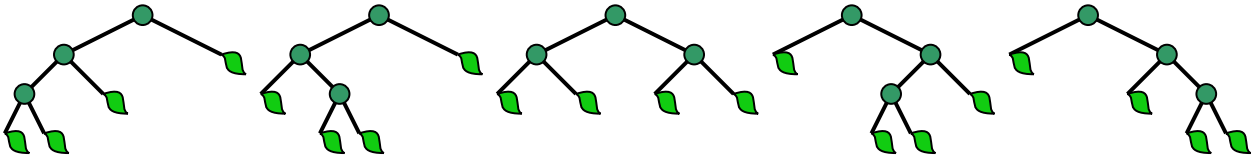

Source: wikipedia.org
Author: Jasampler at es.wikipedia

**Applied [combinatorics and] graph theory** is the theory and applications of discrete, (typically) finite structures. It is both a means and an end: it is a mathematically rich area in its own right, but it also has a broad range of applications, ranging from those arising in the "real-world" to those arising in other areas of abstract mathematics.

## Class Information

Credit Hours: 3

Pre-requisites: Graduate standing in Applied Mathematics or permission of the instructor.

Meeting Days and Times: Mondays and Wednesdays, 9:30AM - 10:45AM

Meeting Room: Student Commons Building 4113

Course Website: `https://jcmartinezmori.github.io/teaching/sp26_6404.html`

## Course Instructor

### Contact Details

Name: Juan Carlos Martínez Mori, PhD

Email: carlos.martinezmori@ucdenver.edu

Office: Student Commons Building 4211

Student (Office) Hours: Thursdays, 11:00 AM - noon, or scheduled by email.

I am available for you primarily during Student Hours, which will be held in my office unless otherwise announced. The next best method to reach me is by email. At some point in the term my email inbox will get quite full, but I still want to hear from you! If you email me but do not hear back within two business days, please send me a reminder.

### About Me

I am a civil engineer turned mathematician. As an undergraduate student at the University of Illinois at Urbana-Champaign, I was primarily driven by the prospect of improving our built environment (e.g., cities, transportation systems) through engineering applications. Later, as I progressed in my degree curriculum, I discovered mathematics not only as an essential tool for developing such applications, but as one that caught my interest in its own right. That prompted me to pivot to a doctoral degree (PhD) in applied mathematics at Cornell University. After graduate school, I continued going back and forth between engineering and mathematics, with postdoctoral fellowships at the Simons Laufer Mathematical Sciences Institute and the Georgia Institute of Technology,

before finally joining the Department of Mathematical and Statistical Sciences here at CU Denver in the fall of 2025.

I believe that mathematics drives new applications and applications drive new mathematics. And, as it turns out, the content of this course is particularly relevant to this interdisciplinary interaction. I am excited to explore it this term alongside you!

## Agreement

This course aims to offer an empowering mathematical experience for all. Its technical content will challenge you, but the class is designed to support you throughout your learning process. To facilitate this goal, I expect you to agree with and adhere to the CU Denver Honor Code:

> *As a member of the University of Colorado Denver community, I pledge to:*
>
> - *Act with honesty and ethics in academia and in society by building mutual trust and responsibility as a foundation for lifelong integrity;*
> - *Advance learning, knowledge generation, and the free exchange of views and ideas as the lifeblood of academic freedom and of democracy;*
> - *Embrace diversity and practice inclusion, showing civility, respect, and care toward all persons, standing up for the essential worth and dignity of every individual;*
> - *Take responsibility for the consequences of my own actions and share responsibility for the well-being and safety of the community by also holding others similarly responsible.*
>
> *I will honor these commitments in every part of my life.* — CU Denver Honor Code

I more over expect you to review, agree with, and adhere to the CU Denver Student Code of Conduct. Any departure from the Student Code of Conduct will be handled in full accordance with established University guidelines.

## Course Materials and Procedures

### Learning Outcomes

Through this course, you will have the opportunity to:

- Learn and apply essential enumerative concepts, results, and techniques.
- Learn and apply essential graph-theoretic concepts, results, and techniques.
- Gain some exposure to discrete mathematics-based mathematical modeling.
- Strengthen your ability to distill technical literature with an eye for research.
- Strengthen your written and oral technical communication skills.

### Expectations

To make the most of the opportunity this course represents, you should expect to:

- Consciously spend time on it. This will be a proof-based course, meaning attention to detail and mathematical elegance is the point. The necessary time commitment might vary depending on your individual circumstances. However, as a rough estimate, you should expect to spend around five hours per week on readings, assignments, and projects.
- Be mathematically curious. Many of the topics that I will cover in class are (at times subtly) inter-connected: it is good practice to ponder how they all fit together.

## References

Most of the course content can be found in standard textbooks on the subject, such as *D. West, Combinatorial Mathematics, Cambridge University Press, 2021.* Clearly-written lecture notes will be crowd-sourced and posted on the course website (refer to the Assessment and Grades section for more information). Any additional references will announced in class as necessary.

