UNIVERSITY OF MARY WASHINGTON

where great minds get to work

Department of Mathematics
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Welcome from the Chair

We are excited to begin the academic year here at UMW with all of the new changes and opportunities around the department. Over the past year we've seen excellent work done by our students, especially in their research with faculty. This coming year promises to show sustained activity in these pursuits, with planned presentations by our students at regional conferences as well as the upcoming Joint Mathematics Meetings in Baltimore. If you are a current student, don't be shy about asking how to set yourself up for getting involved in research with faculty!

When you visit the department, be prepared to see some changes. We had a round of "musical offices" this summer, so faculty may not be where you're accustomed to seeing them (but we're all still here). Once Keith Mellinger was named Dean of CAS, I moved down the hall to the Gary Collier Memorial Office. I decorated my office with some art by our very own mathematics/studio art double-major Riley Anderson; you should stop by and see it. Melody Denhere took my place in Trinkle 128, and Jeb Collins moved across the hall down in the basement suite. When you walk by Trinkle 127, be sure to say hi to our new office manager, Katina Shelton. Katina has worked at UMW for 13 years, and she came to us in August after Joyce's retirement. We're glad to have her.

We've got a full slate of interesting courses lined up this year. In the fall we have MATH 351 (Numerical Analysis), a great course for preparation for industrial careers and one that also satisfies our programming requirement in the major. Melody Denhere is offering a STAT 461 topics course in multivariate statistics, something we plan on converting to a permanent addition to the course catalog. For the spring term, we are planning on offering MATH 352, the sequel to the first course in Numerical Analysis, Dr. Sumner's popular Chaotic Dynamical Systems (MATH 411), and my own upper-level Cryptology special topics course (MATH 461Q). We've also got a brand new experimental offering: Jeb Collins is teaching a section of the topics course MATH 361 called Programming for Problem Solving. Here, students will learn programming techniques and how to apply them to solve mathematics problems from a variety of areas.

Beyond all this, we are in the midst of planning all of our usual events for the year, including colloquium talks, our fall career panel, and our spring "featured alum" visit. The biggest news here is that we are hosting the fall regional meeting of the MAA the weekend of November 2nd. This is a large meeting and a high-profile event, so if you're interested in helping or contributing we're definitely interested in talking with you! If you ever have any questions, ideas, or just want to stop by and chat, please come by and visit with us. Best wishes for another great year.

Randall Helmstutler
Chair, UMW Department of Mathematics

Transitions

The department is pleased to welcome Katina Shelton as our new Office Manager. Katina is not a new face to UMW, but has been here for 13 years, previously working as administrative assistant to the assistant dean of Residence Life. If you see Katina in Trinkle, please welcome her.

Of course, a new Office Manager means that Joyce Durham has retired after years of service to our department. We will surely miss Joyce and wish her the best in her retirement.

Congratulations should be given to Keith Mellinger, who began as Dean of the College of Arts and Sciences in June 2018 after serving as Interim Dean for a year. Congratulations also to Jennifer Magee, who was promoted to Senior Lecturer.

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Honors Defenses

Prior to the fall of 2017, **Henry Darron** collected some data aboard the schooner *Zodiac* from January to August. Under the direction of Dr. Melody Denhere, he analyzed this data along with publicly available data from National Oceanic and Atmospheric Administration (NOAA). His research, which used multivariate analysis and time series analysis methods, focused on modeling and assessing the performance of the business cycle and the operation efficiency of the *Zodiac*. He proposed an operating efficiency model that used probabilistic methods to generate an efficiency measure. Henry is currently back on the *Zodiac* as he takes a gap year before going to graduate school.

Shannon Haley completed her honors research in the area of non-commutative cryptography, defending her thesis "Non-commutative Massey-Omura Encryption with Symmetric Groups." Shannon's thesis was the culmination of a year and a half of work with her advisor, Dr. Randall Helmstutler. In her research, Shannon examined ways to extend the original commutative Massey-Omura encryption scheme to the symmetric groups. This required a complete re-working of the system, replacing modular arithmetic and exponentiation with symmetric groups and conjugation actions. Shannon then had to prove that the implementation of such a scheme is possible, and she derived two distinct ways of doing so. Her thesis ends with a nice comparison of the two techniques and an analysis of the security of the resulting systems. Shannon presented her work at the Joint Mathematics Meetings in San Diego and at the regional MAA meeting in Lexington, VA. Shannon graduated with departmental honors in mathematics and University honors, and is now completing her fifth year in UMW's College of Education for her master's degree.

