Mathematical Association of America
MD-DC-VA Section, November 1 & 2, 2013
Hampden-Sydney College / Longwood University
Abstracts

Invited Addresses

FRIDAY WORKSHOP

Adrian Rice, Randolph-Macon College

Amy Shell-Gellasch, Montgomery College & Smithsonian National Museum of American History

A Beginner's Guide to Teaching a History of Math Course

4:00 PM, Room 217, Bagby Hall (HSC)

This workshop offers a beginner's guide to teaching an undergraduate history of mathematics course. In particular, we will discuss and offer suggestions on pitching the course to the right audience, historical and mathematical content, assignments and activities, modes of assessment, and resources to use. This workshop is designed to be of interest, not only to those who have never taught a history of mathematics course before, but also to anyone who is looking for more information on teaching such a course. Our hope is for you to leave with ideas and inspiration to embark on an exciting intellectual adventure with your students.

BANQUET ADDRESS

Colm Mulcahy, Spelman College and American University

The Mathematics, Magic, and Mystery of Martin Gardner

8:00 PM, Chairman's Room, Settle Hall (HSC)

Martin Gardner (1914–2010), Prince of Recreational Mathematics, died at the end of an astonishing publishing career spanning 80 years. His "Mathematical Games" column in Scientific American ran from the 1950s to the 1980s, and introduced thousands of budding mathematicians to elegant problems and magical items which still inspire "Aha!" moments today. Every October worldwide there are Celebration of Mind events inspired by his writings. As we approach his centennial, we'll survey some of what "the best friend mathematics ever had" achieved and the legacy he leaves behind. Twitter users may enjoy following @WWMGT (What Would Martin Gardner Tweet).

SATURDAY INVITED ADDRESSES

Lorena Bociu, North Carolina State University

Snowflakes, Balloons, and the Cardiovascular System

9:45 AM, Auditorium, Blackwell Hall (LU)

Snowflakes are beautiful, balloons are fun, and the cardiovascular system is, well, complex. Even though they seem unrelated at first glance, they are all examples of "free boundary problems (FBPs)", which deal with solving partial differential equations (PDEs) in a domain, a part of whose boundary is not known in advance. FBPs represent a very active research area right now, due to their numerous applications in science and technology. In this talk, we will start with two classical examples of FBPs (the obstacle problem and the Stefan problem), and move on to some more recent problems, like the arterial blood flow.

Adrian Rice, Randolph-Macon College

Commutativity and Collinearity: A Fundamental Connection Between Pappus and Diophantus

2:05 PM, Auditorium, Blackwell Hall (LU)

This talk investigates the discovery of an intriguing and fundamental connection between the famous but apparently unrelated work of two mathematicians of late antiquity, Pappus and Diophantus. This link went unnoticed for well over 1500 years until the publication of two groundbreaking but again ostensibly unrelated works by two German mathematicians at the close of the nineteenth century. In the interim, mathematics changed out of all recognition, with the creation of numerous new mathematical subjects and disciplines, without which the connection might never have been noticed in the first place. This talk examines the chain of mathematical events that led to the discovery of this remarkable link between two seemingly distinct areas of mathematics, encompassing number theory, finite-dimensional

real normed algebras, combinatorial design theory, and projective geometry, and including contributions from mathematicians of all kinds, from the most distinguished to the relatively unknown.

Contributed Papers by Author (non-student)

Abdinur Ali, Norfolk State University
Mushtaq Khan, Norfolk State University
Mathematical Theory of Error Detection and Error Correction Codes
8:50 AM, Room 350, Ruffner Hall (LU)
Bose, Chaudhuri, and Hocquenghem (BCH) codes and Reed-Solomon (RS) Codes are based on Galois Fields. Each code word in the finite field can be written as a polynomial code. Primitive polynomial is used to generate all the elements of the Galois Field. Then, the generator polynomial is found using least common multiple of minimal polynomials. Systematic coding is done with cyclic redundancy check techniques and decoding is done with Peterson's algorithm. RS codes are non-binary BCH codes and BCH codes are extension of Hamming codes for correcting multiple errors. Hamming codes can correct single errors only. This talk will cover the encoding, syndrome error patterns and decoding of linear and nonlinear codes.