## Assessment and Grades

Your final point grade will be determined based on your course performance across several categories. These are described below:

- **Scribe Duties (15%)**. At the start of each lecture, I will appoint a student (ideally voluntarily, but otherwise randomly without replacement) as the "scribe." The scribe's main duty will be to prepare a clearly-written version of their lecture notes using the LaTeXtemplate provided. Serving as a scribe is a requirement: you can expect to serve as a scribe around three or four times throughout the semester, depending on enrollment. The scribe will need to send me their notes as a `.tex` file within five business days of their appointment, so that I can post them on the course website in a timely manner. No unexcused late submissions will be accepted.
- **Midterm Oral Exam (15%)**. There will be a 20 minute midterm oral exam. The exam will consist of a discussion on two course topics (spanning both lectures and written assignments): one of your choosing, and one of my choosing. The goal of this exam will be assess your knowledge of definitions, main results, and proof sketches. The exam will take place in my office at individually-scheduled time slots on or around March 18th, 2026. There will be no class meeting on the day of the exam.
- **Homework Assignments (30%)**. There will be (a target of) six homework assignments throughout the semester. You will need to upload your assignments, as a single `.pdf` files, electronically through Canvas. You may work individually or collaborate in groups of two: in either case, you must independently prepare and upload your individual submission. If you choose to collaborate with someone else, you must both acknowledge each other in your individual submissions. In the interest of gaining experience with academic writing, all submissions must be typed in LaTeX. No unexcused late submissions will be accepted.
- **Final Project (40%)**. There will be no final exam. Instead, there will be a final project starting halfway through the semester. The project will consist of a literature review of a relevant topic not covered in class; the topic will be of your choosing subject to my approval. An attempt to conduct original research on your topic of choosing is welcome but not at all expected. The project deliverables are a write-up, written as an expository article (or as a research paper, if you attempt and succeed at conducting original research), and an expository

presentation to your classmates and me. You may work individually or collaborate in groups of two. If you choose to collaborate with someone else, the two of you must commit to the collaboration upon my approval of your topic of choosing. Only one set of deliverables will be required per group.

### Letter Grade Scale

Please expect to receive a letter grade according to the scale in Table 1. This class is not designed

| Letter Grade | Score Interval | Catalog Description |
|---|---|---|
| $A$ | $[93, 100]$ | Excellent performance |
| $A-$ | $[90, 93)$ | Excellent performance |
| $B+$ | $[87, 90)$ | Good performance |
| $B$ | $[83, 87)$ | Good performance |
| $B-$ | $[80, 83)$ | Good performance |
| $C+$ | $[77, 80)$ | Competent performance |
| $C$ | $[73, 77)$ | Competent performance |
| $C-$ | $[70, 73)$ | Competent performance |
| $D+$ | $[67, 70)$ | Minimum passing performance |
| $D$ | $[63, 67)$ | Minimum passing performance |
| $D-$ | $[60, 63)$ | Minimum passing performance |
| $F$ | $[0, 60)$ | Course failure (no credit allowed) |

Table 1: Grading scale.

as a competition, and therefore I do not believe your grade should be tied to the grades of other students. I reserve the right to implement a grading curve if an extraordinary need arises, but you should not expect this to be the case. If applicable, please keep in mind how this grading scale aligns with the requirements of your degree program.

## Academic Integrity

You are capable of meeting the expectations of this course. If you are concerned about how well you are doing in this course, please contact me instead of engaging in academic misconduct.

Academic misconduct involves misrepresenting any work you submit for grading as your own when it is not. You are encouraged to discuss the material with your classmates, but any work you submit for grading must ultimately be your own. Please review the CU Denver Student Code of Conduct, and in particular its guidelines on academic integrity. Any departure from the Student Code of Conduct will be handled in full accordance with established University guidelines.

The use of large language models (LLMs) or generative artificial intelligence (AI) products, including but not limited to `ChatGPT`, `Copilot`,`Gemini`, and `Claude`, for graded course components without prior approval constitutes an academic integrity violation. Besides any academic misconduct implications, as a general suggestion, I encourage you to avoid the use of these products for any material you are in the process of learning. Not doing so puts you at risk of being unable to critically reason about correctness: I believe this is one of the main value propositions of a college education.

## Tentative Schedule

The following schedule is tentative. The specific topics may be adjusted based on progress, interests, and unforeseen circumstances.

1. *Jan 19 – 25.* Course organization, introduction.
2. *Jan 26 – Feb 1.* Combinatorial arguments.
3. *Feb 2 – 8.* Combinatorial arguments (continued).
4. *Feb 9 – 15.* Recurrence relations.
5. *Feb 16 – 22.* Recurrence relations (continued), inclusion-exclusion.
6. *Feb 23 – Mar 1.* Inclusion-exclusion (continued), graphs.
7. *Mar 2 – 8.* Matchings, **Final Project Topic Selection (Mar 6)**.
8. *Mar 9 – 15.* Matchings (continued), connectivity.
9. *Mar 16 – 22.* Connectivity (continued), **Midterm Oral Exam (20%, Mar 18).**
10. *Mar 23 – 29.* Spring break (Mar 23 – 29).
11. *Mar 30 – Apr 5.* Connectivity (continued), coloring.
12. *Apr 6 – 12.* Coloring (continued)
13. *Apr 13 – 19.* Planar graphs.
14. *Apr 20 – 26.* Planar graphs (continued).
15. *Apr 27 – May 3.* Spectral arguments.
16. *May 4 – 10.* Interdisciplinary connections.
17. *May 11 – 17.* **Final Project (40%, finals week, May 11 – 16).**