

Graph theory, SF2740

Topics to cover, Fall 2021

Johan Håstad, KTH

The below list is a candidate list of topics that can appear in the course. The list of topics will be discussed during the course. Some topics might be covered in less depth or not at all. This might occur either because a good fraction of the class has already seen the material or a lack of time. The numbers refer to chapters in the book by Diestel.

1. Overview, basic properties of graphs. Bipartite graphs, connectivity, spanning trees. Contraction and minors. (D 1)
2. Computing the min cost spanning tree. Available on the web or most books on algorithms. One source is “Algorithms” by Cormen, Leiserson, Rivest and Stein.
3. Euler tour. Hamiltonian tours/paths. (D 1.8 some from D 10)
4. Complexity theoretic aspects. (Many sources on the net, the draft version of the book “Computation complexity” by Arora and Barak is a good source.)
5. Graph connectivity, Menger’s theorem. Min-cut and Max-flow. (D 3 some D 6)
6. Bipartite matching, Hall’s marriage theorem. König’s theorem. Theorem by Erdős-Posa (D 2.1, 2.3)
7. Matching in general graphs. (D 2.2)
8. Planar graphs. Kuratowski’s theorem. Efficient algorithms for planarity. (D 4)
9. Vertex Coloring of graphs. The four color theorem (proof of the five color theorem). List-vertex colorability. Coloring of edges. (D 5)
10. Ramsey theory. Ramsey numbers. (D 9)
11. Random graphs. Threshold functions for basic properties. The second order method. Chebychev’s and Chernoff’s inequalities. (D 11)
12. Extremal graph theory and in particular Turán’s theorem. (D. 7.1)
13. Dense graphs. Szemerédi’s regularity theorem and a proof of Erdős-Stone based on this (or possibly some other application). (D 7.4)
14. Expander graphs. The aim is to provide lecture notes for this topic, but they are not ready yet.

15. Cayley graphs, some other algebraic graphs. If this topic is discussed some material will be provided.
16. Additional algorithmic problems in graphs. Finding cliques in random graphs. Approximating Max-Cut. If this topic is discussed some material will be provided.

Updates to this plan will be published as the course progresses.