Math 4032: Combinatorial Analysis

Syllabus

Days:	Mon/Wed
Time:	3:30–4:45PM ET
Location:	Skiles 255

Instructor:	Dr. Corrine Yap	**Office:**	Klaus 2111
Email:	cyap35@gatech.edu	**Office Hours:**	TBA
Website:	canvas.gatech.edu		

About this class: Combinatorics is a broad subject that mainly deals with the counting, construction, and optimization of discrete objects. Such problems are near the intersection of mathematics and computer science; many can be solved using algorithms, but many cannot! We will study different types of combinatorial problems and the techniques used to answer these problems, which form the foundations of today's research in discrete mathematics.

This class is not lecture-based but discovery-based. Much of class time will be spent in developing and exploring key concepts by working on problems in groups. Why? Because discovering ideas for yourself and discussing them with others can help you understand them more deeply. But we will always follow up on our discoveries with class check-ins and presentations of ideas and solutions.

Course Materials: We will explore a variety of topics in the course so there is no one textbook we will use. Any recommended references will be available online, either via Canvas or as open source textbooks.

Our skill-oriented goals for the semester:

- Discover combinatorial concepts by generating examples and making conjectures.
- Communicate about mathematics in a clear and articulate manner, both orally and in writing, in large discussions and in small groups.
- Apply the theorems and proof techniques discussed in class to discrete problems.

Our virtue-oriented goals for the semester:

- Develop persistence to struggle through problems and learn from that struggle.
- Approach new and unfamiliar problems strategically but with an openness to creativity and imaginative solutions.

Some Guidelines:

Math does not exist in a void. Each of you will enter the class with different math-and-life experiences. I do not expect us to leave our identities at the door - they inform how we learn, view, discuss, teach, and internalize math. No matter what, you are capable of excelling in this course, and I am here to help you.

Attendance and participation are important, especially since much of class time will consist of activities that will help you discover new material or understand material more deeply. Repeated absences will affect your grade in the course. If your absence is unavoidable (e.g. religious holiday, personal emergency), speak to me beforehand about turning in work, and speak to me and your classmates about the material you missed.

Late submissions for homework will generally not be accepted, unless due to an unavoidable circumstance. But I would prefer you turn in homework late, rather than plagiarize someone else's work in order to hand it in on time. If you find yourself having to make this choice, talk to me.

Makeups for quizzes and exams will not be granted unless due to unavoidable absence, in which case a makeup must be requested via email at least 24 hours in advance of the quiz/exam. If granted, the makeup must be scheduled no later than a week from the original date.

Academic integrity is taken seriously. All students are expected to comply with the Georgia Tech Honor Code which can be found at https://policylibrary.gatech.edu/student-life/academic-honor-code. In particular, copying work from the internet or another student and submitting it as your own is a violation, and it will not help you succeed in this course.

Collaboration is not the same as copying. You are encouraged to work with other students when solving problems, but when you write up a solution to be handed in, you should do so on your own, without the aid of others.

In particular, **the use of AI is prohibited** in writing up your homework solutions. All work you submit for a grade must be your own or done in collaboration with your peers in the class as described above, not with the use of AI. The use of AI on assignments will constitute a violation of the academic integrity policy and will be treated as such.
This does not mean you are not allowed to use AI in your mathematical learning! There are ways in which AI can aid your understanding of the course concepts. In particular, AI may be used to help find reading material online, clarify concepts discussed in class, or provide practice problems for quizzes and exams. However, generative AI is also unreliable and inaccurate, so you should critically evaluate its sources and outputs! At the end of the day, AI is not a substitute for your instructors or peers.

Feedback is more than welcome. If you have any thoughts on how the course is going, or personal circumstances that are affecting your ability to participate, I want to know. **Email me**, and I will try to answer as soon as possible, but give me 48 hours before expecting a response.

Course Outline: (subject to change; a schedule will be posted on Canvas and updated frequently.)

