Math 5707, Spring 2017: **Graph Theory and Non-Enumerative Combinatorics**
– Syllabus –
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last update: January 10, 2019

Time & Place

Lectures: MW 11:15–13:10, Vincent Hall 311.

I am planning to do 50 minutes of class + 15 minutes of break + 50 minutes of class. But this is subject to change.

Office hours: Monday 15:00–16:00, Tuesday 12:00–13:00, Thursday 10:00–11:00. All in Vincent Hall 203B. Otherwise, by appointment (email).

Homework will usually be due on Wednesday biweekly. Submissions can be made electronically **provided that the problem set is submitted as 1 single PDF file**. See "Grading" and "Coursework" below for details.

Requirements

This is a pure mathematics class and focuses heavily on proofs. You have to feel at home reading and writing mathematical proofs. You need to know how to work with congruences ($a \equiv b \bmod n$), matrices (only basics, such as multiplication) and summation signs ($\sum$). For a few sections, you'll need to know about the sign of a permutation[1]. It helps to know the notion of a group, but it's not strictly needed.

Texts

required:

I will write lecture notes accompanying the classes:

http://www.cip.ifi.lmu.de/~grinberg/t/17s/nogra.pdf

(not started yet, but soon!). Everything examinable will be in these notes (and homework).

recommended:

There are many sources on graph theory around these days. Google for "graph theory" (possibly with "ext:pdf" to get PDF files) to get an impression. We don't follow any particular text precisely, and we have our own biases (e.g., we will try to go deeper into Hamiltonian paths, but ignore subjects like planarity). Here are some sources:

- J. A. Bondy and U. S. R. Murty, *Graph theory with Applications*, NH 1976. Downloadable from https://www.iro.umontreal.ca/~hahn/IFT3545/GTWA.pdf.

[1] This is explained briefly, e.g., in §8.1 of Lankham/Nachtergaele/Schilling.

- J. A. Bondy and U. S. R. Murty, *Graph theory*, GTM 244, Springer 2008.
  Downloadable from `https://www.classes.cs.uchicago.edu/archive/2016/spring/27500-1/hw3.pdf`
- Keijo Ruohonen, *Graph theory*, 2013.
  Downloadable from `http://math.tut.fi/~ruohonen/GT_English.pdf`
- Reinhard Diestel, *Graph Theory*, GTM 173, 5th edition, Springer 2016.
  Downloadable (in low quality for free) from `http://diestel-graph-theory.com/basic.html` .
- Oystein Ore, *Graphs and their uses*, revised and updated by Robin J. Wilson, MAA 1990.
- Edward A. Bender and S. Gill Williamson, *Foundation of Combinatorics with Applications*.
  Downloadable from `http://cseweb.ucsd.edu/~gill/FoundCombSite/`
- Mitchel T. Keller, William T. Trotter, *Applied Combinatorics*, version 26 May 2015.
  Downloadable from `https://people.math.gatech.edu/~trotter/book.pdf`
- John M. Harris, Jeffry L. Hirst, Michael J. Mossinghoff, *Combinatorics and Graph Theory*, UTM, Springer 2008.
- Solutions to Math 5707 Spring 2015 HW: `http://www-users.math.umn.edu/~bahra004/5707.html`

Contact

All material regarding the course (including homework) can be found on my homepage `http://www.cip.ifi.lmu.de/~grinberg/t/17s/`.

The best way to reach me is by email to `dgrinber@umn.edu`.

Schedule (preliminary)

This is my best guess at this point (and "best" does not mean "good"). Even the midterm dates are not set in stone. Topics inside parentheses are the most likely to be sacrificed if I run out of time.

week	**material**	
Jan 16	introduction	
Jan 23	dominating sets; Hamiltonian paths	
Jan 30	multigraphs; Eulerian paths; digraphs	
Feb 6	de Bruijn circuits; tournaments	
Feb 13	tournaments; trees	MT 1 due?
Feb 20	trees; spanning trees	
Feb 27	spanning trees; matrix-tree theorem; (BEST theorem)	
Mar 6	bipartite graphs; matchings; Hall's theorem	
Mar 13	*spring break*	
Mar 20	Hall's theorem; Gallai-Milgram theorem	
Mar 27	network flows	
Apr 3	stable marriages; Menger's theorem; Ore-Ryser theorem	MT 2 due?
Apr 10	(more matchings); chromatic polynomials; probabilistic method	
Apr 17	(more matchings); Pfaffians	
Apr 24	sandpile theory	
May 1	sandpile theory; (link reversal); (rotors); ((graph Riemann-Roch))	MT 3 due?

Grading

The grade will be computed based on three take-home midterms (totalling to 60% of the final grade, each giving 20% of the final grade) and about 6 homework sets (totalling to 40% of the final grade, but the lowest score will be dropped).

Points will be deducted if your proofs are ambiguously worded or otherwise hard to understand. Writing readable arguments is part of mathematics.

Coursework

Collaboration on homework is allowed, as long as:

- you **write** up the solutions autonomously and in your own words (in particular, this means that you have to **understand** them), and
- you **list the names of your collaborators** (there will be no penalties for collaboration, so you don't lose anything doing this!).

On the midterms, you have to **work alone** (you can **read** whatever you want, but you must **not contact** anyone about the midterm problems[2]; in particular, you must **not ask** them on the internet).

Homework and midterms should be submitted either in person during class, or by email to `dgrinber@umn.edu` . (Note: "dgrinber", not "dgrinberg"!)

If you handwrite your solutions:

[2]It is OK to contact me with questions.

- Make sure that your writing is legible.
- If you submit your solutions by email, make sure that your submission is **1 single PDF file** for a given homework set (not many 1-page JPGs!). Double-check that your scans are readable and aren't missing any relevant text near the margins.

If you type up your solutions:

- Again, make sure that your submission is **1 single PDF file** for a given homework set.
- Double-check that your text doesn't go over the margins (something that often happens when using LaTeX). If something is not on the page, we cannot grade it...

Calculators and computer algebra systems may be used, but are not necessary (and you are responsible for any errors they make, or you make at using them). For emails, I suggest using "[Math 5707] Homework set #n submission" (n = the number of the problem set) as the subject line.

Late homework or late midterms are **not accepted** in any situation; instead, submit whatever you have done before the deadline. If you want to update your submission, you can do so (before the deadline!) by sending me an email that includes the whole updated submission (not just the parts you want changed).

See also the following university policies:

- https://policy.umn.edu/education/gradingtranscripts
- https://policy.umn.edu/research/academicmisconduct