Mathematical Association of America
MD-DC-VA Section, November 7 & 8, 2014
Bowie State University
Abstracts

Abstracts for the workshop and invited addresses are listed first, in chronological order, followed by faculty abstracts alphabetized by submitting presenter's last name. Graduate student presentation abstracts and undergraduate student presentation abstracts follow (all alphabetized the same way).

Invited Addresses

FRIDAY WORKSHOP

Gwyneth Whieldon, Hood College

Integrating Tablets into the Mathematics Classroom

4:00 PM, Theater, Student Center

Many college students have tablets, phones, and laptops (often all out in front of them in the same class), but those devices often function more as distractions than as learning tools. This doesn't have to be the case: from function visualization tools and electronic textbooks to effective note-taking software and group collaboration apps, there are plenty of ways to integrate mobile devices into the mathematics classroom in ways that avoid distractions, gimmicks, or time-wasting. Similarly, on the faculty side, there are apps that make it easier to create and distribute innovative course materials, or keep track of student involvement, questions and resources. This is hands-on workshop on how to use web or mobile-based apps in the math classroom, with a focus specifically on calculus, precalculus and linear algebra. Participants should bring their own device to the workshop, as only a limited quantity of iPads will be available as extras.

BANQUET ADDRESS

Craig Bauer, York College of Pennsylvania

Unsolved: History's Greatest Ciphers

8:00 PM, Ballroom A, Student Center

While developments in cryptanalysis (the art/science of cracking ciphers) have forced enciphering techniques to become more and more sophisticated, there remain scores of ciphers stretching back to antiquity that remain unsolved. These were created variously by professional cryptographers, amateurs, artists, killers, and victims. In some cases the identity of the author is also unknown. The talk covers many of these mysteries, along with some mathematics that provides a glimmer of hope for those seeking the solutions. These solutions could reveal the identity of a serial killer or spy, provide the exact location of buried treasure worth millions, expose a secret society, illuminate our understanding of ancient history, or even rewrite the history of science.

SATURDAY INVITED ADDRESSES

Valentina Harizanov, The George Washington University

Computable Mathematics

9:45 AM, Theater, Student Center

In 1936, Turing invented the Turing machine and established formal computability theory as a rigorous mathematical theory of algorithms. Computability theory paved the way for the creation of the modern programmable computer. The main thrust of the field is to understand the power and limitations on algorithmic computation without regard for the physical implementation. Interaction of computability theory with algebra, as well as other areas of mathematics, has resulted in computable structure theory and, more generally, computable mathematics, a very active research area in the last few decades. The talk will focus on the history and significance of computability theoretic ideas and methods in mathematics, including undecidability problems, complexity of truth, and the Gödel incompleteness theorem. We will also discuss algorithms with oracle information, Turing degrees, and some of our recent results.

Larry Washington, University of Maryland
Cannonballs, Triangles, and Secrets: An introduction to elliptic curve cryptography
2:05 PM, Theater, Student Center
Elliptic curves have been around for centuries, but recently they have become very important in cryptography. I'll start with a light introduction to elliptic curves and then discuss some recent cryptographic applications.

Contributed Papers by Author (non-student)

Bill Abrams, Longwood University
Teaching Discrete Mathematics to First Year Majors
3:15 PM, Ballroom C, Student Center
The Longwood University Department of Mathematics and Computer Science, as of Fall 2013, requires a Discrete Mathematics course of all majors. This course is meant to be taken during their first year. I will talk about what motivated us to create this course, what the goals of this course were (and what I think they should be), what material was covered and why, the difficulty of using a book that is not entirely accessible to first year majors, and what I learned from teaching the course the first time.

Emmanuel Addo, American University
Ben Muirhead (Graduate Student), American University
Every Vote Counts - Exit Poll Project
9:15 AM, Columbia Room, Student Center
In Fall 2013 an exit poll was conducted in Northern Virginia to explore the effect of voter ID laws on voter turnout, as a pilot project for a more extensive poll this fall in DC, Northern Virginia, and suburban Maryland. A graduate class in survey sampling designed the survey based on stratified sampling by income and racial composition of precincts; undergraduate students in basic statistics classes conducted the exit poll to determine how many potential voters were turned away because of voter ID requirements. The results of the 2013 project are known and will be presented. The results from 2014 will be known after November 4.

