Catherine Babecki

Contact Information

Email: cbabecki@caltech.edu
Websites: https://www.its.caltech.edu/~cbabecki/
https://github.com/cmbabecki/GraphicalDesigns

Employment

California Institute of Technology, Pasadena, CA, USA — Sept 2023 –
Mathematics & CMS Departments
Olga Taussky and John Todd - Von Kármán Postdoctoral Scholar Teaching Fellow

Education

University of Washington, Seattle, WA, USA — June 2023
Ph.D., Mathematics (Thesis: "The Polyhedral Geometry of Graphical Designs")
Advisor: Rekha Thomas

University of Washington, Seattle, WA, USA — December 2021
M.S., Mathematics (Thesis: "Codes, Cubes, and Graphical Designs")
Advisor: Rekha Thomas

The Pennsylvania State University, University Park, PA, USA — May 2017
B.S., Mathematics, minor in German

Mercer County Community College, West Windsor, NJ, USA — December 2014
A.S., Mathematics

Publications

Sparse graphical designs via linear programming (with J. Carlos Martínez Mori and Hessa Al-Thani). 2023. https://arxiv.org/abs/2309.00765

Spectrahedral geometry of graph sparsifiers (with Rekha Thomas and Stefan Steinerberger). 2023. https://arxiv.org/abs/2306.06204

Eigenpolytope universality and graphical designs (with David Shiroma). 2023. https://arxiv.org/abs/2209.06349. Accepted to *SIDMA*.

What is … a graphical design? AMS *Notices*, October 2022. https://www.ams.org/journals/notices/202209/rnoti-p1571.pdf

Graphical designs and Gale duality (with Rekha Thomas). *Mathematical Programming*. 2022. https://link.springer.com/article/10.1007/s10107-022-01861-0

Codes, cubes, and graphical designs. *Journal of Fourier Analysis and Applications* 27, 81. 2021. https://doi.org/10.1007/s00041-021-09852-z.

Higher order smallest parts functions and rank-crank moment inequalities from Bailey pairs (with Chris Jennings-Shaffer and Geoffrey Sangston). *Research in Number Theory*, Vol. 2(1), pp. 1-35. 2016.

Teaching & Mentorship

California Institute of Technology

ACM 270 Section 2: Spectral Graph Theory (topics course). Fall 2023

University of Washington, Seattle

Instructor:

Math 307: Introduction to Differential Equations. Summer 2019, Spring 2020

Teaching Assistant:

Math 516: Convex Optimization. Fall 2021
Math 514: Combinatorial Optimization. Spring 2022, Fall 2022
Math 480A: The Power of Polynomials. Spring 2021
Math 408: Nonlinear Optimization. Winter 2022, Winter 2023
Math 308: Matrix Algebra. Fall 2020
Math 307: Introduction to Differential Equations. Winter 2020, Winter 2021
Math 126: Calculus with Analytic Geometry III. Fall 2018, Winter 2019
Math 120: Precalculus. Fall 2019

Graduate Student Mentor:

Undergraduate research project with David Shiroma, Spring and Summer 2022
Washington Directed Reading Program – Spectral Graph Theory, Winter 2022
Washington Experimental Mathematics Laboratory, Fall 2021
Graphical Designs
Faculty mentor: Rekha Thomas
Washington Directed Reading Program – Error Correcting Codes, Winter 2021
Washington Directed Reading Program – Intro to Graph Theory, Winter 2019
Washington Experimental Mathematics Laboratory, Fall 2018 & Winter 2019
Tactile Patterns in Art and Mathematics
Faculty mentors: Sara Billey and Timea Tihanyi

The Pennsylvania State University, University Park

Tutor with Penn State Learning (mathematics), December 2015 – July 2017
Leader of Math 220: Matrices exam reviews, August 2016 – May 2017
Grader for Math 404: Classical Analysis II, Spring 2018

Talks

The Spectrahedral Geometry of Graph Sparsifiers
UC Irvine Probability and Combinatorics Seminar, October 2023

Recent Progress on Graphical Designs
SIAM Conference on Optimization (OP23) in Seattle. "Algebraic and Geometric Methods in Optimization" session, June 2023

The Polyhedral Geometry of Graphical Designs
ICERM, Combinatorics and Optimization workshop, March 2023
https://icerm.brown.edu/video_archive/?play=3086

Structure and Complexity of Graphical Designs for Weighted Graphs through Eigenpolytopes
JMM 2023 Boston. SIAM minisymposium on combinatorial optimization. January 2023
University of Washington, Seattle. CS Theory seminar, January 2023
TU Berlin, Germany. Discrete Mathematics and Geometry Seminar, January 2023
Boise State University. TATERS seminar, January 2023

Caltech. Discrete Analysis seminar, January 2023

Graphical Designs and Gale Duality (https://www.youtube.com/watch?v=pRBd4XemcME)
University of Massachusetts, Amherst. Discrete Math Seminar, May 2022
SIGMAP conference at the University of Alaska, Fairbanks (abridged), June 2022
University of Waterloo, Algebraic Graph Theory Seminar, August 2022

Codes, Cubes, and Graphical Designs (https://www.youtube.com/watch?v=JyGq4Ui6FQk)
University of Washington. Combinatorics Seminar, March 2021
University of California, Davis. Algebra and Discrete Math Seminar, April 2021
ETH Zürich. Graduate Geometry Colloquium, June 2021

Error Correcting Codes (https://www.youtube.com/watch?v=KgiB2Vq2d6I)
University of Washington. Combinatorics Pre-seminar, March 2021

Service

Creator and organizer of a weekly Caltech CMS Department Tea, Sept 2023 –
Organizer with UAW4121, the academic student employee union, Mar 2021 – June 2021
Organizer of the UW math graduate student happy hour, September 2020 – August 2022

Workshop Participation

MSRI/BIRS summer school – Sums of Squares Methods in Geometry, Combinatorics, and Optimization. Aug 1- Aug 12, 2022
ICERM semester – Discrete Optimization: Mathematics, Algorithms, and Computation. March – May 2023

Non-Academic Employment

Project Manager with Nate Brown, September 2017 – August 2018
Research, data analysis, graphic design, and administrative work for a diversity in STEM initiative in the Penn State Math Department. Our projects included studies on the gender gap in calculus outcomes, analysis of gender gaps in faculty service, and a poster campaign.

Awards & Honors

Douglas Lind Graduate Fellowship, UW Department of Mathematics, October 2022
McFarlan Fellowship, UW Department of Mathematics, September 2018 – June 2021
Leonhard Euler Memorial Scholarship, PSU Department of Mathematics, April 2017
Kermit C. Anderson Memorial Award, PSU Department of Mathematics, September 2016

Software

Proficient with Matlab and Adobe Illustrator
Some experience with Java, Python, Mathematica, Macaulay2, Julia, SPSS, and Photoshop