Math/Comp Sci/Stat 475: Introduction to Combinatorics, Lecture 003, Fall 2023

Course Information

Course Description: Problems of enumeration, distribution, and arrangement. Inclusion-exclusion principle. Generating functions and linear recurrence relations. Combinatorial identities. Graph coloring problems. Finite designs. Systems of distinct representatives and matching problems in graphs. Potential applications in the social, biological, and physical sciences. Puzzles. Problem solving.

Credits: 3.

Course Designations and Attributes:
Breadth – Natural Science
Level – Advanced
L&S Credit – Counts as Liberal Arts and Science credit in L&S

Requisites: (MATH 320, 340, 341, or 375) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program.

Meeting Time and Location: MWF: 11:00am–11:50am in Ingraham Hall, room 22.

Instructional Modality: In-person.

Instructor: Mikhail Ivanov, Teaching Faculty, *Email:* mivanov@wisc.edu

Instructor Office hours: MW: 1pm–2pm in Van Vleck Hall, room B127, or by Appointment.

Grader: Jiahao Wan jwan23@wisc.edu.

Course Assistant: Ethan Ewer eewer@wisc.edu. Th: 7pm–9pm in Van Vleck Hall, room B224.

Course Learning Outcomes

By the conclusion of this course, students are expected to be able to:

- Recall basic objects that are used in combinatorics, such as permutations and combinations of sets and multisets, binomial and multinomial coefficients, the Catalan numbers, the Stirling numbers, and the partition numbers.
- Analyze a given combinatorial problem using the standard theorems of combinatorics, such as the pigeonhole principle, the Newton binomial theorem, the multinomial theorem, the Ramsey theorem, the Dilworth theorem, the Burnside theorem, and the Polya counting theorem.

- Convey his or her arguments in oral and written form in English, using appropriate mathematical terminology, notation, and grammar.
- Construct mathematical arguments related to combinatorial problems using the above definitions, properties, theorems, and counting strategies; including the construction of examples and counterexamples.
- Understand basic counting strategies, such as staged thought-experiments, inclusion/exclusion, generating functions, and recurrence relations, and apply these strategies to solve a wide variety of counting problems.

How Credit Hours are Met by the Course

This class meets for three 50-minute class periods each week over the fall semester and carries the expectation that students will work on course learning activities (e.g. reading, problem sets, papers, and studying) for about two hours outside of classroom for every class period. The syllabus includes more information about meeting times and expectations for student work.

Course Overview

We will cover roughly Chapters 2–8 and 11, 14 in the text. The main topics include permutations and combinations; pigeon-hole principle; partial orders; the inclusion-exclusion principle; recurrence relations and generating functions; difference sequences; Catalan numbers; Stirling numbers; partition numbers; graphs, paths, cycles, trees, counting equivalence classes in the presence of symmetries.

Course Website and Digital Instructional Tools

- Our Learning Management System is Canvas. All important course information will be relayed through Canvas. It is your responsibility to read any Canvas announcements.
- We will use Piazza. This page is a forum for you to discuss the material of this class with other students and your TAs and/or instructor. Posts to this page should be confined to questions regarding the material and logistical questions about the class (e.g., exam dates and locations). Any posts containing comments (either positive or negative) about the instructors, the class, the students, or anything else, will be deleted. Unprofessional conduct may result in disciplinary action. Please do not use email for math questions.

Required Textbook, Software and Other Course Materials

- Introductory Combinatorics, 5th edition, by Richard A. Brualdi. Errata for the textbook (10 pages) is located at https://www.math.wisc.edu/~brualdi.
- Lecture notes will be provided.

Exams, Quizzes, Papers, Homework and Other Assignments

Homework. Weekly homework assignments can be accessed through the Canvas website. Written assignments will be several questions long and will be assigned weekly usually due on Fridays. The way assignments will be submitted (online or in-person) is to be determined by grader.

Collaborating with other students on the homework is encouraged, but you must write up all reasoning and solutions on your own (in other words, no copying). Failure to abide by this guideline could be construed as a form of academic dishonesty.

Each problem should be completed with neat, understandable, detailed solutions and explanations. Your explanations and proofs must be sound and rigorous, paying attention to detail and clarity.

