

# Introduction to Graph Theory, MATH 3545

## Spring 2020

*Northeastern University*

- **Instructor:** Gabor Lippner (547 LA)
- **Office hours:** MT 1:30-3
- **Time and place:** TF 9:50-11:30, SL 043
- **Problem Clinic:** M 3-4:30, T 9-9:50
- **Prerequisites:** MATH 1365 or MATH 2310 or MATH 3533 or CS 1800 or CS 3800 or Permission of Instructor
- **Texts:**
  - Main text: *Introduction to Graph Theory, 2nd edition* by Doug West (2000, Pearson)
  - Handouts as needed
  - Supplemental reading: *Modern Graph Theory* by Bela Bollobas (1998, Springer)
- **Course description:**

Graph theory studies mathematical properties of networks. As such, it has become an indispensable tool in a broad range fields, from computer science through biology to social science and economics.

This course will focus on classical problems and results in Graph Theory with dual objectives. First, to familiarize students with the fundamental concepts regarding networks. Second, to build and practice both verbal and written logical reasoning skills involving abstract objects.

The course will cover the following topics:

  1. Paths, cycles, degrees
  2. Special graphs (trees, bipartite graphs)
  3. Matchings, colorings
  4. Connectivity
  5. Planar graphs
  6. Eulerian and Hamiltonian graphs
  7. Optional topics: Ramsey Theory, Random graphs, Linear algebraic methods
- **Grading:** The grade for this course will be based on homework (60%), four 30 minute long in-class quizzes (5% each), and a final (20%).
- **The final grade:** will be determined according to the following scale: A from 93.0% , A- from 88.0%, B+ from 83.0%, B from 78.0%, B- from 73.0%, C+ from 68.0%, and so on...

- **Homework, quizzes, final:** One of the main objectives of this course is to learn and practice understanding abstract definitions, using technical terminology correctly, and clear proof-writing skills.

*Homework* will consist of 13 problem sets, assigned and scored weekly throughout the semester, based on exercises from the textbook. Problems will be scored on a pass/fail basis, and partial credit **will not** be given. Homework will always be assigned on Friday and due **the following Thursday at the end of the day**, starting on week 2. Late submissions will not be accepted under any circumstances. However, only the 10 best scores out of the 13 will count towards the final grade.

*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 quizzes take place at the beginning of class on the following **Fridays**:

Jan 17            Feb 7            Mar 13            Apr 10

The *final* will consist of exercises similar in scope to the homework, and will be designed to test the usage of the learned material.

- **Problem Clinic:** There will be a weekly, 90 minute long, collaborative problem solving session. Participation will not be compulsory, but very strongly encouraged. Students will have the opportunity to work on the homework problems in small groups, in a supervised setting.

- **Other Policies**

- **Electronic devices:** Use of electronic devices (phones, laptops, calculators, etc) is not permitted in class. Please be so kind to silence and put away your phones.
- **Syllabus:** All information contained in the syllabus is provisional and subject to change. Any changes will be announced in class. It is your responsibility to be aware of changes the instructor may make to the syllabus as they are announced in class or on BlackBoard. Students are responsible for information given when they are absent.
- **Makeups:** Without prior notice, there will be no makeups of in-class exams. You must contact the instructor *before* the event if you need to request special accommodation.
- **Cancellations:** If classes are cancelled due to snow or any other official emergency, then any homework due or exam scheduled for that day will defer to the next scheduled class meeting.
- **Final Exam:** All students without legitimate exam conflicts, meaning two exams at the same time or three exams in one day, will take the final exam at the scheduled time. Do not make travel plans which conflict with the final exam. The final exam schedule will be posted by the registrar at [www.neu.edu/registrar/finexsched.html](http://www.neu.edu/registrar/finexsched.html).
- **Grades:** It is University policy that no grade, including an incomplete, can be changed after one year. Exceptions must be authorized by the Academic Standing Committee.
- **Academic Integrity:** Cheating will not be tolerated. Cheating includes sharing answers on exams or copying other students' work on written assignments. All incidents of cheating will be reported to the Office of Student Conduct and Conflict Resolution (OSCCR). A copy of the full University Academic Integrity Policy can be found at the link below.

[www.northeastern.edu/osccr/academic-integrity-policy](http://www.northeastern.edu/osccr/academic-integrity-policy)

- **Title IX:** The University strictly prohibits sex or gender discrimination in all university programs and activities. Information on how to report an incident of such discrimination, which includes sexual harassment and sexual assault, is located at [www.northeastern.edu/titleix](http://www.northeastern.edu/titleix).
- **Students with Disabilities:** Students who have disabilities and who wish to receive academic services and accommodations should follow the standard Disabilities Resource Center (DRC) procedures, available at the link below.

[www.northeastern.edu/drc/getting-started-with-the-dr](http://www.northeastern.edu/drc/getting-started-with-the-dr)

- **College of Science Policies:** Other College of Science Academic Course Policies are available at the link below.

[cos.northeastern.edu/wp-content/uploads/2012/10/COS-teaching-policies-April-2017.pdf](https://cos.northeastern.edu/wp-content/uploads/2012/10/COS-teaching-policies-April-2017.pdf)

- **Concerns:** If you have a concern about the course, I am always happy to meet with you to resolve them. If the issue is still not resolved, you can discuss it with the Teaching Director, Prof. Robert McOwen ([r.mcowen@northeastern.edu](mailto:r.mcowen@northeastern.edu)).

• **Course Outline**

|           | Topics Covered  | Text                             |
|-----------|---|----------------------------------|
| Week 1    | Graphs and isomorphism<br>Paths, cycles, components<br>Special graphs         | §1.1–1.2                         |
| Week 2    | Degrees and graphic sequences<br>Trees, spanning trees                        | §1.3, §2.1<br><b>Quiz</b>        |
| Week 3    | Enumerating trees<br>Trees and optimization                                   | §2.2<br>§2.3                     |
| Week 4    | Maximum matchings<br>Min-Max theorems   | §3.1<br>§3.2                     |
| Week 5    | Stable matchings*<br>Connectivity, blocks<br>Menger’s Theorem                 | §3.2*<br>§4.1–4.2<br><b>Quiz</b> |
| Week 6    | Network Flows<br>Vertex coloring  | §4.3<br>§5.1                     |
| Week 7    | Graphs with large chromatic number<br>Turan’s theorem<br>Chromatic polynomial | §5.2–5.3                         |
| Week 8    | Planar graphs and duality<br>Euler’s formula, Platonic solids                 | §6.1                             |
| Week 9    | Characterizing planar graphs<br>Testing planar graphs*<br>Special embeddings  | §6.2<br><b>Quiz</b>              |
| Week 10   | Coloring planar graphs<br>Tait’s Theorem<br>Crossing numbers*                 | §6.3<br>§7.3*                    |
| Week 11   | Edge coloring<br>Hamiltonian cycles   | §7.1–7.2                         |
| Week 12   | Ramsey theory<br>Infinite graphs<br>Sperner’s lemma*                          | §8.3                             |
| Week 13   | Optional topics: Random graphs* /<br>Eigenvalues of graphs*                   | §8.5* or<br>§8.6*<br><b>Quiz</b> |
| Week 14   | Review  |                                  |
| Exam Week | <b>Final Exam</b>   |                                  |

\* Optional topic that may be omitted depending on the progress of class.