Math 244: Discrete Mathematics

Fall 2014 Course Information and Syllabus
Nathan Kaplan, DL 418, `nathan.kaplan@yale.edu`

Lectures: Tu,Th 11:35 - 12:50 in Mason Laboratory 211.
TA: Shaked Koplewitz, shaked.koplewitz.edu.
Peer Tutors: Dan Mitropolsky, daniel.mitropolsky@yale.edu.
Teddy Weisman, theodore.weisman@yale.edu.

Office Hours

Nathan: Tuesday 11:00 - 11:30 AM and 1:00 - 1:30 PM, and Wednesday, 2:30 - 3:30, DL 418.
Also, feel free to email me to set up an appointment.
Shaked: Monday and Tuesday 7:00 - 9:00 PM in LOM 201.
Dan: Tuesday 4:00 - 6:00 PM and Wednesday 4:00 - 6:00 PM in Thain Cafe in Bass Library.
**Teddy**: Monday 10:00 - 11:59 AM and Wednesday 7:00 - 9:00 PM in Davenport Common Room.
Also feel free to email Dan and Teddy to set up individual meetings.

Course Goals

Math 244 will provide a broad introduction to combinatorics and graph theory. Combinatorics can be described as the art of counting. A graph is just a collection of vertices and edges connecting them. These subjects give an accessible introduction to what mathematics is all about. They are built up from simple concepts but we will quickly run into difficult problems that require clever insights. We will learn what sorts of objects mathematicians are interested in counting and many techniques for studying them, and how to think about graphs in a rigorous and abstract way.

Another goal, probably more important than learning a body of material, is to develop your mathematical reasoning ability. We will learn lots of problem-solving techniques in this course and use them to solve lots of different kinds of problems. We will also do lots of proofs. Previous experience with proofs is not a prerequisite for this course. In fact, there aren't really any prerequisites except a willingness to develop mathematical skills by thinking hard about challenging problems.

This course will serve as a good foundation for aspiring mathematicians, but will also be very useful even if you never intend to take another math class. Ideas we will encounter have far-ranging applications in computer science, applied mathematics, and other quantitative areas. The experience you will gain here will help prepare you to reason clearly in our increasingly quantitative and data-driven world.
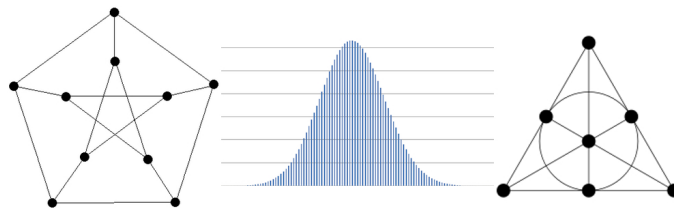
Grading

- Homework: 40%
- First Midterm Exam (in class- Oct. 9): 15%
- Second Midterm Exam (in class- Nov. 11): 15%
- Final Exam: 30%

Weekly homework will be a big part of this course. The best way to learn any mathematical subject is by doing lots of problems, and this is especially true for discrete math. Some of these problems will be straightforward while others will require come very clever thinking. I have always found that I think better about mathematics when I can discuss it with others and that I only really understand a problem when I can explain its solution to somebody else. You are encouraged to work together on problem sets, but write up your solutions individually. If you use outside sources (other textbooks, websites, etc.) for your homework, you must acknowledge them.

Course Outline

1. **Combinatorial Counting**

   (a) Binomial Coefficients, Fibonacci Numbers, Permutations and Combinations, Pascal's Triangle.
   (b) Proof by Induction, The Principle of Inclusion/Exclusion, The Pigeonhole Principle.
   (c) Basic Discrete Probability, Conditional Probability, The Law of Large Numbers.

2. **Graph Theory**

   (a) Basic Definitions and Examples, Eulerian Walks and Hamiltonian Cycles.
   (b) Spanning Trees and the Traveling Salesman.
   (c) Planar Graphs, Euler's Formula, The Classification of Regular Polyhedra, Graph Coloring.

3. **Other Possible Topics**

   (a) Interactions between Combinatorics and Geometry. Error-Correcting Codes. Turán's Theorem. Ramsey's Theorem.

Books

1. *Discrete Mathematics: Elementary and Beyond*, L. Lovász, J. Pelikán, K. Vesztergombi.
   ISBN: 0387955852
   This book is available for free online through the Yale Orbis system or from Springerlink.

2. *An Invitation to Discrete Mathematics, 2nd ed.*, J. Matoušek and J. Nešetřil.
   ISBN: 0198570422
   This book is not required but is recommended as a secondary resource, especially for the graph theory.
   There are inexpensive used copies (around $20 or so) available on the internet.
   Copies of both books are also available at the Yale book store.