Tauqir Bibi, South University
Formulas, Skeletons, and Halloween!
11:05 AM, Room 350, Ruffner Hall (LU)
College Algebra is a required class for all Nursing students. Unfortunately, student success rates are very low in this course (about 30% online and 65% on-ground). Most students in College Algebra classes take Intermediate Algebra prior to taking College Algebra, but they still have difficulty recalling the basic algebraic facts. The lack of procedural knowledge leads to low motivation and effort. To help overcome these issues, I have designed several class activities and worksheets, which were applied in summer 2013 classes. Our attendance and pass rates significantly improved this quarter. Besides academic success, these activities also help students visualize real world applications of mathematics, especially in Nursing. After reviewing these worksheets, I am planning to publish them as a workbook for nursing students. In this presentation, I would like to share some of the activities from this workbook.

James Blowers, Retired (US Army CASCOM)
Tracking the Mail Truck, An Adventure in Graph Theory
11:05 AM, Room 354, Ruffner Hall (LU)
The author recently moved, and at his new home found that the mail truck makes frequent U-turns, some on a busy 2-lane road. Therefore, the author wanted to know if there were routes for the mail truck without U-turns. This problem is that of finding Eulerian circuits on a symmetric oriented planar graph without U-turns (and minimizing left turns). In this presentation it is proved that there is no such circuit on such a graph with an odd number of interior regions and all vertices being 3-vertices, along with some other results and some ideas for further research.

Brian Bradie, Christopher Newport University
A Course in Mathematics for Life Sciences
3:40 PM, Room 354, Ruffner Hall (LU)
This presentation will describe a mathematics course that was designed with biology and ecology majors in mind, as well as anyone with an interest in the life sciences. Topical coverage includes model building and parameter estimation through regression analysis, analysis of life tables and analysis of matrix population models. No specialized knowledge of biology or ecology is assumed, and no background in calculus is needed.

Bud Brown, Virginia Tech
Connections Between Hamming Codes over q-element Fields and Singer Block Designs
9:15 AM, Room 350, Ruffner Hall (LU)

The first error-correcting codes developed, and the first ones students usually encounter, were efficient ways to detect and correct errors in binary strings by including parity-check bits along with the message bits. Hamming's scheme produced perfect single-error correcting codes -- they correct all single-error patterns and only those patterns. Subsequent researchers described such codes for character strings over arbitrary q-element fields, now known as q-ary Hamming codes. We show how to construct such codes, and describe their connections with so-called Singer block designs.

Hongwei Chen, Christopher Newport University
On Summation of Subseries of the Riemann Zeta Function
4:05 PM, Room 254, Ruffner Hall (LU)
Three classes of subseries of the Riemann zeta function are evaluated in closed form. All the results are expressed in terms of the Riemann zeta function itself and powers of pi. By using the Euler totient function, we prove that these three classes are unique subseries that exhibit this kind of closed form.

David Clark, Randolph-Macon College
The Celestial Element Method: Finding Polynomial Roots in 18th Century Japan
3:15 PM, Room 254, Ruffner Hall (LU)
Far-removed from the development of calculus and analytic geometry in the West, Japanese mathematicians nonetheless tackled difficult problems and proved beautiful results in the 18th century. Questions about packings of planar shapes often boiled down to high-degree polynomial equations, and Japanese scholars were adept at finding roots numerically using a technique of Eastern origin—a technique that was subsequently named after an Englishman.

Boyd Coan, Norfolk State University
Exterior Algebra: A Friend to R-modules over Commutative Rings
4:05 PM, Room 350, Ruffner Hall (LU)
Many are more familiar with the role that exterior algebra plays in differential geometry than with what it tells us about algebra in general. Some examples are given of how exterior Algebra may be used to discover some properties of algebraic systems. Specifically, invariants and techniques arising from the study of exterior algebras of modules over commutative rings are used to uncover properties of the underlying modules. The non-negative integer p=Csrank(M) is defined and shown to count the maximum number of times that the top exterior power can appear as a direct summand of M. If P is finitely generated projective of constant rank n, then an isomorphism $\mathrm{Hom}(P,\bigwedge^n P)\cong\bigwedge^{n-1}P$ is set up. The class of FGC rings is recalled as those rings for which every finitely generated R-module may be written as a direct sum of cyclic R-modules and is demonstrated to be coincident with a new class of rings.

