



College of Science and Mathematics

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Department of Mathematics

## **Fifth Annual Kennesaw Mountain Undergraduate Mathematics Conference Program and Abstracts**

October 24, 2015

## Welcome

Welcome to the fifth annual Kennesaw Mountain Undergraduate Mathematics Conference!

We are thrilled that this year KMUMC attracted over 160 participants from 27 universities in 8 states!

We hope you will enjoy the talks, activities, food, great weather, and the beautiful Kennesaw State University campus and come back next year!

We would also appreciate any feedback and any suggestions you have. Please fill out the feedback form included in your registration materials or send comments to Dr. Yuliya Babenko (ybabenko@kennesaw.edu).

Sincerely,  
KMUMC Chairpersons  
Yuliya Babenko  
David Glassmeyer  
Ken Keating

## Accessing KSU WiFi Network

1. Select “KSUGuest” from the list of available wireless networks.
2. Enter “kennesaw” as security key.
3. Open a web browser.
4. Login with your email address.
5. You are now connected to the WiFi network.

Note: Guests have limited bandwidth, will only be able to access the Network between 6am and midnight, and are restricted to Internet connectivity through a web browser.

## Location of Talks

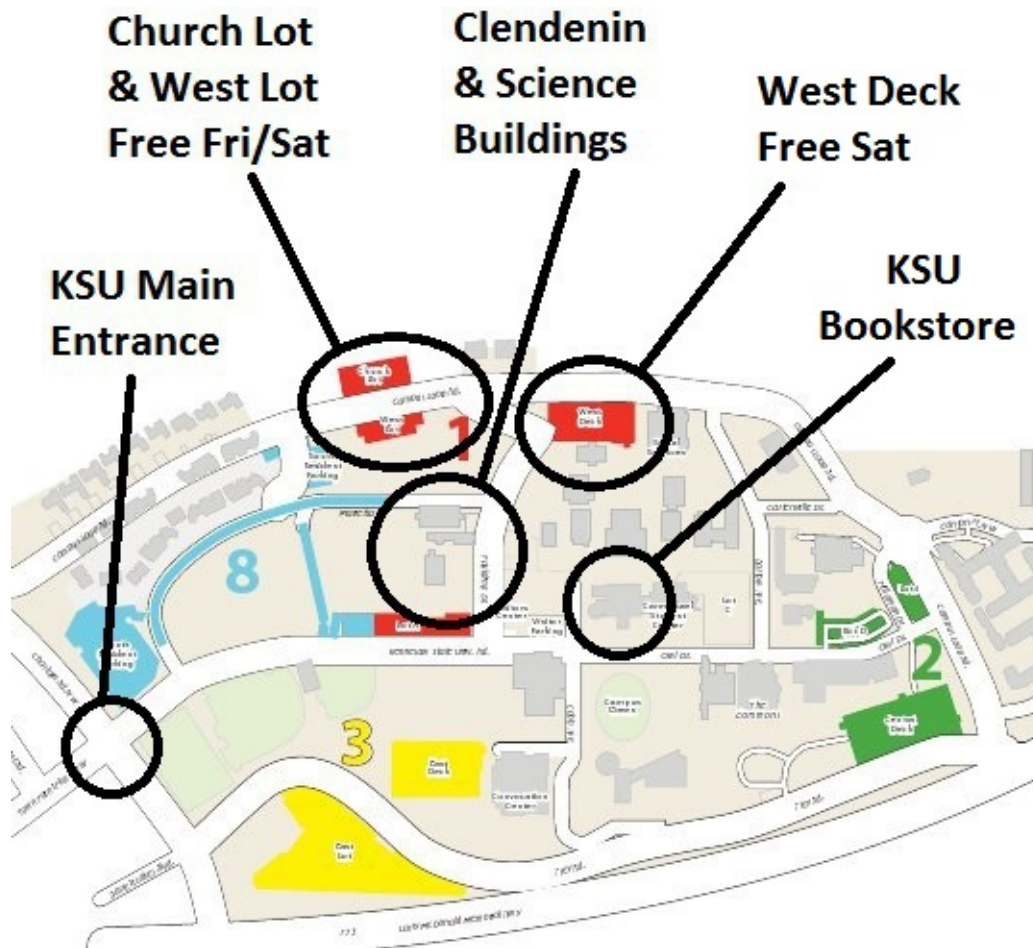
The conference will take place in the Clendenin, Science, and Science Lab Buildings, abbreviated CL, SC, and SL, respectively. See the campus map in your registration packet for directions. Registration and all breaks will be in the Clendenin and Science Lab Building Atriums (CL 1000 and SL 1001).

## KSU Campus Bookstore

The KSU Campus Bookstore is located about 200 yards from the main entrance to the Science building (see parking map on the next page). Its posted hours of operation during the conference are:

- Friday 7:30am – 5:00pm
- Saturday 10:00am – 5:00pm
- Sunday closed

## Campus Parking Map



On Friday, all visitors can park for free in the Church Lot or West Lot Parking (see map above). **The Visitor Parking Lot is not free on Friday.** Saturday parking is free anywhere. We have been asked to use the West Deck, if possible. All these lots are conveniently close to the Science and Clendenin Buildings.

Please take notice, open parking excludes dedicated parking spaces, service vehicle spaces, loading/unloading spaces, handicap spaces, fire lanes, and police spaces.

