

Mathematics at UMW

Fall 2011

a newsletter of the Department of Mathematics at the University of Mary Washington

Welcome from the Chair

Dear Friends,

Welcome to all of our returning students and faculty after a long hot summer. I had a very busy one myself between teaching, research, travel and, luckily, a few vacations. I really enjoy the beginning of the academic year. Plans are being made for the department's activities this year and it's sure to be a good one.

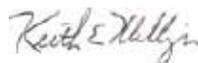
Every year I use this forum to talk about changes at UMW and this year is no exception. Monroe Hall has officially reopened for business, and the convocation center (known as the Anderson Center after our former president Bill Anderson) is also opening this fall. New students will be some of its first visitors as we hold our first honor convocation in the new facility. Most of us have noticed the construction at Eagle Landing during the last year. The mixed-use residential and retail complex now contains several restaurants that have been thriving, no doubt, because of their proximity to campus. The larger complex, known as Eagle Village, is still being planned and we expect to hear more details about the building of a hotel and more retail facilities.

The last academic year was an active one for the department. You can read in this newsletter about

our record six honors students, plus five students involved in summer research. The 400-level courses have been filling so well that additional sections had to be added for this coming academic year. The faculty have been very active in and out of the classroom. Their professional work is ever expanding with book projects, research projects, and conference participation around the world. We are also pleased to welcome Elizabeth Creath, the newest member of the Department of Mathematics. Read more about Ms. Creath in this newsletter.

I hope you enjoy reading about the department's activities this past year. Visitors are always welcome to our departmental events including the colloquia, career night, and Pi Day celebration. Events are regularly updated on the department website and through the open UMW Mathematics group on Facebook. Please consider joining the group if you want to keep up with departmental happenings and, as usual, please do not hesitate to contact me if you believe we can be of service to you.

Sincerely,



Keith E. Mellinger, Chair

Students Winning Awards

Andrew Snyder-Beattie
Best student presentation
Mathfest 2010, Pittsburgh, PA,
August 2010



Ryan Vaughn
Second place for student presentations
Summer Science Research Symposium
at UMW, July 2011



Kevin Doubleday
Best student presentation
MD-DC-VA Meeting of the
Mathematical Association
of America, Randolph-Macon College,
Ashland, VA, April 2011



Welcome Elizabeth Creath



Ms. Elizabeth Creath

This past year has been about transitions for Ms. Elizabeth Creath. After successfully defending her thesis, *Highest-Weight Vectors in the Tensor Products of Representations of the Quantized Universal Enveloping Algebra $Uq(sl_2)$* , and teaching College Algebra at the University of North Carolina Wilmington, she prepared for her

move from Wilmington, NC to Fredericksburg, VA. Yes, indeed, Ms. Creath joins our department this fall as a new full-time instructor. She will be actively involved in the pedagogical development and teaching of our lower-division offerings.

Elizabeth says she is thrilled to join the mathematics faculty at the University of Mary Washington and in her words “looks most forward to engaging students in mathematical thinking as I embrace a new environment of world-class teaching and learning that enables students to make positive changes in the world.” Outside of the office, Elizabeth enjoys creating hand-made projects for her home and listening to live music with friends. Please offer her a warm welcome when you see her around Trinkle Hall. Her office is in the lower suite.

Honors in Mathematics 2010

Kathryn Christian worked on a project titled *Mathematical and Numerical Solutions for a Heat Conduction Model* under the direction of Dr. Leo Lee, an extension of her 2009 SSI project. Mathematically, she found two different forms of the solution to a specific heat conduction problem, one using four subproblems and one using two subproblems. Numerically, she used polynomial basis functions to approximate the solutions. She then ran numerical experiments to test the accuracy of the numerical solution and gave comparisons between the four- and two-subproblems approaches. She presented her work at several regional and national math meetings

including SUMS, MathFest, and the Joint Mathematics Meetings. This fall Kathryn will begin her first year in the master’s of accounting program at William and Mary.

For Kevin Doubleday’s honors project, the Dow Jones Industrial Average was analyzed with a discrete time stochastic model, namely a Markov Chain, under the guidance of Dr. Julius Esunge. Two models were highlighted, one where the DJIA is considered as being in a state of gain or loss, and a separate model where small, moderate, or large gains or losses are examined. A portfolio of five stocks was then considered along with two models of the portfolio much the same as those for the DJIA. These models were used to obtain transitional probabilities and steady state probabilities. The results showed that the steady state distributions for all of the models closely resembled those determined by examining data not included in the model. Kevin presented his results at the regional meeting of the MAA at Randolph-Macon College and was awarded first place for his presentation.