Late homework will generally not be accepted. Since it is quite likely that during the semester you will either experience a technical difficulty (e.g., missed the deadline, your computer shut down as you were submitting it, internet outage, etc) or a personal emergency (being sick, attending a funeral, etc), the two lowest HW scores will be dropped. You do not need to contact your instructor if such a situation does come up.

Exams. The course will have two midterm exams and final exam. The exams will be in-class exams. No notes, books, cell phones, or other devices will be permitted during the exams

- Exam I: Tuesday, October 17, 7:30pm–9:00pm.
- Exam II: Tuesday, November 14, 7:30pm–9:00pm,
- Final exam: Saturday, December 16, 12:25pm–14:25pm.

Participation. This course depends on students' active participation in class discussions and group works. You are expected to engage your fellow classmates in relevant discussions, work on the assigned problems, ask questions, share your approach to problems, keep on task by contributing ideas and analyze material of lectures after class. Your attendance and attention are important to your success in this course. Please remove any distractions while attending this course. If you experience long-term absence due to a serious illness with verification or accommodations from the McBurney Center, then contact your instructor.

Other comments. This is a rigorous course in which the students see many proofs based on combinatorial reasoning. The students are expected to employ similar reasoning in order to solve the problems on the homework and exams.

Grading

In this course, you will be evaluated based on components described above with their corresponding percentages:

Homework	20%
Exam 1	25%
Exam 2	25%
Final Exam	30%

Grading Scale. Final grades will be curved.

Calculator Policy. During an exam no books, notes, calculators, cell phones, pagers, or any electronic devices will be allowed.

Rough Schedule

Week	Mon		Wed		Fri		HW
1	Sep 4	Labor	Sep 6	Ch 2	Sep 8	Ch 2	
2	Sep 11	Ch 2	Sep 13	Ch 2	Sep 15	Ch 2	HW1 (Friday)
3	Sep 18	Ch 3	Sep 20	Ch 3	Sep 22	Ch 4	HW2 (Friday)
4	Sep 25	Ch 4	Sep 27	Ch 4	Sep 29	Ch 5	HW3 (Friday)
5	Oct 2	Ch 5	Oct 4	Ch 5	Oct 6	Ch 5	HW4 (Friday)
6	Oct 9	Ch 5	Oct 11	Ch 6	Oct 13	Ch 6	HW5 (Friday)
7	Oct 16	Ch 6	Oct 18	Ch 7	Oct 20	Ch 7	HW6 (Friday)
8	Oct 23	Ch 7	Oct 25	Ch 7	Oct 27	Ch 7	HW7 (Friday)
9	Oct 30	Ch 8	Nov 2	Ch 8	Nov 4	Ch 8	HW8 (Friday)
10	Nov 6	Ch 11	Nov 8	Ch 11	Nov 10	Ch 11	HW9 (Friday)
11	Nov 13	Ch 11	Nov 15	Ch 11	Nov 17	Ch 11	HW10 (Friday)
12	Nov 20	Special	Nov 22	Special	Nov 24	Thanksg.	
13	Nov 27	Ch 14	Nov 29	Ch 14	Dec 1	Ch 14	HW11 (Friday)
14	Dec 4	Ch 14	Dec 6	Ch 14	Dec 8	Ch 14	HW12 (Friday)
15	Dec 11	Ch 14	Dec 13	Ch 14			HW13 (Final)

Academic Policies and Statements

- Academic Calendar and Religious Observances
- Academic Integrity Statement
- Accommodations for Students with Disabilities
- Course Evaluations
- Diversity and Inclusion Statement
- Mental Health and Well-Being Statement
- Privacy of Student Records and the Use of Audio Recorded Lectures Statement
- Students' Rules, Rights and Responsibilities
- Teaching and Learning Data Transparency Statement

Mathematica

Mathematica and Wolfram—Alpha Pro are available at no charge to UW Madison students. They are useful for: (a) solving problems, (b) obtaining step-by-step solutions, and (c) writing programs with the assistance of Artificial Intelligence. (AI chat is built in.) To get access, go to www.wolfram.com/siteinfo and enter your University of Wisconsin email. Here are click-by-click steps if you need them: wolfr.am/UWMadison. Learn how to use Mathematica at www.wolfram.com/wolfram-u/.