Randall Cone, Virginia Military Institute
The AMC5: An Initiative by the MAA MD-DC-VA Section
8:50 AM, Room 356, Ruffner Hall (LU)
The MAA's American Mathematics Competitions (AMC) are annual events designed to encourage young mathematical talent in our nation's middle and high schools. In hosting these tests, some institutions from the MAA MD-DC-VA Section have had significant participation from regional school systems. This, in turn, illustrates tremendous desire by our public school systems for such mathematically substantive activities. Presently, there exist few AMC-type events for elementary school students. In consideration of these latter two points, the MD-DC-VA MAA Section has formed a large development team for a new grades 3-5 mathematical event: the AMC5. In this talk, we discuss the project's goals, illustrate example AMC5 competition problems, and describe the foundational divergence of this project (both in format and substance) relative to other competitions and standardized tests. In addition, we encourage other section members to get involved in the AMC5 and highlight the recent positive national press the project has received.

James Cook, Liberty University
Abstract Number Theory
8:50 AM, Room 352, Ruffner Hall (LU)

In this talk we initiate a study of functions on a real, commutative, semisimple algebra. Some elementary theorems of calculus in our context are discussed.

Susan Goldstine, St. Mary's College of Maryland
Tessellations on Bead Crochet Bracelets
4:05 PM, Room 356, Ruffner Hall (LU)
Bead crochet bracelets are easy to wear, fun to make, and astonishingly hard to design--without math. Learn how to use simple but clever geometry to turn a tessellation of a flat plane of beads into a stunning, seamless, edgeless bracelet!

Brian Heinold, Mount St. Mary's University
Creative Approaches to Teaching Discrete Mathematics
9:15 AM, Room 356, Ruffner Hall (LU)
In the couple of years that I've been teaching Discrete Mathematics, I've tried a few things to make the class interesting and to help students better understand the concepts. This talk will be about a few of those things, including writing assignments to help students with difficult concepts, some tricky problems to help students understand things like equivalence classes and functions, a variety of non-algebraic induction and recursion problems, and some interesting applications.

Brant Jones, James Madison University
The Affine Symmetric Group
3:40 PM, Room 350, Ruffner Hall (LU)
The symmetric group of permutations is one of the first groups that students often encounter in abstract algebra. In this talk, we introduce a generalization known as the affine symmetric group. This group arises naturally in the study of geometric reflections, representation theory, and algebraic combinatorics; it also affords a beautiful example of an "infinite" version of Lagrange's theorem.

Jeff Ledford, Virginia Commonwealth University
Approximating Continuous Functions with Scattered Translates of the General Multiquadratic
3:40 PM, Room 254, Ruffner Hall (LU)
In this paper, we use Taylor's theorem to show that scattered translates of the general multiquadric may be used to approximated continuous functions.

Larry Lehman, University of Mary Washington
An Arithmetic View of a Classical Calculus Problem
11:30 AM, Room 356, Ruffner Hall (LU)
A familiar calculus problem asks the following: For a rectangular sheet of cardboard of a given length and width, find the length of the side of a square to be cut out from each corner so that the open-topped box obtained by folding up the resulting flaps has the largest possible volume. Using a method of finding all rational points on a particular algebraic curve, we find a formula for all integer dimensions of the cardboard sheet such that the solution is a rational number. We also consider which rational numbers are possible.

John McGee, Radford University
An Expository Proof of Bezout's Theorem
8:50 AM, Room 354, Ruffner Hall (LU)
We present the results of a summer undergraduate research experience involving a proof of Bezout's Theorem which states that the number of intersection points of two polynomials in $k[x,y]$ is the product of the degrees of the polynomials, as long as you count carefully. Our proof follows the outline given in Appendix A of "Rational Points on Elliptic Curves" by Silverman and Tate. I will describe the research experience, some mathematical background, and highlight a few key steps of the proof.

Colm Mulcahy, Spelman College and American University
What's the Deal? Mathematics Inspired by Dealing Cards into a Pile
3:40 PM, Room 356, Ruffner Hall (LU)
In 2003 an interesting move of period 4 for packets of cards was discovered which gives rise to some entertaining card effects, especially when applied three times. A decade later, a family of generalizations was stumbled upon, also of period 4, with interesting consequences when applied just twice. However, the proof developed at first was for one extreme case, and it was not an extension of any known proof in the older scenario; a different decomposition of a packet of cards into three parts was used. Here, in joint work with Neil Calkin (Clemson Univ), a single unified proof is presented which covers the whole spectrum of cases; it divides packets into four parts.

