Syllabus

18.218: Topics in Combinatorics

Ramsey Theory

Spring 2023

Course Description:
This graduate topics class covers various topics in Ramsey Theory, not only limited to graph Ramsey Theory. The class starts with classical results such as Ramsey's Theorem for graphs (and hypergraphs), classical bounds for Ramsey numbers, the Erdős–Szekeres–Theorem, Van der Waerden's theorem, and the Hales–Jewett Theorem. Further topics include more recent bounds for graph and hypergraph Ramsey numbers, Size-Ramsey numbers, Ramsey graphs, Ramsey Theory of words, and Ramsey Theory for solutions to linear equations.

Instructor: Lisa Sauermann
Email: `lsauerma@mit.edu`

Time and Location: Tuesday, Thursday, 9:35am – 10:55am in room 4-237

Office hours: Tuesday 11:00am – 11:50am in room 2-171

Homework: There will be five problem sets (roughly every other week). The problem sets will be due at 8pm on March 2, March 23, April 13, April 27 and May 11 (each problem set will be posted two weeks before the due date). Late submissions will only be accepted in exceptional circumstances, with an accommodation letter from Student Support Services or GradSupport (see below).

Homework submission: The problem sets will be posted on Canvas and homework solutions will need to be submitted via Gradescope. Please start each problem on a new page (and don't forget to specify which page is for which problem after uploading your solution).

Collaboration on homework problems: Students are permitted to work together on homework problems, as long as everyone is actively involved in the discussion about the problem (for example, it is not allowed to ask another student who has already solved the problem for their solution). Every student must write down their solutions individually. **The solution to each problem must start with the list of the names of all other people which the problem has been discussed with (except for discussions in office hours for this course). If the list is empty (i.e. if the problem has not been discussed with any other people), this must be indicated as well.**

Grading: Grades will be based entirely on the homework assignments.

Prerequisites: No formal prerequisites. In order to be able to follow the class, students should be familiar with basic combinatorics and graph theory on the level of an introductory undergraduate course.

Textbook/materials: There are no required materials for this course, and the course does not follow any particular textbook. Coming to class and taking notes will be sufficient to learn about the material covered in the course. Some of the material can be found in the following books:

- H. J. Prömel, *Ramsey theory for discrete structures*, Springer, 2013.
- R. L. Graham, B. L. Rothschild, and J. H. Spencer, *Ramsey theory*, Second edition, Wiley-Interscience Series in Discrete Mathematics and Optimization, 1990.

Schedule:
A tentative schedule for the class is as follows (this schedule is subject to change):

- Week 1 (Feb 7, Feb 9): Ramsey's Theorem (for graphs and hypergraphs), applications (Erdős–Szekeres–Theorem, Schur's Theorem), simple bounds for (diagonal) Ramsey numbers.
- Week 2 (Feb 14, Feb 16): Van der Waerden's Theorem, Hales–Jewett Theorem.
- Week 3 (Feb 21, Feb 23): No class and no office hours this week (Feb 21 is held on a Monday schedule, and class on Feb 23 is cancelled).
- Week 4 (Feb 28, Mar 2): Bounds for off-diagonal Ramsey numbers.
- Week 5 (Mar 7, Mar 9): Bounds for hypergraph Ramsey numbers.
- Week 6 (Mar 14, Mar 16): Ramsey numbers for trees versus cliques, and for bounded-degree graphs.
- Week 7 (Mar 21, Mar 23): Size-Ramsey numbers.
- Week 8 (Apr 4, Apr 6): Multi-color Ramsey numbers.
- Week 9 (Apr 11, Apr 13): Induced Ramsey Theorem for graphs.
- Week 10 (Apr 18, Apr 20): Ramsey graphs.
- Week 11 (Apr 25, Apr 27): Rado's Theorem (Ramsey Theory for solutions to systems of linear equations).
- Week 12 (May 2, May 4): Ramsey Theory of Words (characterization of unavoidable patterns and quantitative bounds).
- Week 13 (May 9, May 11): The density Hales–Jewett Theorem.
- Week 14 (only May 16): The density Hales–Jewett Theorem, continuation.

Policies for students needing to isolate due to Covid:
If you have to miss class because of being required to isolate due to Covid, you can contact me to get access to the material covered in the classes you missed (of course, you are also welcome to simply ask another student for their notes from class instead). Students in isolation are expected to submit their homework as usual (homework submission is online via Gradescope). If you are unable to submit your homework on time because of feeling sick, please contact Student Support Services or GradSupport (see below) for an accommodation letter.

Student Support Services (S^3) and GradSupport:
Personal and medical issues can make it hard to focus on academics. If you find that something is getting in the way of your ability to attend class, complete work, or take an exam, you should contact a dean in Student Support Services (S^3) if you are an undergraduate student or in GradSupport if you are a graduate student. The deans will provide you with support and help with determining next steps. You can e-mail `s3-support@mit.edu` or `gradsupport@mit.edu` (or you can visit the websites `https://studentlife.mit.edu/s3` and `https://oge.mit.edu/development/gradsupport/` for more ways to connect with S^3 and GradSupport).

Disability and Access Services (DAS):
MIT is committed to the principle of equal access and we want all of our students to feel welcome here. Students who need disability accommodations are encouraged to speak with Kathleen Monagle, Associate Dean, prior to or early in the semester so that accommodation requests can be evaluated and addressed in a timely fashion. Even if you are not planning to use accommodations, it is recommended that you meet with DAS staff to familiarize yourself with the services and resources of the office. You may also consult with Disability and Access Services in 5-104 or at 617-253-1674. If you have already been approved for accommodations, please contact me early in the semester so that we can work together to get your accommodation logistics in place.

Mental Health Resources:
Your mental health is very important. If you feel in distress, please consider reaching out to Student Support Services or GradSupport (see above). In emergency situations, you can reach MIT Medical Student Mental Health and Counseling at 617-253-2916 (days) or 617-253-4481 (nights and weekends).

Important Dates for Spring 2023:

First Day of Classes	February 6
Add Date	March 10
Drop Date	April 25
Spring Break	March 27–31
Last Day of Classes	May 16