

MATH 244: DISCRETE MATHEMATICS

Summer 2022

Instructor:	Brett Smith	Time:	MWF 9-11:15am
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Course description: Combinatorics is an area of mathematics that deals with finite objects: sets, permutations, relations, partitions, graphs, incidences, etc. These simple combinatorial objects can be used to express beautiful mathematical ideas with little technical work. The goal of this course is to showcase as many such ideas as possible and, along the way, to develop problem-solving techniques that have broad applications in multiple areas in (and out of) mathematics.

The topics that we will explore in this course fall into four broad categories:

- *Counting.* We will enjoy the transparency of combinatorial bijections and the mysterious power of double counting and inclusion-exclusion.
- *Graph theory.* A graph is just a collection of vertices and edges connecting them. But once one starts asking the right questions, a lot of interesting mathematics emerges. In this course, we will study many surprising properties of these objects.
- *Ramsey theory.* The pigeonhole principle and induction are the main tools here. Among their many consequences, Ramsey's theorem is singularly far-reaching: a result about the inevitability of structure in sufficiently large graphs, which paved the way to a remarkable theory.
- *Probabilistic method.* Probability is useful even where order reigns. We will see the manifestation of this great idea in combinatorics; we will use it to construct objects with unlikely properties.

Course format: Our course will meet for 135 minutes every Monday, Wednesday and Friday. Due to the pace of the summer session, **attendance will be formally required**. The classes are designed to be interactive and collaborative, so you should not expect long lectures.

Teaching Assistants: TBD

Office Hours: TBD

Textbook: "Invitation to Discrete Mathematics" (2nd ed.) by Jiri Matousek and Jaroslav Nesetril.

Prerequisites: MATH 115 or equivalent.

Grading Policy: Homework (50%), Midterm Exam (20%), Final Exam (30%).

Homework: After each class, you will be given one problem which will be due the at the beginning of following class (i.e. the problem you get on Monday is due on Wednesday, the problem you get on Wednesday is due on Friday, and the problem you get on Friday is due on Monday).

- Collaboration on homework problems will generally permitted and encouraged.
- No collaboration of any sort will be permitted for the exams. More specific guidelines will be provided when the time comes.
- Late homework or late exam submissions will not be accepted unless accompanied by a note from a Dean. We will begin each lecture by quickly discussing the solution to the homework problem that was due that day.

Academic Honesty: At Yale, academic honesty is taken very seriously. Any deviation from the above policies can result in disciplinary actions (and it is not worth it!).

Rough course plan:

Class(es)	Topic
1 + 2	introduction and basic concepts
3	orderings
4 + 5	counting
6 + 7	introduction to graphs
8	trees
9	planar graphs
10	double-counting
11	spanning trees
12	probability
13	Ramsey's theorem
14 + 15	generating functions