Geoffrey Driskell also worked with Dr. Esunge on his honors thesis. One of the most widely used models in financial mathematics is the Black-Scholes Option Pricing Model. It has been the benchmark against which all other option pricing models have been judged since its introduction nearly forty years ago. The model can be derived in a number of different ways using mathematical techniques of varying sophistication. To gain a better understanding of this model Geoffrey explained and compared two of the most popular and widely used derivations of the model under two completely different mathematical approaches, namely the Dynamic Hedging Strategy and Risk-Neutral Valuation.



Erin Strange’s honors thesis, *Computational Models of the Diffusion Equation*, extended from her 2010 summer research project, was written under the direction of Dr. Leo Lee. In her thesis, she derived and used numerical models to analyze the diffusion of a chemical pollutant in a given region. She designed new numerical algorithms and developed her own computer programs that allowed her to obtain the amount of chemical pollutant for an arbitrary time step. She proved that the solutions of her numerical models are convergent, and then she carried out numerical experiments to check that the solutions of her

numerical models converge to the solution of the original mathematical model equation. Erin gave presentations at the SUMS conference at James Madison University in October 2010 and at the Joint Mathematics Meetings in New Orleans in January 2011. She now works at the Naval Surface Warfare Center at Dahlgren.

Working in the area of graph theory, Kelsie Snyder studied the concept of domination in graphs under the direction of Dr. Keith Mellinger. Determining the so-called *domination number* of graphs can prove highly useful in solving many types of problems, and recent studies of dominating sets reflect this. Kelsie's thesis focused on describing various families of graphs in terms of bounds on the domination number. She presented the results of her work at the spring regional meeting of the MAA at Randolph-Macon College, and her thesis was recently published in *Metamorphosis*, a journal of undergraduate research run by the Council of Public Liberal Arts Colleges.

Geometric Brownian Motion (GBM) has been used to model the behavior of the world's energy markets, but some mathematicians posit that markets for oil are not well-modeled by certain stochastic processes. In Andrew Snyder-Beattie's thesis, advised by Dr. Esunge, he considered the role played in such models by a standard Ornstein-Uhlenbeck process, which suggests that oil prices are mean-reverting. By isolating OPEC quota periods, he determined that this behavior is unlikely OPEC's doing but rather the nature of the commodity market. Andrew is now a graduate student in the applied mathematics program at North Carolina State University in Raleigh.

UMW Calculus Tournament continues to grow

The Fifth Annual UMW High School Calculus Tournament was held April 2, 2011, and this year's



winners of the team competition with Drs. Helmstutler and Mellinger

tournament was the largest one ever. Nearly 40 high school students and teachers from the surrounding region came to Trinkle Hall to compete in the day-long competition, and over 10 UMW math majors helped staff the event. As usual, the matches

were action-packed, with Paul VI Catholic High School from Fairfax taking the championship trophy back to their school. Fredericksburg Christian School placed second in the team competition. In addition to cash, prizes in this year's tournament included software and the new TI-Nspire handheld calculator, all donated by Texas Instruments. This is a UMW math majors event, so keep your eyes open for announcements regarding the next installment of the UMW High School Calculus Tournament.



Dr. Esunge overseeing the individual competition

UMW wins NSF grant

In August, UMW received notification that the National Science Foundation has funded a three-year grant to increase the number of students choosing to major in one of the STEM (Science, Technology, Engineering and Mathematics) disciplines at UMW. Titled "Talent Expansion through Research, Engagement, Preparation and Scholarships," the grant was awarded under NSF's STEM Talent Expansion Program (STEP) and involves faculty in mathematics as well as biology, chemistry, environmental science and education. Dr. Debra Hydorn is one of the authors and co-PIs for the grant and will be working with science faculty to develop a new "lab skills" course for the Summer Transition Program for incoming first-year students. She will also be involved with a new Supplemental Instruction program to provide peer tutoring for Calculus and several science courses. Dr. Suzanne Sumner will be working with Dr. George Meadows (Education) to create science data collection and analysis activities for MATH 111 (PreCalculus) using Vernier probes for the TI-84 calculators. Other grant activities include minority scholarships, undergraduate research opportunities and a Science Outreach Initiative for high school students participating in UMW's James Farmer and Rappahannock Scholars programs. Initially funded for \$262,615, the grant is eligible for two additional years of funding upon a successful third-year review.



