Math 566 Topics in Combinatorics Fall 2009

Instructor Amites Sarkar

Text Combinatorics
Béla Bollobás

Syllabus

I will aim to cover:

- Sperner's theorem, the Kruskal-Katona theorem, and the Erdős-Ko-Rado theorem
- Discrete isoperimetric inequalities in the cube and the grid
- Roth's theorem on 3-term arithmetic progressions

Notes

I chose the above topics mainly because I'm interested in them. The three fundamental results on set systems listed first answer very natural questions; their proofs are important and elegant, and each has many applications, especially in combinatorics. The material on discrete isoperimetric inequalities can be viewed as a translation of the classical isoperimetric inequality in $\mathbf{R}^n$ to the discrete setting. The classical isoperimetric inequality states that, among simple closed surfaces of fixed surface area, a sphere encloses the most volume. In the discrete setting, there are two different interpretations of the phrase "surface area", each of which gives rise to a family of theorems. Roth's theorem, proved in 1952, states that a set $A \subset \mathbf{N}$ of *positive upper density* contains a 3-term arithmetic progression. At least four Fields medalists (Roth, Bourgain, Gowers, Tao) have worked on refinements and extensions of this theorem. We will study a short proof of Gowers from 1996.

Final Monday 7 December 10:30 am–12:30 pm

Grading

I will base the grade on **homework** (there will be 3 homework assignments), **presentations** (you will each have to do a 30 minute presentation at the end of the quarter) and the final (which will be worth about 30%). I'm in the process of drawing up a list of presentation topics, which I'll distribute within the next 2 weeks.

Office hours

My office hours are 10–10:50 on Mondays, Tuesdays, Wednesdays, Thursdays and Fridays, in 216 Bond Hall. My phone number is 650 7569 and my e-mail is amites.sarkar@wwu.edu