<b>Friday, October 23, 2015</b>				
2:00–6:00	Early Registration (CL 1000 Atrium)			
2:00–5:00	Math Scavenger Hunt (around campus)			
5:00–7:00	Student Activity Involving Game Creation Using Probability (CL 1009)			
<b>Saturday, October 24, 2015</b>				
8:00–8:30	Registration (CL 1000 Atrium) and Breakfast (SL 1001 Atrium)			
	Contributed Talks			
Moderators:	<b>Contrib Sess 1</b> (CL 1008) Vandenbussche	<b>Contrib Sess 2</b> (CL 1010) Ellermeyer	<b>Contrib Sess 3</b> (CL 1005) DeMaio	<b>Faculty Seminars</b> (CL 1007) Ritter
8:30–8:45	<b>J. Asplund</b> <i>Thoughtful seating arrangements</i>	<b>N. Bacha</b> <i>Optimal Recovery of Solutions to a Dirichlet Problem for Laplace and Poisson Equations Based on incomplete Information</i>	<b>J. Ashford</b> <i>Does Computer Programming Improve Instruction?</i>	<b>Buddie, Callahan</b> (8:30–8:55) <i>Myths About Undergraduate Research</i>
8:50–9:05	<b>C. Defant</b> <i>Unitary Cayley Graphs</i>	<b>Buie-Collard, York</b> <i>Application of Fourier transforms to corridor paths</i>	<b>K. Payton</b> <i>Student and Teacher Generalization over Direct Variation</i>	<b>A. Johnson</b> (9:00–9:25) <i>Using exam wrappers to increase student performance</i>
9:10–9:25	<b>D. Nguyen</b> <i>A Variant of Nim on Graphs</i>	<b>J. Walters</b> <i>Cheaters: Gotta Catch 'Em All</i>	<b>A. Shipley</b> <i>The Effectiveness of Supplemental Instruction in Introductory College Mathematics Courses</i>	
9:30–9:45	<b>J. Carr</b> <i>Amalgamation, Latin Squares, and Hamiltonian Decompositions</i>	<b>A. McGee</b> <i>The Spread Process of Reinvading Otters</i>	<b>S. Glover</b> <i>An Examination of Definitions Found in Textbooks on Mathematics for Elementary School Teachers</i>	<b>H. Truelove</b> (9:30–9:45) <i>A Qualitative Study of the Mathematical Practices of Pre-Service Mathematics Teachers</i>
9:50–10:00	Coffee Break (SL 1001 Atrium)			
10:00–11:00	Plenary Lecture 1: <b>Ken Ono</b> (SC 109) <i>Ramanujan's legacy in mathematics and film</i>			
11:15–12:15	Career Panel (SC 109) <b>Jerry Baskin</b> (Baskin McGill Tennis Academy) <b>Raj Bondugula</b> (Equifax) <b>Tom Freeman</b> (GE) <b>John Jacobson</b> (Moxie) <b>Julie Kokan</b> (Pope High School)			
12:15–1:00	Lunch (SL 1001 Atrium)			
1:00–2:00	Plenary Lecture 2: <b>Martin Short</b> (SC 109) <i>Applying Mathematics to Combat Crime</i>			
2:00–2:10	Conference Photo			
2:15–3:15	Poster Session (CL 1000 Atrium) <b>E. Bagby</b> <i>Mathematical Billiards in Triangles</i> <b>R. Brown, T. Brown</b> <i>Modeling Historic Outbreaks of the Bubonic Plague</i> <b>C. Defant</b> <i>Characterizing the Dynamics of Certain Sequential Dynamical Systems</i> <b>J. Michelis</b> <i>On Matching Extendability in Grid Graphs</i> <b>C. Mohanakumar</b> <i>Math. Model for Time to Neuronal Apoptosis due to Accrual of DNA DSBs</i> <b>M. Mulholland, P. Rouse</b> <i>Modeling the Dengue Virus</i> <b>P. Tunnell Wilson</b> <i>The Existence of Infinite Anti-Chains on Multi-Graphs</i>			
3:15–3:30	Coffee Break (SL 1001 Atrium)			

Contributed Talks				
	<b>Contrib Sess 4</b> (CL 1008) Westlund	<b>Contrib Sess 5</b> (CL 1010) Adhikari		<b>Faculty Seminars</b> (CL 1007) Wang
Moderators:	<b>E. McCrina</b> <i>The Lights Out Game Over <math>\mathbb{Z}_7</math></i>	<b>K. Doroudi</b> <i>Quantum Error Correction Codes</i>		<b>L. Uko</b> (3:30–3:55) <i>Normal Magic Squares</i>
3:30–3:45	<b>G. Cazacu</b>  <i>About the magic of combinatorics</i>	<b>P. Davis, W. Selman</b> <i>Circling the Triangle: Constructing an Infinite Family of Delta Curves</i>		<hr/> <b>J. Mayer and P. Hartley, R. Mann</b> (4:00–4:25) <i>Modern Algebra: Why Rings First? and Modern Algebra: The Experience</i>
3:50–4:05	<b>S. Roshan Zamir</b> <i>Magic Cubes and Euler Cubes</i>	<b>D. Kotval</b> <i>Optimal Design in Accordance with the Spectrum of a Sturm-Liouville Problem</i>		
4:10–4:25	<b>M. Harbol</b> <i>Augmented Happy Functions of Higher Powers</i>	<b>C. Robalino</b> <i>Platelet counts and their effect on patient outcomes with patent ductus arteriosus (PDA)</i>		<b>S. Molitoris Miller</b> (4:30–4:55) <i>Using Concept Maps as a Tool for Lesson Development in Mathematics</i>
4:30–4:45	<b>J. Boone</b> <i>The Projective Order of a <math>2 \times 2</math> Matrix</i>	<b>J. Ding</b> <i>Commuting Solutions of the Yang-Baxter-like Matrix Equation for a Class of Matrices</i>		
4:50–5:05				
5:10–5:30	Concluding Remarks and Awards Ceremony (SC 109)			

## Biographies of Invited Speakers

**Ken Ono:** Ken Ono received his Ph.D from UCLA in 1993 under the guidance of Basil Gordon. Upon graduation, he held positions at the University of Georgia, the University of Illinois (Urbana-Champaign), the Institute of Advanced Studies, and Penn State University, where he was named the Louis P. Martarano Professor in 1999. He is presently the Asa Griggs Candler Professor of Mathematics at Emory University. Before he moved to Emory in 2010, he was the Manasse Professor of Letters and Science and the Hilldale Professor of Mathematics at the University of Wisconsin at Madison.

He has authored over 150 research papers, as well as the CBMS monograph entitled *The Web of Modularity*. His work includes ground-breaking results on partition congruences, coefficients of modular forms, traces of singular moduli, Borcherds products, mock-theta functions, and much more. He has advised 16 doctoral students to date and sits on the editorial boards of eleven journals. He has received numerous awards and honors, including a Sloan Fellowship, a Presidential Early Career Award, a Packard Fellowship, and a Guggenheim Fellowship.

In addition to his research accomplishments, Ono is also a master lecturer and teacher as evidenced by his receipt of the 2005 National Science Foundation Director's Distinguished Teaching Scholar Award and the 2007 Favorite Instructor Award from the University of Wisconsin Residence Halls.

