

# Discrete Mathematics II

## Winter 2020-21

### Instructors

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**Course webpage** <http://discretemath.imp.fu-berlin.de/DMII-2020-21/>

**Whiteboard site** <https://mycampus.imp.fu-berlin.de/portal/site/15ab1466-fcc7-41b0-a431-bc04ffa3627a/>

### Schedule

There will be two lectures each week, taking place on Tuesdays from 12:15 to 13:45 and on Wednesdays from 14:15 to 15:45. The exercise classes will take place on Tuesdays from 08:30 to 10:00. The lectures and the exercise classes will take place on the Cisco Webex Meetings platform, with the link to the meeting available on the Whiteboard site.

### Topics of the course

The use of algorithms in combinatorics, including:

- graph algorithms (shortest routes: Dijkstra, Travelling Salesman. approximation algorithms; matchings: Tutte's Theorem, Hungarian Algorithm; network flows and applications: Menger's Theorem, Baranyai's Theorem; stable matchings and applications: list colouring),
- linear programming (Simplex Algorithm; duality and its applications; integer programming and LP relaxations), and
- randomised algorithms (randomised matching algorithms; derandomisation and the Erdős–Selfridge criterion; the Algorithmic Local Lemma).

## Literature

Recommended texts:

- L. Lovász, J. Pelikán and K. Vesztergombi, *Discrete Mathematics*.
- J. Matoušek and B. Gärtner, *Understanding and Using Linear Programming*.
- D. West, *Introduction to Graph Theory*.
- D. Hefetz, M. Krivelevich, M. Stojaković and T. Szabó, *Positional Games*.

Further reading:

- V. Chvátal, *Linear Programming*.
- A. Schrijver, *Theory of Linear and Integer Programming*.
- A. Schrijver, *Combinatorial Optimization*.

## Prerequisites

We expect students to have successfully completed Discrete Maths I, or an equivalent course elsewhere (please contact the instructors in this case). During the course we will also make use of undergraduate linear algebra, calculus and probability.

## Final Exam

The grade for the course is based solely on the final exam. The formal and time of the final exam will be announced on a later time.

The final exam will be a closed-book/closed-notes written exam. You must learn everything that was presented and be familiar with how to apply the learned methods. In order to succeed, it is absolutely necessary to actively follow the lectures throughout the semester, immediately revise the new material, and try to solve all the exercises. It will test both

- (a) Lexical knowledge: being able to recall precisely all definitions/theorems from the lecture and explain their proofs.
- (b) Problem solving: creatively applying the encountered theorems and methods to solve problems.

## Exercise sheets

There will be 12 Exercise Sheets. They will be usually released by Wednesday afternoon at **Whiteboard** and will be due the following Tuesday 08:15. Each sheet will have four to six exercises. You should submit solutions for two exercises that you would like corrected.

## Submission of Solutions

Please submit your solutions in pairs on Whiteboard in a .pdf format. Indicate which two solutions you would like to have graded. At the beginning of each solution please state the name of the person who wrote it up for the pair.

You should use the following format to name the .pdf file that you submit: LastName1\_LastName2\_string1\_string2\_string3\_SheetN.pdf

where, LastName1 is the last name of the person uploading the solutions, LastName2 is the last name of the second person of the pair, string 1 is a string of digits corresponding to the exercises that were submitted for grading and were written by LastName1 (if no such exercises exists then set string1 to be 0) , string 2 is a string of digits corresponding to the exercises that were submitted for grading and were written by LastName2 (if no such exercises exists then set string2 to be 0), string 3 is a string of digits corresponding to the exercises that are included to the solutions but not submitted for grading (if no such exercises exists then set string3 to be 0), the N in SheetN corresponds to the exercise sheet's number.

We recommend that you write your solutions in LATEX. Alternative you can hand-write your solutions, scan them or take a picture (using a photo-scan app may produce better results than using just your camera) and then convert the produced document to a .pdf using a pdf converter (there are free pdf converter online). It is your responsibility that your solutions are legible. Illegible solutions will NOT be graded. Late submissions will NOT be accepted.

## Aktive Teilnahme

To obtain the aktive Teilnahme credit you have to

- obtain at least 60% of the point value of  $2 \times 12 = 24$  homework problems (each problem is worth 10 points),
- be the author of 10 submitted solutions,
- present a correct solution in the exercise classes.

(Example: Alice Green and Bob Blue submitted the solutions for exercise sheet 3 together. They indicated for grading exercise 1, written by Bob and exercise 4 written by Alice. Alice, who submitted their solutions named the file Green\_Blue\_4\_1\_23\_Sheet3.pdf. The two exercises that were submitted for grading received grades 7 and 8 respectively.

For the above submission both, Alice and Bob will receive 15 out of the 20 points for exercise sheet 3. In addition both of them are the author of a single submitted solution which counts toward their individual goal of submitting 10 solutions.)

## HINTS

To succeed on the final, regular, hard work is necessary throughout the semester. It is impossible to learn everything at the end. No week can go by without making sure the lecture material is digested, and the solutions of all exercises are understood.

- Doing math TOGETHER is FUN! It is strongly encouraged to talk through the homework in study groups, throw ideas around, and come up with solutions together.

- It is very important though that to write up the solutions by yourself—just as you will on the final exam.

- Finding solutions on the internet for any homework exercise is quite easy, but is strongly discouraged. Such copied solutions will never give you the deep understanding necessary to succeed on the final. You simply cannot spare the time you struggle while thinking about exercises alone, or together with your study group. And actually, why would you want to spare it: this very struggle is the creative and most fun part of mathematics—and of our course as well!

- Feel free to contact us (by e-mail or in Whiteboard) if there are any questions concerning the lecture or the exercises. Let us know your thoughts about any particular exercise: what you have tried, where you got stuck, and feel free to ask for hints based upon them.”