- Weeks 1–3: Combinatorial Foundations and Enumeration (combinatorial proofs, bijective proofs, sequences)
- Weeks 3–7: Probabilistic Combinatorics (review of discrete probability, the probabilistic method, linearity of expectation, random graphs)
- Weeks 8–11: Extremal Combinatorics (extremal graph theory, Ramsey theory, posets)
- Weeks 11–14: Linear Algebraic Methods (brief review, intersecting set systems, combinatorial designs)

Assessments:

- Problem Sets: assigned every 2–3 weeks, for a total of 6 ..... 14%
- Quizzes: every 2 weeks, for a total of 6 ..... 24%
- Reflection writing assignments and surveys 2%
- Midterm exam ..... 25 or 30%*
- Final exam ..... 25 or 30%*
- Final presentation (optional) ..... 10 or 0%*

The final problem set may be due in the last week of class.

Midterm: The midterm exam will take place in-class in the beginning of March. It will cover the units on enumerative and probabilistic combinatorics. The midterm will be structured so that approximately half of the questions will correspond to quizzes taken before the midterm (e.g. questions on the same topic as a quiz but not the identical question). You will have the option of replacing each of these questions with the corresponding quiz scores. Conversely, you may boost one of your quiz scores with the corresponding midterm question.

Final Exam: The final exam will follow the same structure as the midterm and will be *non-cumulative*; it will test the units on extremal and linear algebraic combinatorics.

Final Presentation: This is an optional writing and presentation final assessment. In advance of your final presentation date, you will submit a writeup of a problem or example (chosen from a large list of options). After the final exam, you will schedule an individual time to meet with me and present the ideas from your writeup, and I will have the opportunity to ask questions about the details.

*Because the final presentation is optional, there are two possible grade breakdowns. If you choose not to do the final presentation, your midterm and final exams will be weighted equally at 25% each. If you opt to do a final presentation, then your midterm and final in-class exams will be weighted 20% each and your final writeup and presentation will be worth 10%.

Letter Grades:
I reserve the right to change the grade breakdown at the end of the semester. However, the threshold for each letter grade will only stay the same or decrease; it will not increase.

A ..... [90%, 100%]
B ..... [80%, 90%)
C ..... [70%, 80%)
D ..... [60%, 70%)
F ..... [0%, 60%)

Student Resources:

Disability Services

(404) 894-2563 // https://disabilityservices.gatech.edu/

The Office of Disability Services collaborates with students, faculty, and staff to create a campus environment that is usable, equitable, sustainable, and inclusive of all members of the Georgia Tech community. To receive accommodations and services, students must register with the Office of Disability Services, participate in an intake meeting, and present official documentation of their disability. If the documentation supports your request for reasonable accommodations, please have a Faculty Notification Letter sent to me as early as possible. Details are on the website linked above.

Academic Support

- Academic Advising: https://www.success.gatech.edu/

  Appointment-based coaching for academic success

- Communication Center: http://www.communicationcenter.gatech.edu

  Help with writing and multimedia projects

Health and Wellbeing:

- Belonging and Student Support: https://belonging.gatech.edu/studentsupport

  Belonging and Student Support has programs, services, and resources for all members of the Georgia Tech community, regardless of sexual orientation, gender identity, and gender expression.

- Center for Mental Health Care and Resources: https://mentalhealth.gatech.edu/

  Services include testing and assessment, referral to support services, counseling, crisis intervention, mental health workshops, and consultation for faculty and staff, family and friends of Tech students. All services are confidential and free of charge for all Georgia Tech students.

- STAR (Students' Temporary Assistance and Resources): https://star.studentlife.gatech.edu/ Temporary assistance with food, housing, and financial emergencies

- Academic, Financial and Personal Assistance: https://studentlife.gatech.edu/services/academic-financial-personal-assistance

  Information about missing class, personal leave, and grievances.