrange's implicit function theorem, identities.
- **Ordinary and exponential generating series:** Weight functions, q -analogues, formalism of species, species variants.
- **Sieving methods:** Inclusion/exclusion, Möbius inversion, sign reversing involutions, virtual species, the cyclic sieving phenomenon.
- **Counting with automorphisms:** Orbit counting, cycle index functions.
- Time permitting, additional topics may include: Applications of sl_2 , the transfer matrix method, matching enumeration, asymptotic methods.

Text: There is no formal textbook for this course. Here is a list of references that may be useful.

- *Enumerative Combinatorics, Volumes 1 & 2*, Richard P. Stanley. Cambridge University Press, 1997 & 1999.
- *Introduction to the Theory of Species of Structures*, François Bergeron, Gilbert Labelle, and Pierre Leroux. (Available online.)
- *Combinatorial Enumeration*, David M. Jackson and Ian P. Goulden, John Wiley & Sons, 1983. (Republished by: Dover Publications, 2004.)
- *CO 330 course notes*, David G. Wagner. (Available on the course webpage.)

Format of course:

- Asynchronous **Video Lectures** will be posted in sets, each corresponding to one major topic in the course. A set of videos covers approximately 1.5–2 weeks worth of course material.
- You are strongly encouraged to take notes while watching the videos. However my **Written Notes** from the videos will be also made available. As an alternative to taking notes while watching the video, you may also choose to write your own set of detailed notes based on these notes, completing proofs and adding explanations as necessary.
- Each video will be accompanied by a set of **Exercises**. It is important to treat these exercises as part of the lesson from that video; *you should complete (or at least attempt) all the exercises before moving on to the next video*. Exercises are not to be handed in, and in general, they are not intended to be very hard. They exist to test and reinforce your understanding of the material from the video, and sometimes to teach related concepts not covered in the video.
- **Homework Assignments** will be due approximately every 2 weeks. Each assignment will (approximately) correspond to a set of videos.
- I have set up a **Class Discussion** on Piazza. You should use this forum to ask for hints on the homework, clarifications on material, or any other course-related discussions.
- In addition, we will have weekly **Workshops** starting in the second week. In each workshop, we will work through one or two examples. These examples will generally be harder and more

interesting the examples in the videos lectures. Participation marks will be awarded for attendance (if the workshop ends up schedules at a time that you can't make it, an alternative option for participation marks will be provided).

- There is no midterm exam. Instead, I will schedule a **Midterm check-in** with each of you in February. This will be an opportunity to talk about what's working for you in the course, and what's not.
- The final exam will be a 30 minute **Oral Final Exam**. This will be scheduled during the final exam period, at a time that's mutually convenient.

Marking scheme: Final marks will be calculated via the following formula:

$$60\% \text{ homework} + 30\% \text{ final exam} + 10\% \text{ participation}$$

Adjustments will be made to raw homework marks, before this formula is applied. CO 630 students will be held to a higher standard than CO 430 students, in terms of the number and difficulty of assignment problems completed.

Prerequisite:

CO 430 students: CO 330 or permission of instructor; cumulative overall average of at least 80%.

CO 630 students: No formal prerequisite, but you should be comfortable with Math 239 course material.

Email policy: (*TLDR: Please don't ask math questions over email.*) Most course-related or math-related inquiries should go on the Piazza discussion group. (Note: You can post non-public questions for the instructor/TA too.) Email should be reserved for making appointments to talk, issues that may be too personal to post on a forum (e.g. illness, grades), and non-course related matters.

Late homework policy: You are expected to do as much of the assignment as you can before the due date. However, after the due date, you are encouraged to continue working on any problems you didn't solve. You may continue to hand in solutions up until the end of term, for partial credit. In order to receive full credit for work submitted after the due date, you must request an extension at least two days before the assignment is due.

Collaboration policy: You may discuss the homework problems and even work together to solve problems. However, your solutions must be written up individually, and you may not use any shared notes or anyone else's individual work (including from any online sources) to assist in writing up your own solutions. Every homework assignment must include a detailed account of any collaboration or outside sources.

Missed final exam policy: In the case of illness during the final exam, a make-up exam or incomplete grade will only be granted to students who have completed the required term work to satisfactory standards.

Avoiding academic offenses: Students are expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for their actions. Students who are unsure whether an action constitutes an offense, or who need help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work / collaboration should seek guidance from the course professor, TA, academic advisor, or the Undergraduate Associate Dean. For information on categories of offenses and types of penalties, students should refer to Policy #71, Student Academic Discipline,

<http://www.adm.uwaterloo.ca/infosec/Policies/policy71.html>

Students who believe that they have been wrongfully or unjustly penalized have the right to grieve; refer to Policy #70, Student Grievance,

<http://www.adm.uwaterloo.ca/infosec/Policies/policy70.html>

Note for students with disabilities: AccessAbility Services, located in Needles Hall, Room 1132, 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 the OPD at the beginning of each academic term.