Abdinur Ali, Norfolk State University
Chung-Chu (George) Hsieh, Norfolk State University
Analysis of Antenna Coupling and Magnetic Fields within the Near-Field Region
3:40 PM, Ballroom B, Student Center
Near field communication (NFC) devices are designed to work in short ranges. Communications are exchanged between two NFC-enabled devices by touching or by holding devices in close proximity to each other. NFC-enabled devices can detect other devices in close proximity and interact. These devices successfully function when there are tight couplings between readers and tags. The overall aim of this research is to understand the structure of near fields and to develop suitable antennas for near-field communications. This research was supported by the U.S. Army Research Office under grant number W911NF-12-1-0081.

Bud Brown, Virginia Tech
Multipliers of Difference Sets and How to Find Them
11:05 AM, Ballroom B, Student Center
A (v,k,λ) **difference set** is a k-element subset D of $V=\boldsymbol{Z}$ mod v such that every nonzero element of V can be expressed as a difference $a-b$ of elements $a, b \in D$ in exactly λ ways. A *multiplier* of a (v,k,λ) difference set D on $\boldsymbol{Z}$ mod v is an integer m such that (a) m and v are relatively prime, and (b) the mapping $x \rightarrow mx$ mod v permutes the set $\{D+j \mid 0 \le j \le v-1\}$ of shifts of D mod v. This talk will be about multipliers of difference sets and how to find them. There will also be some pretty pictures.

Abstracts

James Case, SIAM
Efficient Extraction From An Exhaustible Energy Source
11:05 AM, Columbia Room, Student Center
Previous investigations have asked how to make as much money as possible from a given source of fossil fuel. With supplies now nearing exhaustion, it becomes more important -- to society if not to energy companies -- to harvest the largest possible quantity of energy. The problem has a surprising multiplicity of solutions.

Hongwei Chen, Christopher Newport University
Three Real Variable Proofs of the Euler Reflection Formula
8:50 AM, Annapolis Room, Student Center
Among the many beautiful formulas involving the gamma function, the Euler reflection formula is particularly significant, as it connects the gamma function with the sine function. In this talk, we present three real variable proofs of this formula. For deriving this formula, we use the differential equation and functional equation.

Ray Cheng, Old Dominion University
The Best Mate Search Strategy
8:50 AM, Ballroom B, Student Center
A female searching for a mate might adopt a threshold based strategy, i.e., select the first male that meets or exceeds a threshold T in quality. Or, she could use a "best-of-N" strategy. Under simple hypotheses, including a fixed cost per prospect, each strategy could be optimized. Which approach is superior? What if the female can set both a threshold T and a maximum search length N?

Boyd Coan, Norfolk State University
Old Theorems, Alternate Proofs by Exterior Algebra
3:15 PM, Columbia Room, Student Center
Many are aware of the methods using differential forms to supplement vector analysis, although initially, vector analysis supplanted the Grassmann techniques. For example, at one point in time, Maxwell's equations were reduced to a partial differential equation using vector analysis but it was realized that differential forms may be used as a means of achieving that same goal. Using modern terminology, these alternate techniques have exterior algebra as a foundation. Not only is exterior algebra a valuable tool in analysis, but is of use in other mathematical disciplines as well. In this short note, we give examples of how exterior algebra may be used to prove some old theorems of modern algebra and geometry. "The neglect of the exterior algebra is the mathematical tragedy of our century." ---Gian-Carlo Rota, Indiscrete thoughts (1996)

Randall Cone, Virginia Military Institute
The AMC5 Pilot Event: An MAA MD-DC-VA Section Initiative
8:50 AM, Theater, Student Center
In this session, we discuss the ongoing pilot test for the AMC5 elementary school mathematics initiative. We also discuss strategies for moving beyond the pilot phase to a more established and planned event, perhaps by partnering with AIBL and other organizations. Most importantly, we encourage our MAA DC-DC-VA Section colleagues to engage with us in an open dialogue concerning the philosophy and pedagogical choices made so far in the AMC5's development. For an example of these latter choices, AMC5 now signifies 'The American Mathematics Celebration 5', rather than 'The American Mathematics Competition 5'.

