# DM551/MM851 Oral exam January 10-13, 2022.

December 12, 2021

## 1 Order of examination

Soon Inge will post exam lists based on your choices of exam day.

**Remember to show up and do so well ahead of the time corresponding to your number if everyone showed up!** You must show up at least 45 minutes before your time slot starts (The first ones on each of the days Tuesday to Thursday should just be there 15 minutes early).

## 2 Exam Format

**The description below assumes that the exam will be on campus.** If this is changed to an exam via Zoom, you will be notified. Already now you should be prepared that the exam may be moved to Zoom. Hence you must test how you can either share a tablet with us at the examination or use your camera to show what you draw on a piece of white (no lines) paper.

The processs starts by you drawing one of the exam questions after which you will have about 25 minutes to prepare your presentation. The exam itself is 25 minutes, including time to find your grade, that is, approximately 20 minutes of exam. You have roughly 13 minutes for your presentation and after that the censor and I will ask questions in other parts of the curriculum.

The main focus is on demonstrating understanding and usage of concepts and methods and to a lesser extend whether you can derive complicated formulas such as deriving the Chernoff bound formulas. Of course you must be able show that you understand the formulas and how to use them. You are welcome to choose a small example and use that to illustrate the topic you got.

The censor and I may also ask about your solution of the two projects so you must be able to explain that. This is particularly important for the first project if you worked in a group. You are welcome to use examples from the two projects to illustrate the topic you are covering in the question you got. Remember that the grade is given based on the overall impression of your performance at the oral exam and how well you answered the two exam projects. That means that your exam projects can help you get a better grade but also that **you will fail the exam if you show up at the oral exam and can only answer very little**.

# 3 Pensum

- Cormen et al, Introduction to algorithms 3rd ed: Section 5.1-5.3, 5.4.3 (until page 136 line -13), page 182-184, 11.3-11.5, 26.1-26.3 and 32.1-32.3.
- Kleinberg and Tardos, Algorithm Design: 13.1-13.5, 13.6, 13.9.
- Rosen 8th ed. Chapters 6,7, 8.1-8.2, 8.5-8.6
- The material and exercises on all Weekly notes. This includes the various notes on the weekly notes.

# 4 Exam questions

**Note that these have changed!!**

The stuff in the brackets is just to inspire you, there may be many other things to talk about. Remember that if you choose the easiest material then it is harder to get a top grade, so if you aim high, then choose something where you can show your qualities. If you just want to pass/get a decent grade, you may choose some of the easier material. In any case do not choose something which you are not sure you can handle!

**At the exam ifself you are not allowed to look at your notes, except for a very short list of topics you will cover. We can ask you to stop looking if we feel this is necessary.**

1. Basic counting problems (pigeon hole principle, generalized permutations and combinations etc, number of solutions to equations with integer variables)

2. Inclusion-exclusion with applications (derivation of the general formula, number of onto-functions, derangements and the hatcheck problem)

3. Discrete probability, random variables and bounds (expected value, variance, Bayes formula, Markov's inequality, Chebyshev's inequality and Chernoff bounds)

4. Randomized algorithms (Quicksort, median finding and selection, min-cut in graphs, generating a random permutation, majority element and more!!!)

5. Probabilistic analysis (using (indicator) random variables, coupon collector, expected running time of quicksort and selection, randomized approximation for max $k$-SAT).

6. Universal hashing (universal hash functions, perfect hashing (also called 2-level hashing), count-min sketch).

7. String matching (naive algorithm, The Rabin-Karp algorithm, Finite automaton based string matching).

8. Maximum flows (Definitions, Ford Fulkerson algorithm, Max-Flow-Min-Cut theorem, Edmonds-Karp Algorithm)

9. Applications of flows (bipartite matching, integrality theorem for flows, orienting graphs).

10. The min-cut problem (randomized algorithm, solution via flows, solution via max-back orderings).

**NB:** as you can see I removed the exam questions on recurrence equations and on the probabilistic method. This does **NOT** mean that you don't have to read that part of the curriculum, there can still be questions in these things in the last part of your exam. This could be questions like

- Give an example of a second order recurrence equation and explain how to solve such an equation.
- What is a non-homogeneous recurrence equation?
- Give an example of how to use the probabilistic method