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). 2024. To appear in OR Letters. 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). *SIDMA*. Vol. 38, No. 1, pp. 947–964. 2024. https://epubs.siam.org/doi/10.1137/22M1528768

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

Workshops

      Santander Workshop on Geometric and Algebraic Combinatorics. Mini-course TA for Graphical Designs and Graph Sparsifiers, led by Rekha Thomas. January 2024

      BRIDGES conference, University of Utah. Mini-course TA for Three Problems on Graphs, led by Rekha Thomas. July 2024.

California Institute of Technology

      Math 121b: Combinatorial Analysis. Winter 2025

      Math 6b: Introduction to Discrete Mathematics. Winter 2025

      Math 191b: Algebraic and Geometric Methods in Combinatorics. Winter 2024

      ACM 270 Section 2: Spectral Graph Theory. 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

Graphical Designs and Graph Sparsifiers

      CIRM, Analysis on fractals and networks and applications, March 2024

The Spectrahedral Geometry of Graph Sparsifiers

      UC Irvine Probability and Combinatorics Seminar, October 2023

      Georgia Tech Graph Theory Seminar, April 2024

      ICERM, Discrete Optimization: Mathematics, Computation, and Algorithms, Aug. 2024

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