**Martin Short:** Dr. Short received his B.S. in Engineering-Physics from the University of Arizona in 2001. He enjoyed his time at U of A so much that he remained there for his graduate education, receiving his Ph.D. in Physics in 2006 under the advisement of Prof. Raymond Goldstein. He then relocated to Los Angeles, where he worked as a CAM postdoctoral scholar in the UCLA department of Mathematics from 2007-2013, under the advisement of Prof. Andrea Bertozzi. It was during this time that he began his research on mathematics and human behavior, with emphasis on crime, that he continues to this day. In 2013, he joined the faculty in the School of Mathematics at Georgia Tech as Assistant Professor.

## Career Panelists

1. **Jerry Baskin**  
Director  
Baskin McGill Tennis Academy
2. **Raj Bondugula**  
Senior Data Scientist  
Equifax
3. **Tom Freeman**  
Sales Director – Engineered Solutions – North America  
GE
4. **John Jacobson**  
Senior Analyst  
Moxie
5. **Julie Kokan**  
Teacher – Department of Mathematics  
Pope High School

## Plenary Talks

1. TITLE: *Ramanujan's legacy in mathematics and film*

SPEAKER: **Ken Ono**

INSTITUTION: Emory University

EMAIL: [ono@mathcs.emory.edu](mailto:ono@mathcs.emory.edu)

ABSTRACT: Srinivasa Ramanujan is one of the most enigmatic figures in the history of mathematics. He was a self-trained amateur mathematician whose ideas befuddled the accumulated wisdom of western European mathematicians in the early 20th century. His legacy has played a central role in the development of many of the deepest subjects in arithmetic geometry and number theory. Ramanujan tragically died at the early age of 32. Ramanujan's story will be retold as a major Hollywood movie in 2015 with Dev Patel (of *Slumdog Millionaire* fame) playing Ramanujan and Jeremy Irons playing G. H. Hardy, Ramanujan's mentor. The speaker spent much of this past summer working on the film in a variety of roles in preproduction and on-location filming. The speaker will discuss the mathematical legacy of Ramanujan and he will also tell stories about the filming of *The Man Who Knew Infinity*.

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2. TITLE: *Applying Mathematics to Combat Crime*

SPEAKER: **Martin Short**

INSTITUTION: Georgia Institute of Technology

EMAIL: [mbshort@math.gatech.edu](mailto:mbshort@math.gatech.edu)

ABSTRACT: Mathematics is a powerful tool, and has been used to solve problems for quite some time in the physical sciences and, more recently, the biological sciences. But what about problems in the social sciences? In this talk, we will explore how math is beginning to be used to tackle a particularly vexing social problem: crime. We will discuss a number of examples of how mathematics is helping to predict, solve, and understand the nature of crime, including: understanding the nature of crime "hotspots" and using this to predict future crime; using models of human behavior to solve gang-related crimes and locate the "anchor points" of serial offenders; and yielding clues as to the dynamical processes underlying overall crime rates in a society. Importantly, this area of research is one in which undergraduates can, and have, made large contributions, several of which will be highlighted in the talk.

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## Contributed Talks & Posters

1. TITLE: *Does Computer Programming Improve Instruction?*

SPEAKER: **Joy Ashford**

INSTITUTION: University of North Alabama

EMAIL: [eashford@una.edu](mailto:eashford@una.edu)

ABSTRACT: Middle and High School Mathematics teachers often have difficulty teaching abstraction and generalization. We think adding computer programming helps develop abstraction and generalization skills. This study explores whether the addition of computer programming exercises increases the ability to abstract and generalize mathematical concepts. We compared an experimental group that included computer programming in their instruction with a control group that received identical instruction without programming. In this small case study, we will show results from pre- and post-tests scores and in depth interviews with the teachers.

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2. TITLE: *Thoughtful seating arrangements*

SPEAKER: **John Asplund**

INSTITUTION: Dalton State College

EMAIL: [jasplund@daltonstate.edu](mailto:jasplund@daltonstate.edu)

ABSTRACT: How do you ensure that you can pair up an entire class room of students day after day without repeating partners? Is it possible to seat 9 students at 3 round tables each with 3 chairs for 4 days so that each student sits next to every other person exactly once? These questions and more will be answered! Two areas of mathematics will help us delve into these problems. Graph theory will help give a more visual representation of the problems while design theory will help solve these problems using structures such as balanced incomplete block designs.