Summer Science Institute 2011

In SSI 2011, Rebecca Presor and Kathryn Dillinger worked together on an option pricing model under the direction of Dr. Leo Lee. Becca's project was titled *Mathematical Analysis of Option Pricing*. In her project, she examined the economic phenomenon of option pricing through mathematical means using the Black-Scholes model. She derived the analytical solution to the model based on given input data such as terminal and boundary conditions. She then wrote computer



programs to simulate her analytical solutions. *Profiting with Options Using the Black-Scholes Equation* was the title of Katie's portion of the project. She derived and analyzed numerical models of the Black-Scholes equation using the explicit, implicit, and Crank-Nicolson methods attained through finite difference equations. She also developed her own codes to determine which numerical method was best by comparing her computational results with analytical output from Becca's work. After finding both analytical and numerical solutions, the team gathered data from the real-life examples of the S&P 500 index and its European option chain for the month of June 2011. The data allowed them to compare the accuracy of each solution in a real-life scenario and to analyze the result.



Ryan Vaughn worked with Dr. Helmstutler on a project titled *The Homotopy Theory of Finite Spaces*. Their project attempted to understand how finite topological spaces may be used to define groups, thereby providing a formal link between finite topology and abstract algebra. The idea for the project came from the observation that so far only infinite spaces have been used to form groups in topology: no one had figured out how to use finite spaces for the same purpose. It turns out there is a good reason for this, as Ryan eventually proved that no finite space can give the right kind of algebraic structure in topology. Ryan's talk at the Jepson Summer Science Symposium took the second place award for best presentation. Ryan and Dr. H plan to travel to Boston to present their work at the AMS-MAA Joint Mathematics Meetings in January.



Marianne Dubinsky and Catherine O'Doherty worked on a project with Dr. Esunge focusing on properties and applications of the Laplace Transform in analysis, probability and differential equations. It was interesting to see how the construction and properties of some important functions flow naturally from determining the transforms of certain base functions. The project was presented during the closing symposium of the Jepson Summer Science Institute, and both students presented talks at MathFest in Lexington, KY in August. In January 2012, they will present some of their work at the Joint Mathematics meetings in Boston and both will be completing honors theses in the spring with Dr. Esunge.

Recent Graduate and Alumni News

Our graduates continue to find success in both the job market and graduate schools. Many of our 2011 graduates found employment in area industries. Emily Antos, Erin Strange, and Stacey Aylor all found jobs at the Naval Surface Warfare Center, Dahlgren Division, Kelsie Snyder is doing software engineering for Blazeware (a government contractor) and Nicole Conti landed a job with Lockheed Martin. Amber Blagg is working as a middle school teacher in Roanoke. Others are currently enrolled in graduate programs including Kathryn Christian in the accounting program at William and Mary, Andrew Snyder-Beattie at NC State's Applied Math PhD program, Houston Sanders in the econo-physics program at the University of Houston, and Meghan McLaren is in the applied mathematics program at Wake Forest. As you can see, UMW math grads are everywhere!

Faculty Highlights

The faculty in mathematics have had a very busy year with their professional work. Several faculty have seen their research published in professional journals. **Leo Lee** had two articles published, including "Error Estimates of Stochastic Optimal Neumann Boundary Control Problems" in the prestigious SIAM Journal on Numerical Analysis. **Yuan-Jen Chiang's** article "Transversal Biwave Maps" was published in *Archivum Mathematicum*, and **Keith Mellinger's** article "Spreads, arcs, and multiple wavelength codes," was published in the journal *Discrete Mathematics*. Finally, **Janusz Konieczny** saw five of his articles appear in print this year, including "Minimal paths in the commuting graphs of semigroups" which was published in the *European Journal of Combinatorics*.

International travel was also very popular over the last year with **Debra Hydorn** giving an invited talk at the International Conference on Teaching Statistics in Slovenia, and **Leo Lee** giving a series of six invited lectures on his research at Ajou University in Kyonggi-do, Korea. **Suzanne Sumner** was invited to speak at an international meeting of the American Mathematical Society in Pucon, Chile, and **Janusz Konieczny** gave a talk at the Center of Algebra at the University of Lisbon in Portugal. Finally, **Julius Esunge** spoke at the Southern

African Mathematical Sciences Association Conference in Botswana, and **Yuan-Jen Chiang** presented at the International Congress of Mathematics in Hyderabad, India.