Edwin O'Shea, James Madison University
Euclid for Thespians (and Everyone Else)
4:05 PM, Room 354, Ruffner Hall (LU)
Euclid's Elements was once considered a bedrock of every liberal arts education and we wish to offer some first reflections on professing Euclid to a "math for poets" class where it is the primary text. Many of the students are not poets but rather theatre, music and dance majors hence the talk title. Some attention will be given to using the founding documents of the United States as a metaphor for understanding Euclid, a metaphor that is especially helpful for a liberal arts audience to understand what we mean by an axiomatic system and what it means to prove something by contradiction.

James Parson, Hood College
Roll Your Own Quartic Formula
9:15 AM, Room 352, Ruffner Hall (LU)
Galois theory illuminates much about solving polynomial equations in one variable. Its generality and abstractness, however, obscure its concrete application. I will show how one can use the earlier ideas of Lagrange and the symbolic-manipulation features of a computer-algebra system to create many procedures to solve quartic equations similar to Ferrari's original solution.

Cherng-Tiao Perng, Norfolk State University
On a Formula of Liouville Type for the Quadratic Form $x^2+2y^2+2z^2+4w^2$
11:05 AM, Room 356, Ruffner Hall (LU)
We generalize the factorization of the classical Lipschitz quaternions to the Lipschitz type quaternions associated with the quaternary quadratic form $x^2+2y^2+2z^2+4w^2$. We are able to prove a unique factorization theorem under a suitable model for the Lipschitz type quaternions in question. As a consequence, we obtain a simple and conceptual proof for the number of representations of a positive integer in terms of the above quadratic form, which was first historically stated by Liouville.

Victoria Powers, NSF and Emory University
Mari Castle, Kennesaw State University
Comparing Pairwise and Election Outcomes
3:15 PM, Room 356, Ruffner Hall (LU)
It is well known that if there are 3 or more candidates in an election, for most election methods it is possible for a candidate to beat all others in pairwise comparisons and lose the election. In recent work, Donald Saari and Tomas McIntee connect pairwise tallies and positional (e.g. plurality, antiplurality, Borda count) election outcomes. In this work, we generalize the work of Saari and McIntee in two ways: connecting pairwise tallies and two-stage election outcomes (e.g. Instant Runoff) and connecting proportional pairwise tallies to election outcomes. No previous knowledge of voting theory is required for this talk.

Laura Taalman, James Madison University
JMU 3-SPACE: 3D Printing in the Classroom
3:15 PM, Room 354, Ruffner Hall (LU)

JMU 3-SPACE is a new 3D-printing general education classroom at James Madison University. This classroom gives students the opportunity to experience an interactive DIY/maker environment that will help them succeed in future STEM courses and an increasingly technological society. 3D printing is an additive manufacturing process whereby objects are built up from plastic filament, liquid resin, layers of powder, or even bio-compatible and edible materials. Desktop 3D printing is today's printing press, putting rapid prototyping, customizable products, and individualized medical appliances in reach of the general public. Literacy in basic 3D modeling and manufacturing is an essential skill for future STEM success in this country. This presentation will include a discussion of 3D modeling options and mathematical classroom uses, as well as an active demonstration of a model being 3D printed.

Eve Torrence, Randolph-Macon College
Bruce Torrence, Randolph-Macon College
Colm Mulcahy, Spelman College and American University
Mathematics, Magic, and Mystery
11:30 AM, Room 350, Ruffner Hall (LU)
In 2014 the MAA is heading Mathematics Awareness Month and has selected "Mathematics, Magic, and Mystery" as the theme. The program organizers will present a sneak peak at their plans for next April. They will discuss their concept for the MAM poster and website and what your department can do to get involved in this exciting program.

Gwyneth Whieldon, Hood College
Poincaré-Betti Series of Monomial Quotient Rings
3:15 PM, Room 350, Ruffner Hall (LU)
The resolution of residue fields over polynomial rings is given by the Koszul complex, but in the case of resolutions of a residue field over quotient rings the situation becomes much more complex. These resolutions may or may not be finite, but more interestingly, may or may not have resolutions with total Betti numbers given by a rational function. Much recent research has focused on determining which classes of ideals I in a polynomial ring R have resolutions of k over $Q=R/I$ with rational Poincaré-Betti series. In this talk, we present several classes of monomial ideals M with Betti numbers given by combinatorial data of M.