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3. TITLE: *Optimal Recovery of Solutions to the Dirichlet Problem for Laplace and Poisson Equations Based on Incomplete Information*  
SPEAKER: **Najia Bacha**  
INSTITUTION: Kennesaw State University  
EMAIL: [Nouga982010@hotmail.com](mailto:Nouga982010@hotmail.com)  
ABSTRACT: A Laplace equation is a partial differential equation of the second order, which has a different use in mathematical physics (electrostatics, mechanics, thermodynamics, etc.). Frequently, a boundary condition is also added (Dirichlet's problem). The solution to this problem is well known in the case when the boundary function is fully known. Our goal in this study is to develop an optimal method of recovery of the solution based on information we have on hand about the function  $f$  (when this information is not complete; for example,  $f$  is known at  $N$  points) and to compute the optimal error between the actual solution and the recovered one. We also consider a similar question for Poisson's equation.
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4. TITLE: *Mathematical Billiards in Triangles* (poster)  
SPEAKER: **Elliot Daniel Bagby**  
INSTITUTION: Dalton State College  
EMAIL: [ebagby@daltonstate.edu](mailto:ebagby@daltonstate.edu)  
ABSTRACT: Given a point mass moving inside a triangle with a given initial position and direction, a closed path is one for which the point travels back to where it began, traveling in the initial direction that it started in. We study the number of bounces involved in various closed paths.
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5. TITLE: *The Projective Order of a  $2 \times 2$  Matrix*  
SPEAKER: **Joshua Boone**  
INSTITUTION: Lincoln Memorial University  
EMAIL: [josh.boone@lmunet.edu](mailto:josh.boone@lmunet.edu)  
ABSTRACT: The  $n$ -th power of a square matrix  $M$ , written  $M^n$ , can be found without explicitly multiplying  $n$  copies of  $M$  together. We will show two interpretations and formulas for  $M^n$  when  $M$  has integer entries. We then say that  $M$  has *projective order*  $n$  if  $M^n$  is a scalar multiple of the identity matrix  $I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ . We discuss for which values of  $n$  this is possible. Examples will be given throughout. This presentation is accessible to undergraduate mathematics majors, as well as mathematically-inclined non-majors.
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6. TITLE: *Modeling Historic Outbreaks of the Bubonic Plague* (poster)  
SPEAKER: **Ryan Brown** and **Talon Brown**  
INSTITUTION: Francis Marion University  
EMAIL: [rbrown7666@g.fmarion.edu](mailto:rbrown7666@g.fmarion.edu), [tbrown0358@g.fmarion.edu](mailto:tbrown0358@g.fmarion.edu)  
ABSTRACT: Throughout history, the bubonic plague has periodically ravaged many areas in Europe and Asia. This project focuses on modeling localized historic outbreaks of the bubonic plague using a basic susceptible, infected, recovered (SIR) model. The SIR model is widely used within the field of epidemiology and, with proper parameterization, allows for modeling specific events. This presentation will discuss the implementation of the model and the attained results as well as limitations and challenges in proper parameterization.
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7. TITLE: *Myths About Undergraduate Research*  
SPEAKER: **Amy Buddie** and **Kadian Callahan**  
INSTITUTION: Kennesaw State University  
EMAIL: [abuddie@kennesaw.edu](mailto:abuddie@kennesaw.edu), [kmcallahan@kennesaw.edu](mailto:kmcallahan@kennesaw.edu)  
ABSTRACT: Many faculty members think that supervising undergraduate research is a poor use of their time for several reasons, including (a) the lack of quality research that is produced by undergraduates, (b) the lack of publications resulting from undergraduate research, (c) the lack of funding for undergraduate research, and (d) the amount of time it takes to train undergraduates, who often graduate before the project is finished. Come join us for a conversation regarding common misconceptions about undergraduate research as well as strategies to address such misconceptions.
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8. TITLE: *Application of Fourier transforms to corridor paths*  
SPEAKER: **Geoffrey Buie-Collard** and **Taylor York**  
INSTITUTION: Valdosta State University



EMAIL: [gbbuiecollard@valdosta.edu](mailto:gbbuiecollard@valdosta.edu), [tyork@valdosta.edu](mailto:tyork@valdosta.edu)

ABSTRACT: In this presentation we explore the properties and formulas associated with a particular type of restricted lattice path. Following a brief introduction of corridor paths and their associated random walks, we will show how discrete Fourier transforms can be applied to describe each state vector, step-by-step along the progression of the corridor paths, using a structure called the dual corridor. Furthermore, we will introduce a new technique of using Fourier transforms together with an eigenvector decomposition of the state vector in analyzing a highly symmetric corridor problem.

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9. TITLE: *Amalgamation, Latin Squares, and Hamiltonian Decompositions*

SPEAKER: **John Carr**

INSTITUTION: University of North Alabama

EMAIL: [jacarr1@una.edu](mailto:jacarr1@una.edu)

ABSTRACT: Amalgamation in Latin squares (i.e., completing a partially filled Latin square) has been studied since the 1950s. It has been exploited in fields such as cryptography and physics. Recently, the concept of Graph Amalgamation has been introduced, considering the reconstruction of a complete graph missing certain edges. The amalgamation process can be used to study properties of the original structure in a simpler context, without losing any data. More general applications include network flow, Hamiltonian decompositions, and certain cryptography systems. We show the relationship between Hamiltonian decompositions and corresponding Latin squares, and show a necessary condition for such a correspondence. Currently, we are working to use the well-known results in Latin squares to provide insight into the newly discovered graph theory setting.

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10. TITLE: *About the magic of combinatorics*

SPEAKER: **George Cazacu**

INSTITUTION: Georgia College & State University

EMAIL: [george.cazacu@gcsu.edu](mailto:george.cazacu@gcsu.edu)

ABSTRACT: Important concepts in combinatorics can be described in a fun way, for example using magic tricks. This talk is an attempt at making the teaching and learning of combinatorics more interesting by considering mathematical explanations of magic tricks.

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11. TITLE: *Circling the Triangle: Constructing an Infinite Family of Delta Curves*

SPEAKER: **Philip Davis** and **William Selman**

INSTITUTION: Kennesaw State University

EMAIL: [pdavis82@students.kennesaw.edu](mailto:pdavis82@students.kennesaw.edu), [wselman1@kennesaw.edu](mailto:wselman1@kennesaw.edu)

ABSTRACT: A delta curve is a curve that can rotate inside of an equilateral triangle while constantly making contact with all three sides. Two examples of such a curve are a circle and the far more interesting delta-biangle. It is known that the Minkowski sum of any two delta curves is a delta curve. We present a straight edge and compass construction of an infinite family of delta curves obtained by adding the circle and the delta-biangle.

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12. TITLE: *Unitary Cayley Graphs*

SPEAKER: **Colin Defant**

INSTITUTION: University of Florida

EMAIL: [cdefant@ufl.edu](mailto:cdefant@ufl.edu)

ABSTRACT: If  $X$  is a commutative ring with unity, then the *unitary Cayley graph* of  $X$ , denoted  $G_X$ , is defined to be the graph whose vertex set is  $X$  and whose edge set is  $\{\{a, b\} : a - b \in U(X)\}$ , where  $U(X)$  denotes the group of units of  $X$ . When  $R$  is a Dedekind domain and  $I$  is an ideal of  $R$  such that  $R/I$  is finite and nontrivial, we refer to  $G_{R/I}$  as a *generalized totient graph*. After generalizing to Dedekind domains the arithmetic functions known as Schemmel totient functions, we provide a simple formula, for any positive integer  $m$ , for the number of cliques of order  $m$  in a generalized totient graph. We then proceed to determine many new graph parameters of generalized totient graphs. Finally, we mention two erroneous claims that have appeared in the literature; the second such claim leads to a fascinating number-theoretic open problem.