Donna Dietz, American University
Twisty Puzzles for Liberal Arts Math Courses
11:05 AM, Ballroom C, Student Center
The general public tends to presume that anyone who can solve Rubik's Cubes (and similar puzzles) is very smart. Teaching Liberal Arts students how to solve these puzzles is a great way to improve their mathematical self-esteem while teaching them about group theory, modular arithmetic, algorithmic design, 3D geometric visualization and much more. The key realization that makes this possible is that with just 2 or 3 simplistic routines, the pocket cube (or other puzzle) can be solved. Most published solutions focus on the overall speed of solution rather than reducing human

memorization. By focusing on reducing the number and complexity of the routines, solutions are within reach of all undergrads and can be mastered after just a few class periods. (Students who are good at mathematics tend to learn the pocket cube in well under an hour.)

Ming Fang, Norfolk State University
Issues in Implementing Newton's method
4:05 PM, Ballroom B, Student Center
In this talk, we will discuss several practical issues in implementing Newton's method.

Raymond Fletcher III, Virginia State University
Properties of Self-inversive Cubic Curves
3:15 PM, Annapolis Room, Student Center
Let K be an irreducible cubic curve which inverts onto itself via a circle with center X. A binary operation can be defined on K by setting a*b equal to the third point besides a, b which lies on the line [a,b] and on K. Also a ternary operation f can be defined on K by setting f(a,b,c) equal to the unique fourth point on circle (a,b,c) and on K. We will show that these two operations are related by the formula: f(a,b,c) = X*((X*a)*(b*c)). Using this formula we will show that there exist 2 orthogonal circles, or possibly 3 mutually orthogonal circles which invert K onto itself.

Spencer Hamblen, McDaniel College
Jan Term at the Joint Meetings
4:05 PM, Columbia Room, Student Center
McDaniel College offers a 3-week January Term every winter and offers a number of on-campus and travel courses. In 2011 and 2014 I ran a course centered around bringing students to the Joint Mathematics Meetings. I will discuss some of the difficulties and rewards of structuring an academic and experiential course around a mathematics conference.

Gregory Hartman, Virginia Military Institute
Open Textbooks and APEX Calculus: A Final Report
11:30 AM, Ballroom C, Student Center
In this talk we discuss the growing open textbook movement and reasons why one should be interested in adopting or writing an open-source text. Pleasures and pitfalls of writing one's own text will be discussed, and an overview of open textbook repositories will also be given. We also give a final (well, probably final) report on APEX Calculus, a "Calc 1" through "Calc 3" text that was written under the APEX (Affordable Print and Electronic teXtbook) model and is in use at VMI.

Dan Kalman, American University
Companion Matrices and Difference Equations 2
11:30 AM, Ballroom B, Student Center
A companion matrix is famous in linear algebra as an answer to the problem "Given a monic polynomial p, find a matrix whose characteristic polynomial is p." But companion matrices have several additional interesting properties that deserve to be better known. In particular, there is a strong connection between companion matrices and difference equations. In this talk I will show an explicit reduction to Jordan Canonical Form for a companion matrix whose polynomial has repeated roots, and use it to derive a beautiful matrix equation for the sum of the kth powers of the first n natural numbers.

Caroline Melles, United States Naval Academy
Undergraduate Capstone Projects in Graph Theory and Other Topics
9:15 AM, Ballroom B, Student Center
For the past three years I have run a one-semester capstone course for undergraduate math majors. Students spend the first six weeks reading and lecturing from Graph Theory, A Problem Oriented Approach, by Daniel A. Marcus. The rest of the course is spent on capstone projects. Topics have included: scheduling a volleyball tournament so that no team plays more than two games in a row, applying the Hungarian algorithm to minimize the total travelling distance of the 64

college basketball teams participating in March madness, a study of the graph-theoretic properties of fullerenes, an optimal solution for plebe watch-standing to minimize class time lost, designing a bicycle route for a triathlon, and applying a Markov model to major league baseball data from the 2013 season to calculate scoring indices for various players. Software used includes Gusek, Matlab, Mathematica, Excel, and Sage. I will discuss the course and some of the projects.

