Spring 2-1-2022

M 584.01: Topics in Combinatorics and Optimization - Combinatorics II

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UNIVERSITY OF MONTANA

Department of Mathematical Sciences

M 584
Combinatorics II

Course: M 584 Sec. 01 (CRN 32037) 3 cr., Spring 2022
Topics in C & O: Combinatorics II
TΘ 9:30–10:50am in MATH 211

Instructor: Mark Kayll

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umontana.zoom.us/j/6948539958 (in case of remote OH)
hs.umt.edu/math/people/default.php?s=Kayll

Office: MATH 209
406.243.2403

Hours: TΘ 1:00–1:50pm & by appointment
(*tentative*) (open for all course matters, including ODE accomm.)

Prerequisites: background for graduate-level mathematics. Additionally, it's desirable to have *some* prior exposure to discrete mathematics, as might be gained from M 485 (Graph Theory) or M 581 (Combinatorics). Students excelling in M 361 (Discrete Optimization) or M 325 (Discrete Mathematics) should also be prepared for this course.

Text: nothing official, though D.B. WEST, *Combinatorial Mathematics*, Cambridge University Press, 2021 will be a comprehensive source.

Important Dates:

last day to add w/o instructor consent	Wednesday, 26 January (5pm);
last day to drop or change to Audit	Monday, 7 February (5pm);
Presidents' Day holiday	Monday, 21 February;
spring break	21–25 March;
last day to drop via Add/Change/Drop link and avoid 'WP' or 'WF'	Tuesday, 29 March (5pm);
last day to add/drop with higher approval	Friday, 6 May (5pm);
last class meeting (during finals)	Wednesday, 11 May 8:00–10:00am.

Description: This course samples and surveys graduate-level combinatorics. An alternate, more whimsical, title could be: ***"Everything you wanted in your first graduate combinatorics[1] course if it had just been twice as long"***. Topics will more deeply probe combinatorial theory under headings introduced in UM's M 581 (Combinatorics) but limited by time. Students who didn't take M 581 need not fear—the instructor will provide refreshers on earlier concepts and results as needed.

Combinatorics II topics will be selected from the following (non-exhaustive) list: extremal set theory (Kruskal-Katona Theorem, LYM Inequality), Ramsey theory (Schur's and van der Waerden's Theorems), graph and hypergraph coloring, combinatorial designs, matching theory, partially ordered sets, correlation inequalities (the 'Four Functions Theorem'), and infinite combinatorics.

Teaching modality: This course is face-to-face. The instructor is prepared to shift to Zoom should the need arise, as dictated by the pandemic status.

Assessment: Grades are based on performance on items to be discussed in class, e.g., attendance, homework, and a presentation (not exams). Traditional letter grades are assigned using the +/− system (see *UM catalog* at catalog.umt.edu/academics/policies-procedures/). UM's policy on Incomplete grades is followed (see *UM catalog*).

(over)

Homework: Details will be discussed in class.

Presentations: Each presentation consists of a 50-minute lecture scheduled during a regular, or final, class meeting. The content of the presentations should be related to the course content and may be inspired by one or more sections of the text, by related paper(s), or by other related material. Students should schedule their lecture date privately with the instructor early in the semester; time slots are assigned on a first-come, first-served basis. Lecture topics must be approved by the instructor, and students should take the following preparatory steps.

Step	Timing	Action
0	early in semester	Schedule lecture date with instructor.
1	3 weeks prior to lecture	Submit a $\leq$ 1-page typed summary proposal of lecture topic, with references.
2	2 weeks prior to lecture	Receive proposal approval or suggested modifications from instructor.
3	1 week prior to lecture	Meet with instructor privately for final informal discussion of lecture topic; be prepared to field questions.

Accommodation: UM assures equal access to instruction through collaboration between students with disabilities, instructors, and the Office for Disability Equity (ODE). If you anticipate or experience barriers based on disability, please contact the ODE at 406.243.2243, `ode@umontana.edu`, or visit `www.umt.edu/disability` for more information. Retroactive accommodation requests will not be honored, so please do not delay. The instructor will work with you and the ODE to implement an effective accommodation, and you're welcome to contact the instructor privately if you wish.

General Remarks

On homework: Please use complete sentences, proofread, and polish your work prior to submission. You're encouraged to type homework solutions unless your handwriting is clear. You may work with others on homework problems, and you're encouraged to do so; however,

Solutions should be written down privately in your own words.

If you use an important idea of someone else, then please acknowledge that person by giving an appropriate citation in your write-up. This professional courtesy will not affect your grade.

On make-ups: There are no homework make-ups; this policy will be elaborated in class.

On deadlines: Any stated deadlines are firm; please do not ask for extensions. (Violating this request is considered grounds for a penalty on the corresponding assignment.)

On electronic devices: Cell phones must be silenced during class meetings and office hour visits.

On coronavirus: Masks are required in all UM's indoor spaces (e.g. classrooms & offices); students feeling sick or exhibiting COVID-19 symptoms shouldn't attend class and instead contact Curry (CHC: 406.243.4330). UM recommends obtaining a vaccine; please visit the CHC. Students required to isolate or quarantine will receive support for continued academic progress. Specific seating arrangements may go into place; attendance/seating may be recorded photographically to support contact tracing. Consuming food or beverages in the classroom is discouraged.

On conduct: All students need to be familiar with the Student Conduct Code; it can be found in the 'A to Z Index' on the UM home page. All students must practice academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or a disciplinary sanction by the university.

Additional References (as examples)

1. B. Bollobás, *Combinatorics: Set Systems, Hypergraphs, Families of Vectors, and Combinatorial Probability*, Cambridge University Press, 1986 (reprinted 1990)
2. J.A. Bondy and U.S.R. Murty, *Graph Theory*, Springer, 2008
3. R.L. Graham, B.L. Rothschild, and J.H. Spencer, *Ramsey Theory*, 2e, Wiley, 1990
4. L. Lovász, *Combinatorial Problems and Exercises, 2e*, AMS Chelsea Publishing, 2007

[1]Combinatorics is the most fundamental, and hence the most important, branch of mathematics, since it deals with FINITE structures, and the world is finite.

Doron Zeilberger, *Board of Governors Professor of Mathematics*
Rutgers University