Bailey Stewart also worked with Dr. Helmstutler in non-commutative cryptography, studying extensions of the Feige-Fiat-Shamir zero-knowledge protocol. Their original scheme, first published in 1988, used modular arithmetic to establish a way of proving the possession of information or verifying identity electronically, all done in a way to thwart impersonation by adversaries. Bailey's work focused on finding ways to implement the same scheme but in a non-commutative setting, hopefully increasing its security. She was able to prove that implementing a zero-knowledge protocol by squaring within a permutation group is actually much weaker than the original commutative protocol, a bit of a surprise. Bailey then moved on to analyze other generalizations, including using matrices over finite fields and implementations that employ monoids instead of groups. She presented her research at the regional MAA meeting in Lexington in April. Bailey graduated with departmental honors in mathematics and is now employed by the federal government.

Haley and Stewart Attend Princeton Crypto Program

UMW math majors **Shannon Haley** and **Bailey Stewart** were both admitted to the 2018 Women and Mathematics summer school at the Institute of Advanced Study at Princeton University. The topic for this intensive week-long program was *The Mathematics of Modern Cryptography*. At IAS Shannon and Bailey attended short courses, seminars, and workshops on the most recent developments in the field of cryptography. The programming was delivered by pioneering women mathematicians and cryptographers, including Kristin Lauter, the research manager for the crypto group at Microsoft. Shannon and Bailey both graduated with honors in May, completing thesis work in non-commutative crypto under Dr. Helmstutler.

Gallery

Check out our website

– cas.umw.edu/math –

view our page devoted to our alumni and, better yet, email Dr. Helmstutler at rhelmstu@umw.edu to get yourself included!

Majors Present at Joint Mathematics Meetings

Three UMW math majors– **Gail Crunkhorn**, **Ekta Kapoor**, and **Shannon Haley**– presented at the 2018 Joint Mathematics Meetings in San Diego in January in the MAA's undergraduate poster session. All three students are alums of the 2017 Jepson Summer Science Institute, their research from the summer program forming the basis for their conference presentations. Gail and Ekta presented their project *Measuring Inter-rater Reliability for Ordinal Data and Multiple Raters*, work done in statistics under the guidance of Dr. Hydorn. Shannon presented her poster *Non-commutative Massey-Omura Encryption with Symmetric Groups*, an extension of her summer research with Dr. Helmstutler who also attended the meeting. The students' travel was funded by the Dean of the College of Arts and Sciences and the Jepson Summer Science program.

Under the guidance of Dr. Julius Esunge, **Creigh Brigman** conducted an investigative project on "The Beauty of Complex Analysis" during the 2018 Summer Science Institute. The project allowed him to highlight differences between real and complex analysis, identify some of the key tools and techniques in the field and show how these simplify otherwise intractable problems from calculus and real analysis. Creigh gave an oral presentation of his work at the closing SSI symposium.

Riley Anderson and **Makenzie Clower** worked under the supervision of Dr. Jeb Collins on implementing and refining a machine learning algorithm to improve performance of a software called Bertini. The Bertini software works to solve polynomial problems and can be very slow when using the default settings. Riley and Makenzie used machine learning techniques to determine the optimal settings for Bertini to optimize the computational efficiency. Riley used neural networks to determine when a polynomial is singular, as different settings are required to solve singular polynomial equations. Makenzie examined the various other settings of Bertini, and used neural networks to determine their optimal values for a particular polynomial. Both of them had to generate sufficiently large datasets for the machine learning algorithms, and then used those data sets to find the best machine learning algorithm for their particular tasks. Makenzie presented a poster at the SSI conference at the end of the summer, and Riley presented a talk. Riley won the best oral presentation out of all SSI speakers. They will be continuing their work during the semester, and presenting at three conferences in the next few months, including the Joint Mathematics Meetings in Baltimore.

