

# Computational Discrete Mathematics

Chien-Chung Huang and Ariel Levavi

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## Synopsis

This course presents a selection of topics in discrete mathematics and more specifically in combinatorics. Instead of plunging into the realm of abstraction and aesthetics as in pure mathematics, we select our topics primarily based on their applications in computer science and entertainment values.

In the first half of the course we will cover material which is indispensable for a student with an interest in theory. The second half of our course will be a selection of more advanced research topics, including the (in)famous stable marriage problem and combinatorial games.

We propose that the course is made up of two hours of class time and one hour of exercise time. The topics will be broken up as mentioned above such that the first part of the material will take up roughly  $3/5$  of the course, and the special topics will use the remaining  $2/5$ . Below is an outline of the material we wish to cover.

## Outline

### Part I: Basic Material

1. Graph Matchings (e.g. Hall's Theorem, Birkhoff's Theorem)
2. Network Flow (e.g. min-cost flow, circulation)
3. Extremal Graph Theory (e.g. Ramsey's Theorem, Turán's Theorem)
4. Generating Functions and Applications (e.g. Stirling Numbers, Cayley's Formula)

### Part II: Special Topics

5. Stable Matchings (marriage, roommates, family, hospital-resident, kidney-donor)
6. Combinatorial Games (Pegging Solitaire, Permutation Tableaux)