Godfred Yamoah, Norfolk State University
An Adaptive Scheme for Flow in Porous Media
9:15 AM, Room 354, Ruffner Hall (LU)
Obtaining robust numerical solutions to flow in porous media efficiently continues to be challenging, in particular for infiltration into non-uniform porous media. In this work we present a Galerkin finite element method that coarsens and refines the mesh based on an a priori error indicator paired with a temporal adaption scheme that controls the local truncation error at each time step. The temporal scheme is based on linear extrapolation for smooth functions, but has been rigorously proven to work for nonsmooth problems when a finite-difference Jacobian is used. We present numerical results for the pressure head form of Richards' equation for infiltration problems, which lead to a nonsmooth model. We provide error and work measures to demonstrate the performance of the joint spatial-temporal adaption scheme when compared to a fixed grid approach with temporal error control, a fixed grid approach with heuristic time stepping, and a spatially adaptive approach with heuristic time stepping.

Student Abstracts by Author

Dan Carroll, St. Mary's College of Maryland
Caroline VanBlargan, St. Mary's College of Maryland
Maps and Mirrors
3:15 PM, Room 250, Ruffner Hall (LU)
We investigate extensions of mirror design problems inspired by classical map projections. The map maker's problem is to choose which geographic/geometric data her map will reflect and which it will distort. Given that the simultaneous preservation of angles and areas is not possible, we explore the relationship between area and angle distortion and consider optimal mirror surfaces which minimize these distortions.

Heather Chichura (Senior), Virginia Military Institute
A Traveling Bioterrorist
4:05 PM, Room 250, Ruffner Hall (LU)
What would happen if a bio-terrorist was able to expose the population of the United States to small pox? Assuming the bio-terrorist will want to optimize the sickness that can be done to the population, we modeled the effectiveness of the attack through the use of an epidemic model with a genetic traveling salesman algorithm. In the epidemic model we have included a traditional susceptible-infected-recovered model and have introduced an exposed class to allow for the incubation of the Orthopoxvirus variola virus, better known as the variola virus. Depending on the rate of the exposed population that becomes infected, the reintroduction of small pox could be catastrophic causing an epidemic across the nation.

Dane Lawhorne (Senior), University of Mary Washington
The Fundamental Groups of the Digital Line and Circles
3:15 PM, Room 250, Ruffner Hall (LU)
The topological spaces known as the digital line $\boldsymbol{D}$ and digital n-circles C_n are important objects of study in digital topology. From a homotopy theoretic viewpoint, the digital line and digital circles are discrete versions of the real line and S^1. In support of this statement, we first prove that $\pi_1(\boldsymbol{D})$ is trivial, as is $\pi_1(\boldsymbol{R})$, by constructing a series of homotopies from an arbitrary loop in $\boldsymbol{D}$ to the constant loop at the basepoint. Next, we construct for each C_n a covering map $p: \boldsymbol{D} \to C_n$ analogous to the standard periodic covering map $q: \boldsymbol{R} \to S^1$. We then use this fact, along with techniques from the standard proof that $\pi_1(S^1) \cong \boldsymbol{Z}$, to show $\pi_1(C_n) \cong \boldsymbol{Z}$. This last result is known, but previous proofs relied on the use of simplicial methods.

Hannah Vogel (Senior), St. Mary's College of Maryland
Who You Math With: The Role of Networking in the Accomplishments of Benjamin Banneker and Maria Mitchell
11:05 AM, Room 352, Ruffner Hall (LU)
In the history of math before the twentieth century, women and minorities are hard to find. Benjamin Banneker and Maria Mitchell are remarkable exceptions to the rule. In the eighteenth century, Banneker was a skilled mathematician and astronomer despite his status as an African American in slavery-dominated colonial Maryland. In the nineteenth century, a time when women were usually expected to do no more than keep house and raise a family, Mitchell discovered a comet, calculated data for the American Ephemeris and Nautical Almanac, and taught for many years at Vassar College. How were these exceptional individuals able to accomplish so much? Their own intelligence and perseverance, as well as fortuitous personal circumstances, were major factors in their successes. But more than that, it was their connections to family members and friends who made the difference in establishing their educations, careers, and legacies as mathematicians.

Bailu Zhang (Senior), Liberty University
Differential Equations on Hyperbolic Numbers
11:30 AM, Room 352, Ruffner Hall (LU)
We study differential equations for functions on the hyperbolic numbers. A single ordinary hyperbolic differential equation is connected with several real partial differential equations. We show how the hyperbolic calculus allows an elegant solution where real techniques are tedious.