Jepson SSI

Emily MacIndoe and **Amy Creel** worked together to solve the Susceptible-Infected-Virus (SIV) model for the Human Immunodeficiency Virus (HIV) infection mathematically and computationally under the direction of Dr. Leo Lee. Emily presented analytical solutions to two simplified versions of the model giving exact results. Her results not only give insight into the roles of birth and death rates in the SIV model, but also contribute to our understanding of HIV dynamics. On the other hand, Amy constructed algorithms using various numerical techniques and created computer codes to approximate solutions of the model. Throughout her numerical experiments, she was able to see how rapidly a patient would progress to Acquired Immune Deficiency Syndrome (AIDS). Her results could be used to determine parameters in the model that were estimated from patient data and develop better treatment options for a given AIDS patient.

Calculus Tournament

The UMW Calculus Tournament returned this year after a one-year absence. This year's tournament was held on April 21st and featured four teams from local high schools. Each team competed in three round robin matches during the morning. In concurrent afternoon matches, Riverbend High School edged Fredericksburg Academy for the overall victory and tournament trophy, while James Monroe High defeated the Commonwealth Governor's

School of Riverbend for third place. The afternoon's activities included an individual challenge test for all participants. Cash prizes were awarded to all of the participating teams, and to the two highest scoring students on the challenge test. All participants received t-shirts and breakfast, provided by the math department, and lunch compliments of the Dean's Office. Many thanks to Professors Lehman and Magee for organizing the tournament, Professors Helmstutler and Perkins for moderating matches, and the student volunteers who helped make the tournament a success.

Math Babies

In just over a year, the department welcomed three baby girls. Pictured, left to right, are Evelyn (2 months), Eleanor (11 months), and Kennedy (15 months). The future mathematicians are the daughters of Professors Helmstutler, Collins, and Magee, respectively. For anyone keeping track, the probability of all three babies being girls is 1 in 8.

Faculty Notes

Yuan-Jen Chiang had two research articles published including "Exponentially Harmonic Maps between Finsler Manifolds" in *Manuscripta Mathematica* by Springer. She also delivered two presentations including one at the International Congress of Mathematicians 2018 in Rio de Janeiro, Brazil in August.

In addition to published articles, **Julius Esunge** presented his work at 52nd actuarial research conference in Atlanta, served as an invited reviewer for the Fulbright Commission, and had a special session approved for the January 2019 Joint Mathematics Meetings in Baltimore, MD.

Jeb Collins submitted a paper, "Mastery-Based Testing in Undergraduate Mathematics Courses" to Problems, Resources and Issues in Mathematics Undergraduate Studies, a journal dedicated to mathematical pedagogy. He also co-organized a paper session at Mathfest on mastery testing techniques and attended a workshop on Applications in Algebraic Geometry at Texas Christian University.

Melody Denhere attended the 2017 Women in Statistics and Data Science conference in La Jolla, CA where she presented her work "Model Adequacy Methods for Functional Regression Models".

Debra Hydorn gave the presentation "Statistics Projects in a PIC Math course" at the Joint Statistics Meetings in Vancouver, Canada. She also had the article "Engaging Students in the Practice of Statistics through Undergraduate Research" published in the Journal of Statistics Education.

Janusz Konieczny co-authored a research article published in the prestigious mathematics journal Proceedings of the Royal Society of Edinburgh, Section A: Mathematics.

Leo Lee was invited to present his work on Domain Decomposition Algorithms for Random PDE Optimization Problems at the US-Korea Conference in Queens, NY, where he served as chair of the Modern Applied Mathematics and Statistics session.

Larry Lehman had his book, *Quadratic Number Theory*, accepted for publication in the Dolciani Mathematical Expositions series of MAA Press. This project developed through several directed studies with UMW students led by Professor Lehman. A preliminary version of the text was used in a topics course in algebraic number theory in the Spring 2017 semester.

Suzanne Sumner led 12 workshops at the STEMLabs Summer Institute and gave two presentations at other grant workshops on Vernier Sensors and Geometric Algebra from History. Dr. Sumner was invited to give the Keynote Presentation "Enhancing Instruction for Virginia's Students: Problem-Based Learning and Design Briefs" at the final grant workshop in June 2018.

Are you a member of our Facebook group? Look up UMW Mathematics and join today!