

Syllabus CMSC 752/MATH 858R Ramsey Theory and its “Applications”

Note: Even though Math 858R is listed under *Selected Topics in Analysis* this is *not* a course in Analysis. It is a course in combinatorics.

This document has three parts with three very different functions. (1) **CONTENT:** What is the content of the course. (2) **POLICY:** How the course is run (office hours, tests, HW, etc). This will be particular to this course. (3) **GENERAL INFO:** This information is helpful for any course you take at UMCP.

1 Content of the Course

Overview: Ramsey Theory is a branch of combinatorics having to do with colorings and patterns. Here are three sample theorems:

1. For all 2-colorings of the edges of the complete graph on 6 nodes, there are 3 nodes so that all the edges between them are the same color.
2. For all 2-colorings of the natural numbers there exists a arithmetic sequences of length 6 (arithmetic sequences are equally spaced, like 11,14,17,20,23,26) where all of the numbers are the same color.
3. For all 2-colorings of $N \times N$ (the infinite grid) there exists four points that form a square that have the same color.

In this course we state and prove many such theorems and also “apply” them— to other parts of math and to TCS.

1. The infinite Ramsey Theorem, Hypergraph Ramsey Theorem, Canonical Ramsey Theorem, Large Ramsey Theorem

“APPLICATION”: The Bolzano Weierstrass Theorem,

“APPLICATION”: Proving Programs correct, well-quasi ordering,

“APPLICATION”: Geometry.

“APPLICATION”: Logic.

2. The finite Ramsey Theorems Upper and lower bounds on the Ramsey Numbers, Ramsey Multiplicity.

“APPLICATION”: Lower bounds on computation,

“APPLICATION”: Geometry,

“APPLICATION”: Logic,

“APPLICATION”: Sociology,

“APPLICATION”: History.

3. **Van Der Waerden's Theorem** Multidim VDW theorem, upper and lower bounds on VDW numbers.
“APPLICATION”: Number Theory
“APPLICATION”: Multiparty Comm Complexity,
“APPLICATION”: Diag-queens problem.
4. **Grid Colorings**
5. **Rado's theorem**
6. **Polynomial VDW theorem**
7. **Optional Topics** Euclidean Ramsey Theory, Ramsey over the reals, Ramsey with other graphs, Complexity of Grid Extension, Roth's Theorem.

REQUIRED TEXT There is no text. There will be notes on line and slides on line.

PREREQUISITES Any Ugrad CMSC 45X course or any Math 4XX course or permission of instructor. Ugrads who want to take the course must get permission of instructor.

POLICY

2 Basic Information

Course title and Number CMSC 752/Math 858R: Ramsey Theory and its “Applications”

Term: Spring 2025

Credits: 3

Course Dates Jan 28-May 13. No class March 17-21 (Spring break)

Class Time and Place Tu-Th 3:30-4:45. Room IRB 2107.

Course Website <http://www.cs.umd.edu/~gasarch/COURSES/752/S25/index.html> This is where HW and slides and notes will be.

ELMS Elms will have the recordings of the lectures. Only students from this class will have access to it.

Gradescope You will submit HW on gradescope and this is where you can see your grades and make re-grade requests.

3 Course Guidelines

Academic Integrity

1. **Homework** You may talk to your fellow students about the problems however you must hand in your own work and you must understand your own work. You may use ChatGPT but (1) you must tell me you did so, and (2) its a bad idea for this course.
2. **Exams** These must be solely your own work.

Communication from you to the instructor or TAs You should feel free to email us or post things on piazza or meet us in office hours. You can also request a zoom meeting if that makes more sense.

Communication from us to you We will email you (1) when HWs are posted, (2) when HW solutions are posted, and (3) other things you need to know. We will respond to your piazza posts promptly.

4 Homework, Exams, Grading

For all of the below see the Academic Integrity section above for guidance on how much help you can get on the Homework, Exams, and Optional Project.

1. **Homework** There will be problems based on the material. They will be roughly once a week. The Homework will be posted on the course website (NOT on elms) in three forms. We do an example with hw00.
hw00.pdf
hw00.txt- this is plaintext
hw00.tex- this is LaTeX

You may use the .txt or .tex to help you typeset your homework.

After the Dead-Cat day has passed (see later for what that means) I will post hw00sol.pdf- Solutions to some of the problems.

Typed Homework must be typed and submitted on gradescope. If diagrams are needed to be drawn they can be handwritten.