Edwin O'Shea, James Madison University
Math for Liberal Arts and the Calculus Pump
4:05 PM, Ballroom C, Student Center
In a liberal arts class that is rigorously reading Euclid, a star student told me "I'm not a math person. I just like proofs." The other star students say more or less the same thing, despite their grappling with Elements at the level and depth of a very good senior math major. The stars have two things in common: they are all female and they were somewhat successful but indifferent to most of their high school math experience. What are we to do when the only pump to more math (as the MAA CUPM recommends for liberal art classes) for these potentially strong majors is a calculus path these stars are skeptical to immediately follow? I don't have a comprehensive answer for this question but hope to persuade you that it is a question worth asking and worth grappling with. Ideas, thoughts, even refutations from the audience are sought and welcome!

James Parson, Hood College
Constructive Arguments in an Introduction to Proofs Class
9:15 AM, Ballroom C, Student Center
Textbooks that introduce students to proof often include many nonconstructive arguments, e.g. proofs of "existence" that do not produce examples. I will give illustrations of such arguments and explain how logicians pinpoint what makes an argument constructive or not, arguing that constructive proofs are more vivid and fit well in introductory courses.

Cherng-tiao Perng, Norfolk State University
Some Observations on Klein Quartic, Groups, and Geometry
8:50 AM, Columbia Room, Student Center
The Erlangen Program published by Felix Klein in 1872 remains an effective way of looking at geometry. In Klein's point of view, the study of geometry is the study of the invariants or symmetry under a suitable transformation group. The purpose of this talk is to share some ideas that arose while I was following a proof in Dolgachev's book on algebraic geometry about the simplicity of the automorphism group of the Klein quartic curve. A theorem of Hurwitz says that the maximum size of automorphism group Aut(Y) for any curve Y of genus g greater or equal to 2 is 84(g-1). It is known that the Klein quartic curve X is of genus 3 and Aut(X) has order 168, the maximum possible size for all curves of genus 3, and that this group is simple. In trying to understand the proof, I found some typos, and ways to bypass the part I did not understand. Without going into Klein's original approach, I found a motivating way to introduce an element of order two in Aut(X), and furthermore with the aid of the computer algebra system SAGE, I constructed an explicit isomorphism between Aut(X) and another group of order 168, namely the symmetry group of the Fano plane, which is related to the study of Cayley numbers, or octonions.

Bob Sachs, George Mason University
Teaching the Fundamental Theorem of Calculus for Better Student Understanding
3:40 PM, Ballroom C, Student Center
Calculus instructors know from experience that students have a hard time passing from the integral on a fixed interval to taking the derivative of the integral with moving endpoint. Researchers have documented this too! I will describe a slight variation on this topic. The key idea is to emphasize the difference quotient (F(b)-F(a))/(b-a) and compare with the corresponding integral average of F'(x).

Hamid Semiyari, James Madison University
An efficient Algorithm for Approximating Solutions of Two-Point Boundary Value Problems and Volterra Integrals
9:15 AM, Theater, Student Center
We demonstrate how the Modified Picard method can be applied to Two Point Boundary Value Problems and Volterra Integral Equations. First we present an algorithm for approximating solutions of two-point boundary value problems and then a theorem that gives conditions under which it is guaranteed to succeed. Then we introduce a new algorithm for the case if the original algorithm failed to converge on a long interval. We split the long interval into subintervals and show the new algorithm gives convergence to the solution. Finally, we repose a Volterra equation using auxiliary variables according to Parker-Sochacki in such a way that the solution can be approximated by the Modified Picard iteration scheme.

Amy Shell-Gellasch, Montgomery College
Ancient Indian Verse and the Powers of 2
3:15 PM, Ballroom B, Student Center
Ancient Indian culture regarded the writing of verse as a high art. In fact, even their mathematics was written in verse. An important component of writing verse was Prosody, determining which and how many syllables are stressed in each line of poetry. Ancient Indian's used an ingenious mathematical algorithm to determine how many syllables could be stressed. Given that they did not have exponential notation, their method is more efficient than straight multiplication.

Roman Sznajder, Bowie State University
On Completely Positive Cones
11:30 AM, Columbia Room, Student Center
For a closed cone C in R^n, the completely positive cone of C is the convex cone K_C in the set of symmetric matrices, generated by uu^T with u in C. Such a cone arises in the conic optimization problems. Motivated by the useful properties of the nonnegative orthant and the positive semidefinite cone, in this talk, we investigate irreducibility, self-duality and homogeneity of the cone K_C.