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13. TITLE: *Characterizing the Dynamics of Certain Sequential Dynamical Systems* (poster)

SPEAKER: **Colin Defant**

INSTITUTION: University of Florida

EMAIL: [cdefant@ufl.edu](mailto:cdefant@ufl.edu)

ABSTRACT: A sequential dynamical system (SDS) is a dynamical system defined over a graph in which vertices update sequentially. We present enumeration results concerning periodic points of certain SDS. First, we consider an SDS defined over  $C_n$ , the cycle graph on  $n$  vertices, using an identity update order and using either the update rule  $\text{parity}_3$  or the update rule  $(1 + \text{parity})_3$ . Let  $\alpha_n(r)$  denote the number of periodic points of period  $r$  of the SDS defined using  $\text{parity}_3$ . Similarly, let  $\delta_n(r)$  denote the number of periodic points of period  $r$  of the SDS defined using  $(1 + \text{parity})_3$ . We give explicit formulas, derived using a method reliant on topological conjugacy and on Möbius inversion, for  $\alpha_n(r)$  and  $\delta_n(r)$ . As a surprising consequence of these formulas, we find that if we fix  $r$  and vary  $n$ , then there are only two possible nonzero values of  $\alpha_n(r)$  and only one possible nonzero value of  $\delta_n(r)$ .

For our second enumeration problem, we let  $\eta_n$  denote the maximum number of period-2 orbits that can exist for an SDS defined over a complete graph in which all vertices update via the same rule. We show that  $\eta_n$  is equal to the maximum number of codewords in a binary code of length  $n - 1$  with minimum distance at least 3.

14. TITLE: *Commuting Solutions of the Yang-Baxter-like Matrix Equation for a Class of Matrices*

SPEAKER: **Jiu Ding**

INSTITUTION: University of Southern Mississippi

EMAIL: [Jiu.Ding@usm.edu](mailto:Jiu.Ding@usm.edu)

ABSTRACT: The quadratic matrix equation  $AXA = XAX$  is called the Yang-Baxter-like matrix equation. We find all the commuting solutions of the equations when  $A$  is diagonalizable.

15. TITLE: *Quantum Error Correction Codes*

SPEAKER: **Kaveh Doroudi**

INSTITUTION: Dalton State College

EMAIL: [kdoroudi@daltonstate.edu](mailto:kdoroudi@daltonstate.edu)

ABSTRACT: Coding theory is an area of mathematics that started out as an application. In Bell Labs, Richard Hamming first came up with the Hamming code to keep his punch cards from being misread. Quantum computers are a recently developed class of computational devices that perform calculations by taking advantage of quantum mechanical principles.

16. TITLE: *An Examination of Definitions Found in Textbooks on Mathematics for Elementary School Teachers*

SPEAKER: **Sheila Glover**

INSTITUTION: Kennesaw State University

EMAIL: [sglove20@students.kennesaw.edu](mailto:sglove20@students.kennesaw.edu)

ABSTRACT: Definitions are a critical component of almost every area of mathematics. Developing and applying mathematical definitions provide suitable contexts for elementary and middle school students to engage in informal deductive reasoning. It is important for pre-service teacher education programs to support the development of deeper understanding of this important mathematical construct. In this study we explore the kinds of definitions of various shape types presented in textbooks used to teach elementary mathematics content courses for pre-service teachers. We compare how these textbooks present the concept of definition in light of the recommendations put forth in the geometry installments of NCTM's "Essential Understandings" series.

17. TITLE: *Augmented Happy Functions of Higher Powers*

SPEAKER: **Marcus Harbol**

INSTITUTION: The Citadel

EMAIL: [mharbol@citadel.edu](mailto:mharbol@citadel.edu)

ABSTRACT: The presentation investigates Augmented Happy Functions of Higher Powers, defined as

$$T_{[c,q]} \left( \sum_{i=0}^n a_i 10^i \right) = \sum_{i=0}^n a_i^q + c, \quad 0 \leq a_i \leq 9 \text{ with } c, q \in \mathbb{Z}^+.$$

This function takes the digits of a positive integer, raises each digit to the power  $q$ , sums the results, and adds a constant,  $c$ , to the sum. In particular, the iterative properties of this function are investigated for a range of values of  $c$  and  $q$ .

18. TITLE: *Modern Algebra: The Experience*

SPEAKER: **Patrick Hartley** and **Robert Mann**

INSTITUTION: University of Alabama at Birmingham

EMAIL: hartlepb@gmail.com, robertmann1990@gmail.com

ABSTRACT: Beginning in Spring Semester 2013, UAB revised the course MA435 – Algebra II (Modern) to be an inquiry-based course. This talk will be related to the experience of both the teaching assistant and a student from the course in Spring 2014.

From the point of view of the teaching assistant (Mann), this talk will address the observed divergence of different approaches to the course by students in the course. In inquiry-based courses, students seem to split themselves into groups naturally during the timeline of the course. While this is true in most courses, in inquiry-based courses this splitting seems to occur not based on prior friendships, like in many other courses, but rather based on motivations. The most interesting aspect of this divergence occurs among students who are primarily concerned with their grade versus students who are primarily concerned with their learning of the material. Very often students primarily concerned with learning the material are noticeably more successful in the course than students who are primarily concerned with their grade.

From the point of view of the student (Hartley), this talk will address the order in which the information is taught and how that relates to helping students for whom this course is the one of the first in which they are tasked with writing and presenting proofs. In the past this class has been taught by introducing students to groups first. Recently the class has been changed to introduce students to rings first and then work up to groups. From the perspective of a student, starting with rings helps to build up an understanding from a more concrete standpoint to more abstract ideas. Starting with rings also works towards easing students into writing and presenting proofs by providing them with a concrete starting point and working up to more abstract proofs.

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19. TITLE: *Using exam wrappers to increase student performance*

SPEAKER: **Ashley Johnson**

INSTITUTION: University of North Alabama

EMAIL: ajohnson18@una.edu

ABSTRACT: An exam wrapper is a short assignment given to students with their graded exam to help them reflect on their performance and preparation. In this talk we'll go over a few different examples of exam wrappers, as well as samples of student exam wrappers from a calculus course and a developmental course. Time permitting, we'll follow that with a discussion of other questions that could be included, and how to make it even more useful for student success.

