**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