CS 58500: Theoretical Computer Science Toolkit
Spring 2023

Instructors: [Hemanta K Maji,](#) [Paul A Valiant](#)

When & Where: Tuesday, Thursday, 1:30-2:45 pm, LWSN 1106

Description
This course covers fundamental techniques and a range of mathematical tools that underlie today's research in theoretical computer science and are essential knowledge for students pursuing research in theoretical computer science or machine learning theory. The course targets current graduate and undergrad students interested in pursuing research in these areas.

Topics will be chosen from four core areas:
- Selected Topics in Convex Analysis and Optimization
- Foundations of Spectral Methods
- Concentration Inequalities and their Applications
- Discrete Fourier Analysis

Depending on student interest, additional topics will be chosen. The topics may include applied analysis for learning theory, coding theory, and probabilistic proofs.

Students will read research papers to gain an additional perspective on applying these techniques to different areas and their use and extensions in recent research results.

A more detailed list of topics is available at [[website link](#)].

Prerequisites. Mastery of the material covered in Calc III (Math 261), Linear Algebra (Math 265), Probability (STAT 416), Foundations of CS (CS 182), and Analysis of Algorithms (CS 381 or CS 580). Undergraduates interested in taking the course should contact the instructor for permission.

Tentative Coursework. 4-5 Homeworks (30%), Midterm (25%), Research papers (20%), and Final (25%).

Note: The course builds on the previously offered CS 59200 ``Mathematical Toolkit in CS'' course (last offered in [Spring 2022](#))