MATH 7233: Graph Theory

Northeastern University, Fall 2021

- **Instructor:** Gábor Lippner (email: `g.lippner@northeastern.edu`, office: 547 LA)
- **Time and place:** MW 3:15-4:45pm in Richards 275.
- **Office hours:** M 1-3pm W 9-10am;
- **TA:** Tomas Skacel (email: `skacel.t@northeastern.edu`, office: 526 NI)
- **TA office hours:** R 3:30-5pm F 10-11:30am
- **Prerequisites:** No explicit requirements, but knowledge of some linear algebra (eigenvalues, eigenvectors) and basic probability theory will be useful.
- **Texts:**
  - Handouts (problems sets and solution sheets) during the semester
  - Online lecture notes by Dan Spielman available at http://www.cs.yale.edu/homes/spielman/561/
  - *Graph Theory*, R. Diestel. Available freely online at http://diestel-graph-theory.com/basic.html (for reference only)
- **Course description:** The first half of the semester will be a brief introduction to various classical topics in graph theory. In the second half we will look at linear algebraic methods in more detail. There will be a strong emphasis on problem solving, and learning to give clear explanations both in writing and at the board. A typical lesson will consist of roughly equal parts of a) on-the-spot problem solving **in groups of 2-3**, b) discussion of solutions, and c) lecture.
- **Grading:** Your grade will consist of 5 components, each worth 20%:
  1. Group work with oral "presentations". Basically each group will have to present solutions to at least x problems during the semester, with priority given to those groups with fewer points. Here is $x = 60/\text{number of groups}$. **Details will be given in class.**
  2. Written homework (to be done in groups)
  3. Coding assignments (to be done **individually**)
  4. Four 20 minute long quizzes (to be done individually, 5% each)
  5. One 90 minute test (to be done individually)
  6. No real finals, though test is almost like a final.
- **Dates:**
  - Quiz dates: Sept 29, Oct 20, Nov 10, Dec 6
  - Test date: Dec 1
- **The final grade:** will be determined according to the following scale: A from 90.0% , A- from 85.0%, B+ from 80.0%, B from 75.0%, B- from 70.0%, C+ from 65.0%, and so on...

- **Homework, coding, quizzes, test:**
  - There will be three homework sets during the semester that involve writing up solutions to problems that were discussed in class. There will be 20 such problems in total, each contributing 1%. (One submission per group.)
  - A series of smaller computer assignments in MatLab (e.g. implement an algorithm or method that you learned about, and run it on some kind of data). I will be happy to help with MatLab basics in case you haven't used it before. Everybody works on their own, and submits their work through Canvas, via the MatLab grader.
  - Partial credit **will not** be given for either the homework or the coding assignments. For the written homework you will have a 2nd attempt to improve solution after feedback if the first attempt didn't pass. For the coding assignment you can use the grader's built-in tests to verify your solution before submitting it. You can submit multiple attempts before the deadline.
  - Quizzes will be checking your understanding of basic concepts. You may have to give examples of a certain type of object, or decide whether a given object possesses a certain property.
  - The test will be similar to homework in that you will have to write down solutions to problems previously encountered (or very similar to that) in class. However, you will not be able to use your notes, and will have to finish within 90 minutes.
- **Topics:**
  - Classical concepts:
    1. paths, cycles, trees
    2. bipartite graphs and matchings
    3. Ramsey theory
    4. planar graphs
    5. random graphs.
  - Linear algebra methods:
    1. random walks and electric networks
    2. adjacency and Laplace matrices
    3. eigenvalues, spectral gap, expander graphs
    4. graph partitioning.