Math 280, Fall 2026: Graph Theory

TuTh 8:35 – 9:50am, SMUD 204

Webpage: `https://rlbenedetto.people.amherst.edu/math280/`
(Also linked from the Math 280 moodle page.)

Instructor: Rob Benedetto **Office**: SMUD 406 **Email**: `rlbenedetto@amherst.edu`

Office Hours: Mon, 1:45–3:15pm; Tue, 1:45–3:15pm; Fri, 1:00-2:00pm; or by appointment.

Our Math 280 Fellow (or "TA"): Megan Li

Evening Office Hours: Times and locations TBA

Text: J.M. Harris, J.L. Hirst, and M.J. Mossinghoff, *Combinatorics and Graph Theory*, 2nd ed., Springer, 2008.

For Amherst students: available through the Amherst College Textbook program.

Exams:

- **Midterm 1**: **Thursday, October 8**, in class.
- **Midterm 2**: **Thursday, November 12**, in class.
- **Final**: **TBA; it will be three hours, during finals period**

The only excuses for missing an exam are incapacitating illness, religious conflict, or the like.

Using cell phones, etc. during an in-class exam is CHEATING.
Using outside sources on homework or exams — AI tools, other websites, outside textbooks, etc. — without advance permission is CHEATING.
All cheating will be prosecuted, potentially leading to an F in the course.

Homework: Most weeks, assignments will include:

- Reading from the textbook, sometimes with short videos to watch, too.
- Usually one problem set per week, due **on Gradescope by 11:59pm ET**
  See Homework 0, and see page 3 of this syllabus, for important homework information.

Grading:

- **Effort**: 5%
- **Problem Sets**: 20%
- **Midterm Exams**: Better one: 25%. Worse one: 15%. (Total 40%.)
- **Final Exam**: 35%

"Effort" is a combination of attendance (including being on time), class participation, and handing in problem sets. It is not computed linearly; a student deficient in any one of those areas will get a very low Effort grade. (See pages 2 and 4 of this handout for more on attendance and participation.)

"Problem Sets" means actual grades on the problem sets. Late problem sets will be marked down substantially in the Problem Sets portion of your grade (see the webpage for details); but all problem sets handed in by the last day of classes count towards Effort.

If one component of an individual student's course grade is substantially higher or lower than their other grades, and if the student's Effort grade is strong, I will tweak the above percentages a little for that student to favor the better grades. Overall course grades will be curved.

About Cell Phones and Mobile Devices

Cell phones and similar devices have no place in my classroom. Don't use them. Not for talking, not for texting, not for anything. So at every class:

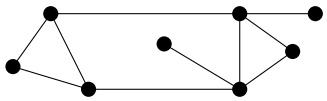
Silence your cell phone, put it away, and pay attention.

Necessary Background and Target Audience

The prerequisite for Math 280 is linear algebra (Math 271), and experience with **writing proofs** (e.g., from Math 220) is strongly recommended. Actually, the proof experience is probably more important. After all, we will only use some very basic linear algebra (determinants or products of matrices), and only occasionally; but we will be writing proofs all the time. To be clear, I don't expect you to feel *completely* comfortable with proofs yet, and indeed, Math 280 is a good place to get more experience with proofwriting. However, if you haven't had to write a lot of mathematical proofs for a course yet, then Math 220 (Mathematical Reasoning) may be a better course for you first.

Course Content

In our context, a *graph* is a set of nodes, or *vertices*, any two of which may or may not be connected by an *edge*. Drawing dots for vertices and lines for edges, we think of a graph as a picture like this:



Graphs can be used to model airline networks (vertices as airports, edges as flight routes), computer networks (vertices as computers, edges as wired or wireless connections), social networks (vertices as people, edges as friendships), maps (vertices as countries, edges as sharing a border), and much more. That said, Math 280 focuses on the mathematical theory of graphs, and not on their applications. In particular, that means that the intuitive ideas and pictures will have to be backed up by formal definitions and rigorous proofs. Here's a more detailed list of some of what we'll see, almost all of which is from Part 1 (pages 1–127) of our textbook:

- Section 1.1 is mostly terminology and definitions, but already with some basic proofs appearing.
- Section 1.2 introduces a notion of *distance* on graphs, as well as the use of matrices (from linear algebra) to encode a graph and facilitate certain computations.
- Section 1.3 is about particular class of graphs called *trees*.
- Section 1.4 is about *walks, paths, trails, cycles, and circuits*, which are different ways of tracing routes from vertex to vertex along the edges of a particular graph.
- Section 1.5 is about *planar graphs*, which are graphs that can be drawn on a piece of paper without any of the edges crossing each other.
- Section 1.6 is about *graph coloring*, which means assigning a value (called a *color*) to each vertex. Different vertices may be assigned the same color, but we usually impose the restriction that no two vertices that share an edge have the same color. This idea is inspired by geographical maps, where each country is colored in with some solid color (blue, red, yellow, etc.), but we don't want two neighboring countries to have the same color.
- Sections 1.7 and 1.8 are about slightly more advanced topics: matchings, factoring, edge colorings, and Ramsey theory. We'll cover as many of these topics as time permits.

Class Participation and Classroom Dynamics

Class participation is part of the Effort portion of your grade. If you are quiet by nature, don't worry; as long as you attend class devotedly, pay close attention, and do the homework, you will get full Effort credit. That said, finding your voice in class helps you learn better. So for your own benefit, **speak up, ask questions, and even try to answer questions I may ask in class**.

On the flip side, **respect your fellow students** both in and out of the classroom. Treat every person's ideas the same way you would if it had been me or the college president sharing them.

