

MAT 307 - Spring 2009

Combinatorics

Instructor: Jacob Fox
E-mail: jacobfox@math.princeton.edu

Class hours: M/W, 8:30-9:50 AM, Fine Hall 601.

Office hours: By appointment.

Recommended books: (optional)

- S. Jukna: *Extremal Combinatorics*
- B. Bollobás: *Modern Graph Theory*
- M. Aigner and G. Ziegler: *Proofs from THE BOOK*
- J.H. van Lint and R. Wilson: *A Course in Combinatorics*

Homework: Bi-weekly problem sets will be posted on the course homepage. No collaboration is allowed. Some problems will be rather routine, while others will be more challenging. You do not have to solve all of the problems to earn a good grade.

Homework grader: Alexandra Ovetsky Fradkin
E-mail: aovetsky@math.princeton.edu

Final exam: This will be a take-home exam which will take place between May 15-18.

Grading policy: Homework 50 %, Final 50 %.

Up-to-date information: See course homepage.
<http://www.princeton.edu/~jacobfox/MAT307.html>

Week	Topics
Feb 2-4	Introduction: examples illustrating combinatorics. Basic graph theory, Eulerian graphs. The pigeon-hole principle, double counting.
Feb 9-11	Sperner's lemma and Brouwer's fixed point theorem. The principle of inclusion and exclusion, applications: derangements and surjections.
Feb 16-18	Ramsey theory for graphs and hypergraphs, bounds on Ramsey numbers, convex polygons among points in the plane.
Feb 23-25	Extremal graph theory: Turán's theorem and applications, the Erdős-Stone theorem.
Mar 2-4	Maximum density of graphs without 4-cycles, graphs without a fixed complete bipartite subgraph, applications to additive number theory.
Mar 9-11	The probabilistic method: tournaments, 2-colorable hypergraphs, sum-free sets, Sperner's theorem on antichains, Bollobás's theorem on set pairs, the Erdős-Ko-Rado theorem.
Mar 16-18	<i>Spring Break</i>
Mar 23-25	Graphs with large girth and large chromatic number. The Borsuk-Ulam theorem and its application to the chromatic number of Kneser graphs.
Mar 30-Apr 1	Applications of linear algebra in combinatorics: Even-odd towns, Fischer's inequality, sets with restricted pairwise intersections.
Apr 6-8	Linear algebra continued: 2-distance sets, number of lines through points in the plane, Borsuk's conjecture and its refutation.
Apr 13-15	Spectral techniques: Eigenvalues of a graph, examples and applications.
Apr 20-22	Variational definition of eigenvalues, bounds on Max Cut, chromatic and independence numbers, expansion of graphs.
Apr 27-29	Review or additional topics depending on interest.
May 4-6	<i>Reading period</i>
May 15-18	FINAL EXAM