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20. TITLE: *Optimal Design in Accordance with the Spectrum of a Sturm-Liouville Problem*

SPEAKER: **David Kotval**

INSTITUTION: University Of Tennessee at Chattanooga

EMAIL: sxg378@mocs.utc.edu

ABSTRACT: Optimal forms are of great importance to many applications in physics and engineering. In this talk, we use the methods of the calculus of variations to investigate the Sturm-Liouville problem with generalized boundary conditions that contain the spectral parameter. We may interpret the results as finding the optimal form, with respect to cross sectional area, of a string (a long elastic cylinder) of a given first eigenfrequency such that its mass is minimal. We then use the duality principle to show that the string of the same optimal form most efficiently resists destructive mechanical resonance, i.e., the first eigenvalue of the Sturm-Liouville problem is maximal.

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21. TITLE: *Modern Algebra: Why Rings First?*

SPEAKER: **John Mayer**

INSTITUTION: University of Alabama at Birmingham

EMAIL: jcmayer@uab.edu

ABSTRACT: Beginning in Spring Semester 2013, we initiated a process of changing how two of the UAB upper-level undergraduate mathematics courses were taught: MA 472 – Geometry I (Euclidean) and MA 435 – Algebra II (Modern). This was partly in response to the report, *The Mathematical Education of Teachers, II* (released 2012 by CBMS) which called for at least three upper-level courses in the mathematics major particularly geared toward what prospective secondary teachers needed to know about school mathematics at a deeper level. One fundamental change we made in Spring 2013 was to alter the pedagogy from lecture to inquiry-based learning (IBL). We already had (for 30+ years) a two semester IBL course in analysis: MA 440-441 – Advanced Calculus. Moreover, we believed that what is good pedagogy for future teachers is likely good pedagogy for all students.

A second fundamental concern was to rethink the content of the courses themselves. This talk is about the change we made in the content of the Modern Algebra course in Spring 2014. Most undergraduate courses in Modern Algebra (Abstract Algebra) begin with a formal study of groups, and then extend to rings and fields. The vast majority of popular textbooks (with a couple of notable exceptions: Hungerford, Anderson and Feil) follow the same pattern. In the Notes I wrote for the course, which were delivered to the students one chapter at a time, rings were developed before groups, principally for two reasons: (1) students are familiar with the integers and with polynomials, and this provides concrete examples from which to abstract, and (2) the METII recommendation that “prospective teachers need mathematics courses that develop a solid understanding of the mathematics they will teach” strongly suggests that the rings of integers and of polynomials should receive emphasis.

In a subsequent presentation, Patrick Hartley and Robert Mann will talk about their experience in the course from the perspective of a student and the teaching assistant, respectively.

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22. TITLE: *The Lights Out Game Over  $\mathbb{Z}_7$*

SPEAKER: **Elizabeth McCrina**

INSTITUTION: University of West Georgia

EMAIL: [etoluba1@my.westga.edu](mailto:etoluba1@my.westga.edu)

ABSTRACT: In this presentation, we examine a version of the *Lights Out Game* over the field  $\mathbb{Z}_7$ . Specifically, we study the game over graphs including: a path on three vertices, a complete graph on  $n$  vertices, and a complete graph on four vertices with one edge removed. We determine a method for solving these instances and their respective solutions.

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23. TITLE: *The Spread Process of Reinvading Otters*

SPEAKER: **Audrey McGee**

INSTITUTION: University of North Alabama

EMAIL: [amcgee@una.edu](mailto:amcgee@una.edu)

ABSTRACT: Sea otters are considered keystone species in the kelp forest community and strongly affect the diversity of other species. However, sea otters were almost extinct in the early 1900s until a small population was discovered in California. This population has grown spatially across the west coast. In this project, I will plot the distance spread versus time in northward and southward directions then plot the total range radius versus time. Then I will derive a mathematical model for the spread process. Other questions that will be discussed are why the spread may be different in north and south directions and if the life history of sea otters explains these differences.

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24. TITLE: *On Matching Extendability in Grid Graphs* (poster)

SPEAKER: **Jacob Michelis**

INSTITUTION: Kennesaw State University

EMAIL: [jmicheli@students.kennesaw.edu](mailto:jmicheli@students.kennesaw.edu)

ABSTRACT: In a bipartite graph  $G$  a subset  $V(G)$  is deficient if the size of the neighborhood of  $V(G)$  is less than the size of  $V(G)$ . The idea of a  $k$ -suitable matching was introduced by Dr. Vandenbussche and Dr. West in their paper “Matching Extendability in Hypercubes.” A matching with vertex set  $U$  is  $k$ -suitable if  $G - U$  has no deficient subset of size less than  $k$ . We find that any matching of size  $L$  in the grid graph extends to a perfect matching if and only if  $N$  is  $(L - 1)^2 + 1$ -suitable.

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25. TITLE: *Mathematical Model for Time to Neuronal Apoptosis due to Accrual of DNA DSBs* (poster)

SPEAKER: **Chindu Mohanakumar**

INSTITUTION: University of Florida

EMAIL: [cmohanakumar@ufl.edu](mailto:cmohanakumar@ufl.edu)

ABSTRACT: We propose a mechanism to explain neuronal aging by tracking the number of nontransient DNA doublestrand breaks (DSBs) and repairs over time that may lead to apoptosis. Neuronal apoptosis depends on the amount of space between DSBs as well as time. We derive three models to track the effect of neurodegeneration: a system of autonomous Ordinary Differential Equations (ODEs), a probability model to track the spatial requirement, and a stochastic model that incorporates both the ODE temporal dynamics and a spatial probability model. Using these models, we estimate a distribution for the lifespan of a neuron and explore the effect of parameters on time to death. We identify three possible causes of premature neuronal apoptosis: problems with

coding critical repair proteins, issues with the neuron detecting DSBs, and issues with the neuron responding to DSBs.

