FYSEM-UA 731: The Mathematics of Ramsey Theory

Fridays, 11:00am-1:30pm, CIWW 1314

Instructor: Vindya Bhat, vbhat@cims.nyu.edu
Office Hours: Thursdays, 11:30am-1:30pm, CIWW 722

Course Description
Ramsey theory answers the question, "under what circumstances can we find order in disorder?" For example, suppose six people are at a party and each pair of guests is either friends or strangers. Can we always find three people at the party who are mutual friends (or strangers)? How many people must we invite to the party so that four people are mutual friends? Five? The Ramsey number is the smallest number of people we must invite to the party to ensure a certain number of guests are mutual friends. We will generalize the “Party Problem” in the context of Ramsey’s theorem for graphs and discuss bounds for Ramsey numbers. We will then explore other results and variations of this theory.

Course Objectives
We will learn and appreciate this beautiful theory, while practicing to write and present Mathematics.

Prerequisites
Prior exposure to discrete mathematics topics (set theory, functions, probability, graph theory) and proof techniques is a plus, but not required as these concepts will be reviewed in the course.

Recommended Textbooks


Note that an online version of [1] is available on NYU Libraries Ebook Central at no charge to students. Also note that [2] is required for MATH-UA 120 Discrete Mathematics, a course elective/requirement for Mathematics/Computer Science majors. Additional resources will be posted to NYU Classes.
Coursework
1. Attendance is mandatory. Class participation and discussion are required. Students are encouraged to ask appropriate questions before, during and after class and at office hours or appointments.
2. Most class meetings will consist of groupwork in which group members will be selected to present their findings to the class by the end of the class period. Groupwork will consist of problem solving, critical reading, proof writing and/or public speaking. Assessment will be based on group dynamics, accountability, self-assessment and student evaluation of team member contributions. All group members will receive the same grade. Groups will be chosen by the instructor.
3. Quizzes will be given weekly to provide feedback to the instructor and students on which topics are well understood and which ones need review. There will be no makeup quizzes.
4. Problem sets will be due biweekly. Students are encouraged to work together, but submitted assignments must be written individually. Solutions to problem sets should be submitted in PDF LaTex. The first problem set is due on Friday, September 20th.
5. Students will write biweekly reflection papers. Reflection paper prompts will be given by the instructor. Possible prompts may include response to problems solved/attempted, department colloquia attended, etc. Reflection papers should be 1-2 pages in length, double-spaced and submitted in PDF LaTex. The first reflection paper is due on Friday, September 13th.
6. For the final project, students will work in pairs to present and summarize a recent article on Ramsey theory from a peer reviewed journal. 25 minute presentations will consist of slides prepared using the Beamer package in LaTex, followed by 5 minutes of Q&A. The summary paper should be 4-5 pages in length, double-spaced and submitted in PDF LaTex. The presentation and summary paper must include history of the problem, statement of the result, examples to illustrate the result, highlights of the proof technique and other relevant details. Proposed journal article must be approved by Friday, November 1st. A draft of the summary paper is due on Friday, November 22nd. Final presentations and papers are due on Friday, December 6th. Presentations will be scheduled on Fridays, December 6th and 13th in class.

Grading Policy

<table>
<thead>
<tr>
<th>Course</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Class discussion</td>
<td>10%</td>
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<tr>
<td>Quizzes</td>
<td>10%</td>
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<tr>
<td>Reflection papers</td>
<td>15%</td>
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<tr>
<td>Class groupwork</td>
<td>15%</td>
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<tr>
<td>Problem sets</td>
<td>20%</td>
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<tr>
<td>Final project</td>
<td>30%</td>
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Other Course Policies
Your success in the course is important to me. I am available during office hours and by appointment to review course material or address course related concerns. If you plan to miss a class due to illness, religious observance, university sanctioned event or personal emergency, please let me know in advance to ensure that you do not fall behind in the course. Failure to do so will result in an unexcused absence.

This course will abide by NYU CAS academic policies and honor code. Students will contribute to a positive learning community: arrive on time to class, pay attention for the duration of the class, participate meaningfully during class and learn from one another. I request no eating and no phone, laptop or internet use during class time, unless instructed, as it is a distraction to me and other students.

Disability Disclosure Statement
Academic accommodations are available for students with disabilities. The Moses Center website is www.nyu.edu/csd. Please contact the Moses Center for Students with Disabilities (212-998-4980 or mosescsd@nyu.edu) for further information. Students who are requesting academic accommodations are advised to reach out to the Moses Center as early as possible in the semester for assistance.
# Tentative Course Schedule

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Topic</th>
<th>Reading</th>
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</thead>
<tbody>
<tr>
<td>F</td>
<td>9/6</td>
<td>Ramsey’s theorem</td>
<td>Scheinerman, § 16,25,47,48 Landman and Robertson, ch. 1 [6,7,9]</td>
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</table>
| F   | 9/13 | Discrete mathematics review  
*Overleaf* introduction  
*Guest speaker: Nate Stemen* | Scheinerman, ch. 1–6,9 (highlights) |
| F   | 9/20 | Induction and upper bound | Scheinerman, § 22,23 [13] |
| F   | 9/27 | Probabilistic method and lower bound  
*Guest speaker: Joel Spencer* | Scheinerman, § 30-34 [4,17] |
| F   | 10/4 | Ramsey numbers | [1,10,16] |
| F   | 10/11| Variations of Ramsey’s theorem | TBD |
| F   | 10/18| Erdős-Szekeres theorem | [3,5,15] |
| F   | 10/25| Schur’s theorem | Scheinerman, § 15 Landman and Robertson, ch. 8 [14] |
| F   | 11/1 | Van der Waerden’s theorem | Landman and Robertson, ch. 2 [11] |
| F   | 11/8 | Hales-Jewett theorem | [8] |
| F   | 11/15| Rado’s theorem | Landman and Robertson, ch. 9 [12] |
| F   | 11/22| Final project sample/working session  
*Letters discussion* | [2] Stewart |
| F   | 11/29| Thanksgiving Recess – no class | |
| F   | 12/6 | Student presentations | TBD |
| F   | 12/13| Student presentations | TBD |

## Journal Articles

Links to journal articles will be posted to NYU Classes.


