

MATH 432 COMBINATORICS

SPRING 2023 SYLLABUS

GRETA PANOVA

Location and meeting times:

Section 39654R: MWF 11-11:50,

Section 39653R: MWF 12-12:50,

Classroom: KAP 148.

Instructor Office Hours: TBA

Teaching Assistants: TBA

Course description. This course is a broad introduction to *Combinatorics*, surveying a variety of topics and methods. We introduce some basic counting techniques (e.g. Pigeonhole principle, independence) and elementary proof techniques (e.g. mathematical induction and counting in two different ways). We apply these to basic enumeration of subsets, arrangements, and other similar structures with restrictions. We will also study generating functions and use them to enumerate more complex structures and solve recurrence relations. We study the basics of graph theory (e.g. colorings, matchings) and algorithms on graphs. We will also briefly cover topics like the Probabilistic Method and Complexity Theory.

Learning Objectives. Our goal would be to develop problem solving skills and mathematical maturity by studying advanced counting techniques. By the end of the course, students should be able to write proofs, analyze basic enumeration questions and combinatorial algorithms, and be able to solve some problems concerning simple finite structures, somewhat similar in spirit to the “logic/quantitative puzzles” typical for software/finance industry interviews.

Mode of instruction. By default, most lectures will take place in person in class at the scheduled times. Some lectures could be on zoom, as will be decided by popular demand. Detailed schedule, material covered, pictures of the blackboard, notes and other materials will be uploaded on blackboard regularly. Course announcements will be posted on blackboard and emailed. Slack will be used for discussions.

Prerequisites: MATH 225 or MATH 226 or MATH 227 or MATH 229.

Course text and sources: Homework, exam solutions, and supplementary notes will be available in Blackboard.

Textbook:

Miklos Bona, *A Walk Through Combinatorics*, 4th edition.

Additional resources (freely available online):

Richard Stanley “Enumerative Combinatorics Volume 1”.

Loren Larson “Problem-solving through problems”.

Grading. Students are expected to complete weekly **problem sets**, whose goal is to reinforce and expand the topics covered in class in order to deepen the understanding, practice, learn. There will be 12 problem sets, each worth the same amount of points. The two lowest homework grades (including zeros for missing homeworks) will be dropped at the end. Homeworks will be generally **due on Wednesdays** uploaded on blackboard. Late assignments will be penalized by 20% per day.

There will be two in-class midterm exams, on **February 15** and **March 29**, and a final exam (section 39654R is on May 3, 11am-1pm; section 39653R is on May 5, 11am-1pm).

Score distribution

Assignment	% Final Grade
Homeworks (10 best out of 12)	17%
Midterm I	23%
Midterm II	23%
Final Exam	37%

Course Letter Grades: Will be based on the total scores and determined relative to the difficulty of the exams, where the median score will correspond to a letter grade B/B+.

Bonus problems will be given regularly in homeworks. They will be more challenging, in the style of math olympiads/Putnam competition or brain teasers, and will not be counted towards the grade.

Preliminary Course Schedule of Topics:

Week/Date	Topic
Week 1, 01/9	Methods of proof: contradiction, pigeonhole principle, induction
Week 2, 01/16	Elementary counting
Week 3, 01/23	Binomial theorem and identities
Week 4, 01/30	Partitions and permutations
Week 5, 02/06	Sieve methods, inclusion-exclusion
Week 6, 02/13	Review and midterm I
Week 7, 02/20	Generating functions
Week 8, 02/27	Introduction to graph theory
Week 9, 03/06	Trees, the matrix-tree theorem
Week 10, 03/13	Spring break!!! :-)
Week 11, 03/20	Colorings and matchings
Week 12, 03/27	Review and midterm II
Week 13, 04/03	Planar graphs, Ramsey theory
Week 14, 04/10	Probabilistic methods
Week 15, 04/17	Algorithms, computational complexity
Week 16, 04/24	Problem solving as a review of course material
Week 17, the end	Final exams on May 3 (section 39654R) or May 5 (section 39653R)

STATEMENT OF ACADEMIC CONDUCT AND SUPPORT SYSTEMS

Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards” <https://policy.usc.edu/scampus-part-b>. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on Research and Scholarship Misconduct.

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at <https://osas.usc.edu>. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call <https://studenthealth.usc.edu/counseling> Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call <https://suicidepreventionlifeline.org> Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press “0” after hours – 24/7 on call <https://studenthealth.usc.edu/sexual-assault> Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086 <https://eetix.usc.edu> Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298 https://usc-advocate.symplicity.com/care_report Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776 <https://osas.usc.edu> OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy. USC Campus Support and Intervention - (213) 821-4710 <https://campussupport.usc.edu> Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - (213) 740-2101 <https://diversity.usc.edu> Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call <https://dps.usc.edu>, <https://emergency.usc.edu> Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call <https://dps.usc.edu> Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC) <https://ombuds.usc.edu> A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - (323) 442-3340 or otfp@med.usc.edu <https://chan.usc.edu/otfp> Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.