Zheng Tong, Christopher Newport University
Equilibrants, Semipositive Matrices, Calculation and Scaling
4:05 PM, Annapolis Room, Student Center
For square, semipositive matrices A (Ax > 0 for some x > 0), two (nonnegative) equilibrants e(A) and E(A) are defined. Our primary goal is to develop theory from which each may be calculated. To this end, the collection of semipositive matrices is partitioned into three subclasses for each equilibrant, and a connection to those matrices that are scalable to doubly stochastic matrices is made. In the process a certain matrix/vector equation that is related to scalability of a matrix to one with line sums 1 is derived and discussed.

Sara Tyler, Hawkes Learning
Learning: Anytime, Anywhere
3:40 PM, Columbia Room, Student Center
Courseware Development Engineers at Hawkes Learning have designed an innovative, browser-based platform built specifically with the tablet in mind. Our Expert System offers a distinctive approach to mastery-based learning with instant and specific feedback when students make a mistake, thus improving learning outcomes and reducing anxiety. We understand a large number of students still depend on our unique ability to work without internet access. Hawkes will continue to support this by offering dual platforms to you and your students. Join us to learn more and be entered in a raffle for a $50 Amazon Giftcard!

Jill Tysse, Hood College
Irish Dancing Groups: Some fun activities for an undergraduate-level abstract algebra course
8:50 AM, Ballroom C, Student Center
Irish dance is a traditional form of dance originating in Ireland that today can be found all over the world in its various forms – as a social dance, as competitive dancing, and as entertainment in shows like Riverdance and Lord of the Dance

and at St Patrick's Day parades everywhere. We will examine some fun in-class activities involving Irish dance and the group D_4 of symmetries of a square. In particular, we will use our dance moves to investigate the cosets of D_4 in the symmetric group S_4 on four letters. Put on your dancing shoes and bring your best moves!

Sanju Vaidya, Mercy College
Geetha Surendran, Mercy College
Applications of Graph Theory to Chemistry
3:40 PM, Annapolis Room, Student Center
In the last twenty years, many scientists have developed mathematical models to analyze structures of various chemical compounds. Graph theory has provided many powerful tools to solve problems in many areas of chemistry such as chemical isomer enumeration and Quantitative Structure-Property Relationships (QSPR).We will analyze theorems and properties of various types of graphs and their applications to describe molecular formulas of certain types of chemical compounds. Additionally, we will analyze topological indices of molecular graphs and correlate them with structures and properties of certain chemical compounds.

Graduate Student Abstracts by Author

Jasmine Alston, Virginia State University
Mohammad Tabanjeh, Virginia State University
On The Numerical and Algebraic Techniques for Computing Matrix Determinant
11:05 AM, Ballroom A, Student Center
The computation of the sign of a matrix determinant is a well-known problem. It is the problem of testing whether det(A) > 0, det A = 0, or det(A) < 0 for an n-by-n matrix A. This problem finds its application in computational geometry, such as computation of convex hulls, Voronoi diagrams, and testing whether the line intervals of a given family have nonempty common intersection. In this talk, we review, modify and combine various techniques of numerical linear algebra and rational algebraic computations (with no error) to achieve our main goal of decreasing the bit-precision for computing det A or its sign which enable us to obtain the solution with few arithmetic operations. Such a decrease is necessary for many of the computational geometry applications.

Shantanu Awasthi, Virginia State University
Krishan Agrawal, Virginia State University
Youngjin Lu, Virginia State University
Comparison of Mathematica and Empirical Modelling in Studying the Relationship Between Single Fiber and its Bundle
11:30 AM, Annapolis Room, Student Center
In recent years, the significant research is being conducted to create high performance polymer based composite materials. These composite materials have various applications such as ballistic armors and consumer products. This advancement is taking place because a better understanding of the relationship between single fiber strength and its bundle. In this study, a relationship based on transfer ratio between the strengths of single fiber and its bundle is discussed using empirical and mathematical modeling. This is achieved using a real time data sets. In empirical modelling, Anderson Darling test is used via Mini tab and in mathematical modeling, Wei bull distribution is used as probability distribution function for strength of single fiber while normal distribution is used for its bundle based on classical mathematical theory. It is observed that empirical modeling is better predictor of transfer ratio, however mathematical modelling can be used to predict the strength of the bundle using single fiber strength.