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26. TITLE: *Using Concept Maps as a Tool for Lesson Development in Mathematics*  
SPEAKER: **Susanna Molitoris Miller**  
INSTITUTION: Kennesaw State University  
EMAIL: [smolitor@kennesaw.edu](mailto:smolitor@kennesaw.edu)  
ABSTRACT: Concept maps are a form of information organization and visualization. This interactive presentation will address how creating your own map of a mathematical topic can help generate detailed learning goals which support students' progression from a novice understanding toward more complete mastery.
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27. TITLE: *Modeling the Dengue Virus* (poster)  
SPEAKER: **Mary Mulholland** and **Phillip Rouse**  
INSTITUTION: Francis Marion University  
EMAIL: [mmulholland5557@g.fmarion.edu](mailto:mmulholland5557@g.fmarion.edu), [prouse5371@gmail.com](mailto:prouse5371@gmail.com)  
ABSTRACT: This research focuses on modeling the dengue virus, a dangerous but still mysterious disease. The SIR model is used to mathematically describe the interactions between susceptible humans and mosquitoes along with their infected and recovered counterparts. Euler's method is implemented to simulate the spread of the dengue virus in both human and mosquito populations. Model results for human populations are compared with data from recorded outbreaks of the dengue virus.
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28. TITLE: *A Variant of Nim on Graphs*  
SPEAKER: **Dang Nguyen**  
INSTITUTION: Rhodes College  
EMAIL: [ngudh-15@rhodes.edu](mailto:ngudh-15@rhodes.edu)  
ABSTRACT: A game of nim is an impartial combinatorial game in which players remove objects from  $n$  distinct heaps. We expand a regular game of nim onto graphs by playing a variation of nim on paths, cycles, caterpillar graphs, dumbbell graphs, and the Petersen graph. By using the Sprague-Grundy theorem and Bouton's Theorem, we explore the winning strategy for the variations of nim played on graphs.
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29. TITLE: *Student and Teacher Generalization over Direct Variation*  
SPEAKER: **Katelyn Payton**  
INSTITUTION: University of North Alabama  
EMAIL: [kpayton1@una.edu](mailto:kpayton1@una.edu)  
ABSTRACT: In this research study we will compare student's and teacher's ability to think abstractly and form generalizations over the mathematical concepts of direct variation. Teachers and students participated in professional development sessions using computer programming to induce participants to build the mental frameworks for abstraction and generalization. The level of abstraction was measured using the APOS theory of learning as a tool to characterize the abilities of students and teachers before and after instruction. This study pursues four hypotheses. Hypothesis one is high school teachers will start at a higher level of abstraction than middle/elementary school teachers. Hypothesis two is high school teachers will obtain higher levels of abstraction than middle/elementary school teachers. Hypothesis three is high school students will start at a higher level of abstraction than high school teachers. Hypothesis four is high school students will show greater improvement in level of abstraction than high school teachers.
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30. TITLE: *Platelet counts and their effect on patient outcomes with patent ductus arteriosus (PDA)*  
SPEAKER: **Chelsea Robalino**  
INSTITUTION: University of Florida  
EMAIL: [crobalino@ufl.edu](mailto:crobalino@ufl.edu)  
ABSTRACT: As a fetus develops, blood passes from the heart through an open aorta to the not yet functional lungs. Once the baby has been delivered, it is expected that the heart closes off the aorta from the pulmonary artery, separating the oxygenated and deoxygenated blood. Sometimes this does not occur, causing a circulatory disorder called patent ductus arteriosus (PDA). This research focuses on premature newborns, who have a higher prevalence of this disorder. Currently, it is unclear to doctors what is the best approach to treating PDA: letting the aorta close on its own, administering medicine (indomethacin), or performing surgery.

Data for 405 preterm newborns was collected at the University of Iowa Hospitals and Clinics. We used logistic regression to examine the relationship between platelet counts in the first 7 days of life and other factors on three clinical outcomes: development of PDA, recovery without intervention, and successful indomethacin treatment. We found a positive correlation between higher platelet counts and better clinical outcomes for the patients. There were interesting dynamics between the early, later, and average platelet counts and their importance in our predictive models.

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31. TITLE: *Magic Cubes and Euler Cubes*  
SPEAKER: **Shahriyar Roshan Zamir**  
INSTITUTION: Georgia Gwinnett College  
EMAIL: [sroshanzamir@ggc.edu](mailto:sroshanzamir@ggc.edu)  
ABSTRACT: A Magic Cube of order  $p$  is a  $p \times p \times p$  cubical array with non-repeated entries from the set  $\{1, 2, \dots, p^3\}$ , such that all rows, columns, pillars and space diagonals have the same sum.  
A Magic Square of order  $p$  is a  $p \times p$  array with non-repeated entries from the set  $\{1, 2, \dots, p^2\}$ , such that all rows, columns and diagonals have the same sum.  
Magic squares and cubes are classic examples of recreational mathematics topics, having – as they do – a large number of enthusiasts, the vast majority of whom are not professional mathematicians.  
In this paper, we adapt ideas from a previous work on normal magic squares done by Uko and apply them to magic cubes. We use basic ideas from algebra and linear algebra to find a canonical decomposition for a general magic cube based on Latin Cubes and Euler cubes. By using this representation, we define a class of magic cubes, referred to as Euler magic cubes, and study some of their properties.
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32. TITLE: *The Effectiveness of Supplemental Instruction in Introductory College Mathematics Courses*  
SPEAKER: **Andrea Shipley**  
INSTITUTION: University of North Alabama  
EMAIL: [ashipley@una.edu](mailto:ashipley@una.edu)  
ABSTRACT: In order to determine the continued effectiveness of the Supplemental Instruction (SI) program at the University of North Alabama, four research hypotheses will be investigated. The first hypothesis is that students in classes that offer SI will have higher final exam grades than students in classes without SI. The second hypothesis is that students in classes that offer SI will have lower DWF rates than students in classes without SI. Students will be given a short pre-test with a selection of topics covered in the course. Similar questions will also be included on the final exam as a post-test. It is hypothesized that the students participating in SI will show greater improvement on these questions than those not participating in SI. Lastly, students participating and not participating in SI will take a qualitative survey near the end of the semester to determine whether there is a correlation between participation in SI and the students' academic and social engagement outside of SI sessions. The hypothesis is that there will be a positive correlation between SI participation and academic and social engagement.
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33. TITLE: *A Qualitative Study of the Mathematical Practices of Pre-Service Mathematics Teachers*  
SPEAKER: **Hazel Truelove**  
INSTITUTION: University of West Alabama  
EMAIL: [htruelove@uwa.edu](mailto:htruelove@uwa.edu)  
ABSTRACT: We recently performed a qualitative study to better understand pre-service secondary teachers' mathematical practices. It was developed using think-alouds and a 'lens' of metacognition. In this talk we discuss our findings from this study.
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34. TITLE: *The Existence of Infinite Anti-Chains on Multi-Graphs* (poster)  
SPEAKER: **Preston Tunnell Wilson**  
INSTITUTION: Rhodes College  
EMAIL: [tunpm-16@rhodes.edu](mailto:tunpm-16@rhodes.edu)  
ABSTRACT: We define a monotonic mapping as a function  $f : A \rightarrow B$  where for all subgraphs in  $B$ ,  $f^{-1}(b)$  is connected; if an edge  $e = (x, y)$  is part of  $f^{-1}(b)$ , then  $x$  and  $y$  are part of  $f^{-1}(b)$ ; and incidence to vertices is maintained for edges. Loosely, we can think of this mapping as taking subgraphs of  $A$  and shrinking them to a single vertex while maintaining the edges we did not shrink along.  
My work serves to extend the progress made by C. St. J. A. Nash-Williams contained in *On well-quasi-ordering infinite trees*. The idea of his paper is that for any partial ordering of trees, there is no infinite anti-chain, a

