

21-301 Combinatorics, Spring 2020

This syllabus is subject to change.

Course: 21-301 Combinatorics, Spring 2020

Class info: MWF. 12:30-1:20pm. Baker Hall 237B.

Instructor: Kaave Hosseini

Email: kaavehosseini@math.cmu.edu

Office hours: Th 2:25-3:25pm WEH7101 or by email appointment

TA: Zoe Wellner

Email: zwellner@andrew.cmu.edu

Office hours: T 1:30-2:30pm WEH6205 or by email appointment

Course website: math.cmu.edu/~seyedkah/combspring2020

Course description The purpose of this course is to introduce a few important tools in combinatorics, these tool have a wide range of spectacular applications in Mathematics and Computer Science, but most of the motivating problems we discuss here are about sets and graphs with Ramsey theoretic flavor. We start with basic techniques such as double counting, pigeonhole principle, inclusion-exclusion, and generating functions. Then we move on to more sophisticated tools such as probabilistic method, spectral graph theory, pseudorandomness, algebraic methods, and discrete Fourier analysis and Additive Combinatorics (if time permits).

Class format The lectures will be presented on black board. Attendance is not mandatory but highly encouraged since most of the motivating material will not be found in the primary resource.

Prerequisites You should be comfortable with linear algebra, basics of discrete mathematics and graph theory, and discrete probability. Familiarity with abelian groups is useful even though the notion of group will be introduced when necessary. Moreover, a high degree of mathematical maturity and ability to understand and write rigorous proofs is necessary.

Learning objectives

1. Obtain dexterity in spotting the need for and applying elementary combinatorial techniques such as induction, double counting, first moment method, etc.
2. Be able to calculate asymptotic estimates and handle error terms without having to do exact computations.
3. Develop intuition and working knowledge about various properties of generic sets and graphs, via probabilistic arguments.
4. Spotting abstract combinatorial objects and concepts in applications and successfully apply methods taught in the course.
5. Developing an understanding of the concept of pseudorandomness, probabilistic methods and algebraic methods as different viewpoints when formulating and understanding combinatorial problems.

Resources I will use a variety of books and lecture notes for this course, however we will use the first item as a primary resource. The second item will be also partially used, and it is highly encouraged as extra reading material.

1. Book: Extremal Combinatorics with applications in Computer Science, Stasys Jukna. Available at CMU online library.
2. Lecture notes: Techniques in Combinatorics, Tim Gowers. <https://gowers.files.wordpress.com/2014/11/techniques2014notes.pdf>
3. Book: Linear algebra methods in combinatorics, László Babai and Péter Frankl

Homework There will be a new homework almost every week. Homework assignments can be solved individually, or in groups of 2 or 3 (you can form a different group for every assignment). However, every individual should write their own solution several hours after group discussions, and list their group members. It's highly encouraged to type your solutions in $\text{\LaTeX}$, however, clear and legible handwritten solutions are also accepted. *You should upload your homework to Gradescope before its due date.* Late homework submissions are not allowed.

Online platforms

- **Piazza:** We use Piazza platform as a discussion environment. Students are welcome to ask/answer questions.

The class link is: piazza.com/cmu/spring2020/21301/home

If you're not already signed up, you can use the following sign-up link: piazza.com/cmu/spring2020/21301

- **Gradescope** Grade scope is used to grade homeworks and midterms and final exams.

Assessment There will be homework most weeks, two midterms, and a final. Your raw grade will be computed as follows.

1. 35% Homework (lowest homework grade will be dropped.)
2. 20% Midterm with higher grade
3. 15% Midterm with lower grade
4. 30% Final

Your final grade will be computed as follows.

A	A-	B+	B	C+	C	D
92	89	84	80	75	70	60

Important dates

January 13	M	First day of classes
January 20	M	Martin Luther King Jr. Day; No Classes
January 27	M	Course Add Deadline
February 24	M	Course Drop Deadline
March 4	W	12:30-1:20pm Midterm I
March 6	F	Mid-Semester Break; No Classes
March 9	M	Mid-Semester Grades Due by 4 pm
March 9-13	M-F	Spring Break; No Classes
March 30	M	Course Withdrawal Grade Deadline
April 15	W	12:30-1:20pm Midterm II
April 16	Th	No Classes
April 17-18	F, Sa	Spring Carnival; No Classes
May 1	F	Last Day of Classes

Academic Integrity Students must follow CMU's Code of Academic Integrity: <https://www.cmu.edu/policies/student-and-student-life/academic-integrity.html>