Other domestic travel and presentations were equally popular this year with **Leo Lee** speaking at the GCAT Synthetic Biology Workshop at Davidson College in North Carolina, **Keith Mellinger** giving both a departmental colloquium and a research seminar at California State University in Fresno, CA, and **Debra Hydorn** continuing to feed her interest in inquiry-based teaching methods by attending the Inquiry-Based Statistics Education workshop at Wesleyan University. **Randall Helmstutler** and **Leo Lee** also accompanied students to regional conferences at James Madison University and Randolph-Macon College.

The department continues to engage the region with activities for students and teachers. **Larry Lehman** and **Keith Mellinger** participated in the second year of UMW's Summer Enrichment Program for talented middle and high school students. They team-taught a 2-week intensive course titled *The Mathematics of Secret Communication* and touched on many of the topics in algebra that are used in modern cryptology including modular arithmetic, computational complexity, and elliptic curves. As mentioned earlier, **Randall Helmstutler** oversaw a dramatic increase in participation in our annual high school calculus tournament this year. Other events are planned throughout the year and we encourage your ideas. Keep up with us on the department website and on Facebook.

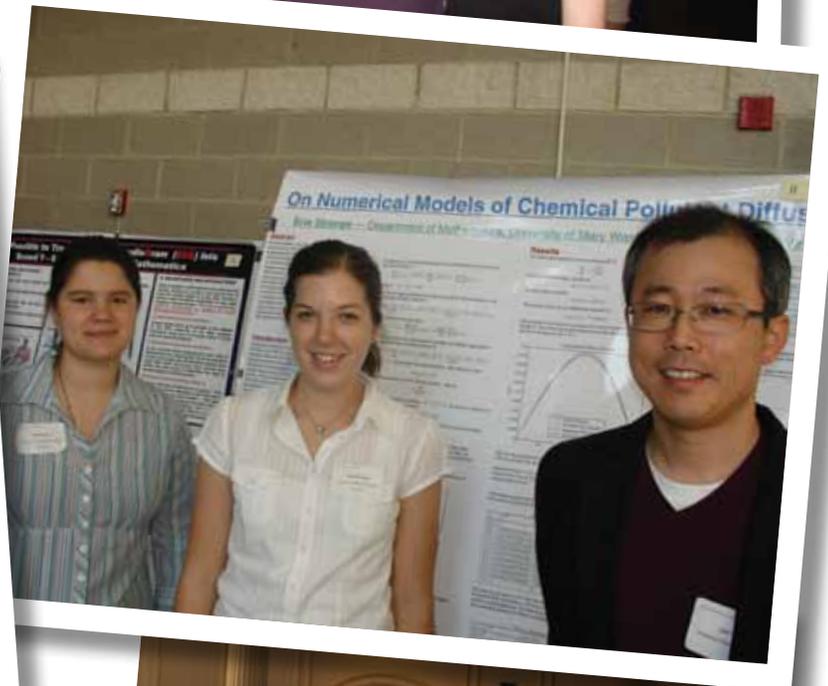
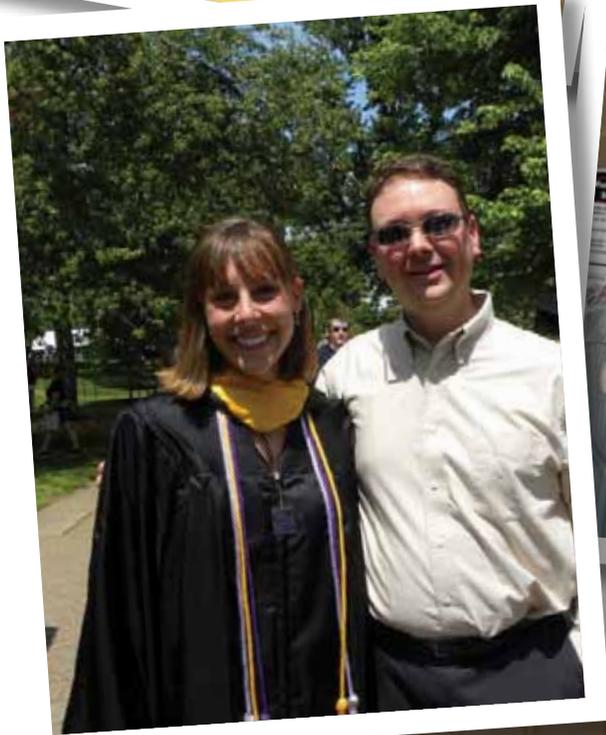
Are you a member of our
Facebook group? Look us up
– UMW Mathematics –
and join today!

Check out our website

– www.umw.edu/cas/math –

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

Gallery







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