series of trees which are incomparable to the others. One can think of this result as for a sequence of trees, it is eventually impossible to include a new tree in this sequence which does not contain a previously used tree. My work is seeing whether this result extends to multi-graphs, graphs where loops and multiple edges between the same vertices are allowed.

We define our ordering operation for two graphs  $G$  and  $H$  as

$$G \leq H \Rightarrow \text{for some mapping } m : H \rightarrow P, G \text{ is a subgraph of } P.$$

With this definition, we are working on proving the existence or non-existence of infinite anti-chains of multi-graphs.

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35. TITLE: *Normal Magic Squares*

SPEAKER: **Livinus Uko**

INSTITUTION: Georgia Gwinnett College

EMAIL: [luko@ggc.edu](mailto:luko@ggc.edu)

ABSTRACT: A Magic Square of order  $p$  is a  $p \times p$  array with non-repeated entries from the set  $\{1, 2, \dots, p^2\}$ , such that all rows, columns and diagonals have the same sum. They were discovered in China as far back as 2200 BC.

Famous magic squares include a magic square which appears in Albrecht Dürer's 1514 engraving titled 'The melancholia', which is depicted on a 1986 postage stamp issued by Aitutaki-Cook Islands, and Benjamin Franklin's magic square which appears on a US 2006 postage stamp. For centuries, magic squares have been a source of mathematical amusements and challenging open problems. It is a classic example of a recreational mathematics topic, having – as it does – a large number of enthusiasts, the vast majority of whom are not professional mathematicians.

We introduced a new class of magic squares not too long ago, referred to as normal magic squares. This presentation shows how basic ideas from linear algebra can be used to characterize, parametrize or count them, and highlights from pending open problems on them.

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36. TITLE: *Cheaters: Gotta Catch 'Em All*

SPEAKER: **Jesse Walters**

INSTITUTION: University of South Carolina Upstate

EMAIL: [jessew@email.uscupstate.edu](mailto:jessew@email.uscupstate.edu)

ABSTRACT: Cheating is an unavoidable part of any prized competition. Nintendo's Pokemon video games are just one example of the many types of competitions in which people have resorted to cheating to gain an advantage against their competitors. Unfortunately, measures taken by Nintendo to prevent cheating have had very limited effectiveness. Why are these measures ineffective? Is it possible to find a more effective solution through statistical modeling? This talk will provide an introduction to the mathematical mechanics behind competitive Pokemon gameplay and describe a statistical model that could be useful if implemented to deter dishonest gameplay.

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## Friday, October 23, 2015

2:00–6:00	Early Registration (CL 1000 Atrium)			
2:00–5:00	Math Scavenger Hunt (around campus)			
5:00–7:00	Student Activity Involving Game Creation Using Probability (CL 1009)			
<b>Saturday, October 24, 2015</b>				
8:00–8:30	Registration (CL 1000 Atrium) and Breakfast (SL 1001 Atrium)			
Contributed Talks				
	<b>Contrib Sess 1</b> (CL 1008) Vandenbussche	<b>Contrib Sess 2</b> (CL 1010) Ellermeyer	<b>Contrib Sess 3</b> (CL 1005) DeMaio	<b>Faculty Seminars</b> (CL 1007) Ritter
Moderators:				
8:30–8:45	J. Asplund	N. Bacha	J. Ashford	Buddie, Callahan (8:30–8:55)
8:50–9:05	C. Defant	G. Buie-Collard, T. York	K. Payton	
9:10–9:25	D. Nguyen	J. Walters	A. Shipley	A. Johnson (9:00–9:25)
9:30–9:45	J. Carr	A. McGee	S. Glover	H. Truelove
9:50–10:00	Coffee Break (SL 1001 Atrium)			
10:00–11:00	Plenary Lecture 1: <b>Ken Ono</b> (SC 109) <i>Ramanujan's legacy in mathematics and film</i>			
11:15–12:15	Career Panel (SC 109) Jerry Baskin, Raj Bondugula, Tom Freeman, John Jacobson, Julie Kokan			
12:15–1:00	Lunch (SL 1001 Atrium)			
1:00–2:00	Plenary Lecture 2: <b>Martin Short</b> (SC 109) <i>Applying Mathematics to Combat Crime</i>			
2:00–2:10	Conference Photo			
2:15–3:15	Poster Session (CL 1000 Atrium) Judges: TBA Presenters: E. Bagby, R. Brown & T. Brown, C. Defant, J. Michelis, C. Mohanakumar, M. Mulholland & P. Rouse, P. Tunnell Wilson			
3:15–3:30	Coffee Break (SL 1001 Atrium)			
Contributed Talks				
	<b>Contrib Sess 4</b> (CL 1008) Westlund	<b>Contrib Sess 5</b> (CL 1010) Adhikari		<b>Faculty Seminars</b> (CL 1007) Wang
Moderators:				
3:30–3:45	E. McCrina	K. Doroudi		L. Uko (3:30–3:55)
3:50–4:05	G. Cazacu	P. Davis, W. Selman		
4:10–4:25	S. Roshan Zamir	D. Kotval		J. Mayer and P. Hartley, R. Mann (4:00–4:25)
4:30–4:45	M. Harbol	C. Robalino		S. Molitoris Miller (4:30–4:55)
4:50–5:05	J. Boone	J. Ding		
5:10–5:30	Concluding Remarks and Awards Ceremony (SC 109)			