Homework

Your homework consists of **ALL THREE** of reading the book, watching any required videos, **AND** doing problem sets. Skim textbook sections **before** the corresponding lecture, and then go back and read more carefully to solidify your understanding and to help with the problem sets.

Please note the following **Important Problem Set Rules:**

1. Problem sets are due **on Gradescope**, each by its specified deadline.
2. You must **assign pages** in Gradescope, matching problems to pages of your submission.
3. **Write legibly**, and organize your work clearly. **Make it a pleasure to read!**
4. If you worked with other students in the class, then say so explicitly on the first page of your problem set. (See the discussion below on the Statement of Intellectual Responsibility.)
5. You **may** also get help from me, Megan (our Math Fellow), the book, and all of the handouts and videos from the course and the course websites.
6. If you want to use any **other** resources, including web searches or other people/texts/websites, **you must first get advance permission from me for each such outside source.**
7. The Problem Sets grade for any late assignment will be substantially reduced. The later it is, the greater the reduction; see the course webpage under "Problem Set Rules" for details.

See Homework 0 and the handout on Gradescope Instructions for more information on Gradescope.

I am often willing to grant penalty-free extensions on problem sets; but see "Class Attendance, Extensions, and Extra Office Hours" on page 4.

I strongly encourage you to work on problem sets together, in pairs or small groups, provided you follow the common-sense guidelines below.

About the Statement of Intellectual Responsibilty

Exams: Your work must be entirely your own, so no looking at other people's papers, no communication of any kind, and no outside help. Cell phones, smart watches, and other devices must be silenced and put away. Unless I specifically allow it, no other aids or reference materials are permitted.

Problem sets: I urge you to collaborate with each other, under the following ground rules:

1. If you collaborate with, say, Jane and Joe, write a note on the front of your problem set saying, "I worked with Jane and Joe." Use similar notation if you got help from a peer tutor, classmate, another professor, or an outside source that I approved. However, you do **not** need to write about help you got from me, Megan, the textbook, or course materials.
2. Working together does not mean that Joe does the first half of the problem set and Jane does the second half; everyone should work on every problem.
3. Each student must submit their own problem set; you can't submit a single packet (or copies of the same packet) as the work of multiple people.
4. Each student must write up each problem **in their own words**. Working together means discussing the problems. Using outside sources without approval, copying someone else's solution, or knowingly allowing someone else to copy your solution, is a violation of intellectual responsibility.

A common question: What if Joe asks Jane about a homework problem she has already solved? If Joe copies Jane's solution, both Joe and Jane would be guilty of academic dishonesty, potentially leading to an F in the course for both of them, among other bad consequences. Instead, Jane can explain her solution to Joe (even showing him what she wrote), before Joe writes up his own solution himself, **in his own words**. Joe would then have to write that he got help from Jane (see rule 1 above), but Jane doesn't need to write anything unless she also got help in return.

If at any time you aren't sure about what's OK and what's not as far as intellectual responsibility is concerned for this course, please talk to me about it.

Class Attendance, Extensions, and Extra Office Hours

Attendance: You should be at every class meeting, and you should be **on time**. Of course, if you're sick, have a religious conflict, or the like, just let me know (in advance, when possible). One or two accidental misses are OK, too; oversleeping can happen, but it should be **rare**. Otherwise, however,

I expect you to be in class, and on time, for every class meeting.

I don't plan to take formal attendance, but I can easily tell who misses class too much; those students' Effort grades will take a hit. (And after more than just a couple unexcused absences, or showing up late too much, your Effort grade will truly plummet, since I do not compute it linearly.)

Extensions: You may request **up to two** homework extensions over the course of the semester, each for up to 48 hours. To claim an extension, you must:

1. Request the extension (by email, or in person) **no later than 8pm ET on the due date**,
2. Not have used both your extensions yet, and
3. Have been attending class devotedly and meeting homework deadlines.

Note: you do **not** need to provide an excuse or reason for your extension request.

Office Hours: You are always welcome to attend my regularly scheduled office hours. In addition, **IF you have been attending class and doing the homework**, you are also welcome to make appointments to see me **outside** of my regularly scheduled office hours.

Getting Help

If you're ever stuck or confused, seek help immediately:

Office Hours: Stop by (unannounced) to see me during my scheduled office hours, or make an appointment to see me another time.

Math Fellow: Visit Megan's evening office hours, too. See the course website for details.

Tutoring: If you feel you need regular one-on-one help from a peer tutor, we can probably set that up. To do so, talk to me first.

Advice, and What to Expect

The amount of proof and rigor in Math 280 will be somewhere between the amount in Math 271 the amount in Math 350/355. So Math 280 is a good place to hone your existing proof-writing skills. That said, the weekly problem sets will be challenging, and you'll need time to ponder and mess around with some of the trickier problems. So every week:

- **Start working on each problem set the same day it is posted**, which will generally be a week in advance.
- In particular, **read and think about ALL of the problems** as soon as possible; do *not* wait until a day or two before it's due.
- Especially for the trickier problems, seek help in office hours and/or by asking questions in class.

The homework will be a mix of working with explicit examples and crafting more general proofs, and you will have to explain your solutions with

words, complete sentences, and well-written paragraphs.

Get in the habit of working things out on scratch paper in advance, figuring out what needs to be said, what **doesn't** need to be said, and what **order** everything should come in. You don't need to explain the intuition; you need to **solve the problem** or **prove the theorem**.

And if you're ever feeling lost, there's always office hours: mine or Megan's.