Dead Cat Policy HW is posted on Tues and due the following Tues at 3:30PM. But *everyone* gets an extension to Thursday at 3:30PM. *Do not think the real deadline is Thursday.* I have already given you an extension to Thursday, hence I am not going to give you another one. I use the phrase **Morally due Tuesday Feb 11, 3:30** to mean you can hand it in either then or, without penalty, on Feb 13, 3:30. **DO NOT ABUSE THE PRIVILEGE.**

2. **Take Home Midterm** Morally DUE 11:00 April 1.
3. **Final** The final will be take home. DUE May 15. NO DEAD CAT. It will be posted May 8 or earlier so you will have plenty of time to work on it and hence no DEAD CAT is needed.

5 Grading Structure

We will make each HW worth 4% of the grade. We intend to have 10 HW. That leads to the following table; however, if we have a different number of HW this will change slightly.

Homework	40%
Midterm	30%
Final	30%

Grades will be ROUGHLY

- 85-100 is an A
- 70-84 is a B
- 50-69 is a C
- 40-49 is a D
- 0-39 is an F

Notice that (1) this is ROUGH- there may be some adjustments in any direction, and (2) this will be further refined with + and - after the final. Academic dishonesty will be dealt with harshly.

Staff, Office Hours, email addresses

- Prof William Gasarch gasarch@umd.edu. Office Hours Tu-Th 12:30-3:15. in his office, IRIBE 2242. You can also make an appointment. This can be very flexible, even at night, since we can use zoom:

<https://umd.zoom.us/my/gasarch>

- TA Adam Melrod abmelrod@terpmail.umd.edu. Office hours: M and W 4-5 in study area IRB 2232. Also available for both in-person and Zoom appointments, including at night.
- TA Issac Mammal imammel@terpmail.umd.edu. Office hours: Monday 5-6. Tuesday 7-8 in study area IRB 2232. Also available for both in-person and Zoom appointments, including at night.

6 Course Evaluations

COURSE EVALUATIONS In May you will be asked to fill out course evals. I will urge you to fill out, not just the eval for me, but the eval for ALL of your courses. I have been on the committees that reads these evals and it is important that they be filled out.

7 GENERAL INFORMATION

UNIVERSITY POLICY We follow university policies. See

<https://www.ugst.umd.edu/courserelatedpolicies.html>

(Note that this is the policy for Undergrad Courses. There is no website for graduate courses, so we will use these policies.)

MASK POLICY Anyone in class must wear a mask that covers their nose and mouth. This is current university policy but also a very good idea. If the university policy changes then the class policy will also change.

Communication with the instructor or TAs You should feel free to email us or post things on piazza or meet us in office hours. You can also request a zoom meeting if that makes more sense.

8 UMD Policies and Resources for Undergraduate Courses

It is our shared responsibility to know and abide by the UMD policies that relate to all courses, which include topic like

- Academic Integrity
- Student and Instructor Conduct
- Accessibility and Accommodations
- Attendance and Excused Absences
- Grades and Appeals
- Copyright and Intellectual Property.

Please visit

<https://www.ugst.umd.edu/courserelatedpolicies.html>

for the UMCP policy on these issues.

9 Resources and Accommodations

9.1 Accessibility and Disability Services

The University of Maryland is committed to creating and maintaining a welcoming and inclusive educational, working, and living environment for people of all abilities. The University of Maryland is also committed to the principle that no qualified individual with a disability shall, on the basis of disability, be excluded from participation in or be denied the benefits of the services, programs, or activities of the University, or be subjected to discrimination. The Accessibility & Disability Service (ADS) (see here:)

<https://www.counseling.umd.edu/ads/>

provides reasonable accommodations to qualified individuals to provide equal access to services, programs and activities. ADS cannot assist retroactively, so it is generally best to request accommodations several weeks before the semester begins or as soon as a disability becomes known. Any student who needs accommodations should contact me as soon as possible so that I have sufficient time to make arrangements. For assistance in obtaining an accommodation, contact Accessibility and Disability Service at 301-314-7682, or email them at adsfront-desk@umd.edu. Information about sharing your accommodations with instructors, note taking assistance and more is available from the Counseling Center.

9.2 Student Resources and Services

If you are not doing well in the course and want to do better feel free to talk to me so we can see what we can do. There are also campus services that might be helpful:

Tutoring and Academic Success <https://tutoring.umd.edu/>

UMD Writing Center <https://english.umd.edu/writing-programs/writing-center>

Website of Heath Services <https://sph.umd.edu/academics/advising-resources/undergraduate-center/casa-student-resources-and-information>

9.3 Basic Needs Security

If you have difficulty affording groceries or accessing sufficient food to eat every day or lack a safe and stable place to live, please visit

UMD Division of Student Affairs website <https://studentaffairs.umd.edu/basic-needs-security> for information about resources the campus offers you.