Discrete Mathematics II — Winter 2014/15

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Time: The course starts with a one week intensive block course on Additive Combinatorics (Lectures: Oct 6, 7, 9, 10, 9:00-12:30PM, Exercises: 16:30-17:30, HS 001, Arnimallee 3)
The regular schedule resumes from November 3rd.
Lectures: Tuesdays, Wednesdays 8:30-10:00, Arnimalle 6 SR 032.
Exercises: Mondays 10:15-12:00 SR 210 Arnimallee 3 OR Tuesdays 12:15-14:00, Arnimalle 6 SR 032.

Course webpage: http://discretemath.imp.fu-berlin.de/DMII-2014-15/

Topics of the course Additive combinatorics, algorithmic combinatorics and its applications

- Additive Combinatorics (basic cardinality inequalities, covering lemmas, Ruzsa's power trick, Freiman isomorphisms, additive energy and Balog-Szemeredi-Gowers Theorem, sum-product estimates, Szemerédi-Trotter Theorem and/or Bourgain-Katz-Tao Theorem)

- Graph Algorithms and Applications (minimum weight spanning tree, Dijkstra's algorithm, asymptotic running time, P vs NP, Hamilton cycles, approximation algorithms, matchings, Hungarian Algorithm, stable matchings, edge colorings, Vizing's Theorem, list colorings, Galvin's Theorem, flows, Ford-Fulkerson Algorithm, connectivity, Menger's Theorem, Baranyai's Theorem),

- Linear Programming (Linear Programs, Polytopes, Integer Programming and LP relaxations, Simplex Method, Duality, Applications of LP)

Prerequisite: basic graph theory, combinatorics, linear algebra, calculus, and probability

Requirement for "active participation at the exercises". There will be 12 sheets of exercises, some of which will also appear on the final exam. Each week **submit solutions for three exercises** that you would like corrected. In order to be good at your craft you should try to solve **all** exercises and also practice writing them up for yourself.

The exercise sheets will usually be placed on the website of the course after the Wednesday lecture. Please submit your written solutions by 2PM on Friday of the following week in the mailbox of Shagnik Das. **Late solutions are not accepted.** For the signature on the exercises ("aktive Teilnehme") you must achieve **60% of the total score** (for each exercise the same score will be given).

It is very beneficial to think about and discuss mathematics in small groups. You are encouraged to solve exercises in study groups and **submit your solutions in pairs**. I also would like to encourage you to please feel free to approach me or Shagnik Das for discussion of your thoughts on particular exercises and ask for a hint about them. Nevertheless, I discourage you to search for the solutions on the internet. Most likely you *can* find one to most exercises, but copied solutions will never give you the deep understanding necessary to succeed on the final, so you cannot unfortunately spare the time you struggle on your own or with your study group while trying to solve exercises. Actually, *why* would you want to spare the struggle: that's exactly the creative and most fun part of the course!

It is also crucial to practice writing up proofs independently. Hence every student is required to **write up solutions to at least fifteen problems** (out of the thirty-six submitted). At the beginning of each solution state the name of the person who wrote it up for the pair.

Furthermore, each student must **present a correct solution at the blackboard at least once.**

In conclusion, you need to fulfil each of the following:

- achieving at least 60% of the point value of $3 \times 12 = 36$ homework problems,
- writing up the solutions yourself to at least fifteen problems (on each solution you should clearly state who the scriber was (and of course the name of the coauthor)),
- presenting at least once a correct solution at the blackboard.

Final. The grade for the course is based solely on the final exam,. The final takes place on February 18th (Wednesday) from 9:00AM to 12:00PM. The make-up final exam will be on the 24th of March (Tuesday) from 9:00AM to 12:00PM. The better of the two grades will count.
The final is a closed-book/closed-notes exam, you must actively follow the presented material throughout the semester to be able to succeed. There will be two different types of exercises on the final:

- Lexical knowledge: Definitions, statements and proofs of theorems
- Problem solving: applying the encountered theorems and methods to solve exercises (some of these will be from the homework sheets, some you have never seen before)

Literature. For the Additive Combinatorics part there will be lecture notes provided, otherwise there will be no separate lecture notes, you are encouraged to take notes. Most of the material is taken from the following books, which are placed on the Handapparat in the mathematics library:

- J. Matoušek, B. Gärtner: Understanding and Using Linear Programming
- T. Tao, V. Vu: Additive Combinatorics
- D. West: Introduction to Graph Theory

Further reading.

- V. Chvátal: Linear Programming
- R. Diestel: Graph Theory
- A. Schrijver: Theory of Linear and Integer Programming
- A. Schrijver: Combinatorial Optimization