Eugene Evans, Virginia State University
Predictive Modeling using Artificial Neural Networks on Polymer Composite Properties
3:15 PM, Ballroom A, Student Center
In this study artificial neural networks (ANN) are utilized to produce a predictive model to investigate the properties of high-performance polymer fibers. This model generalized the behavior between bundled fibers and their single filament counterparts. Several data points are used from the bundled fibers data to determine the average maximum force applied

to break a single filament fiber. In this study five backpropagtion (training methods) methods are compared to determine which method is most effective by using the Mean Absolute Percentage Error (MAPE) of each. This will allow a further understanding of polymer composite properties and possibly make manufacturing processes less expensive by reducing the number of tests when evaluating single filament characteristics. Prior to the comparison of ANNs, appropriately the optimum number of neurons (training cells) is determined. This ensures an adequate comparison of methods.

Lindsey Santos Koos, Old Dominion University
Description of a Computationally Efficient Boltzmann Equation Discretization Algorithm and its Application to Broad Spectrum Neutral and Ionized Space Radiation
9:15 AM, Ballroom A, Student Center
The Boltzmann integro-differential equation describes the propagation of neutral and charged particles within bulk matter. It is a powerful mathematical tool to simulate and study the effect of mono-energetic laboratory radiation beams and a broad-spectrum space radiation environment on biological and solid state end points (targets). In this talk, starting with the 3-dimensional (3D) time and angular dependent Boltzmann transport equation, steps will be discussed to create a computationally efficient 1-dimensional (1D) time and angular independent Boltzmann particle transport equation. Appropriate coordinate transformations will be shown which map the 1D integro-differential equation into a form that allows inversion and discretization. The discretization steps produce three distinct sets of solution methodology for neutral, light particles, and heavy ions. While the bulk of the talk will focus on the mathematical details of the discretization procedure, limited application results will also be shown. For application, the discretized 1D algorithm is applied to the broad energy spectrum of space radiation environment. Here, using the discretized solution, the radiation composition of the free space galactic cosmic rays (GCR) composed of all particles in the periodic table and trapped protons within the Earth geomagnetic field are transported through typical spacecraft material and dosemetric quantities of interest at specific target points are computed. Upon the completion of the particle transport, the computed particle flux quantities are applied to a realistic space vehicle and human phantom models to assess astronaut exposure due to ionizing radiation.

Harry Lang, Johns Hopkins University
A New Proof of the Lovasz Local Lemma
8:50 AM, Ballroom A, Student Center
Traditional proofs of the Lovasz Local Lemma (LLL) rely on the probabilistic method. In 2009, Moser and Tardos presented the first constructive proof, and a series of subsequent papers improved upon their result. In this talk, I will provide a simple proof of the LLL which follows the general idea of recent papers but avoids invoking results from information theory or Kolmogorov complexity.

Dustin J. Robinson, Virginia State University
Self-inversive Group Circle Systems
11:30 AM, Ballroom A, Student Center
Let G be an abelian group and let g be an element of G. Let f be a mapping from G into the projective plane. If for each 4 element subset {a,b,c,d} of G, the corresponding points {f(a), f(b), f(c), f(d)} are cocyclic, then we call the set of points f(G) and the associated circles a (G,g) circle system. We will illustrate several group circle systems and show that some of these invert onto themselves via 2 orthogonal or even 3 mutually orthogonal circles.

John Ross, Johns Hopkins University
Blowing Bubbles in Gaussian Space
3:40 PM, Ballroom A, Student Center
Soap bubbles and soap films are created in nature by minimizing the surface area of the bubble, while keeping the volume of the bubble unchanged. In doing so, soap bubbles of any shape or size will quickly collapse to a stable, spherical shape. In this talk we discuss the mathematics behind this, generalizing the first and second derivative tests from Calculus. We then turn our attention to Gaussian space, and discuss our main result which states that (stable) bubbles will take the form of planes.

Andrew Wills, Virginia Tech
A Glimpse at Bijective Combinatorics
4:05 PM, Ballroom A, Student Center
We will explore some topics in bijective combinatorics by using sets of seemingly innocuous, perhaps even made up, objects to solve difficult algebra problems, without doing the algebra. In particular, we will find combinatorial models for Hall-Littlewood polynomials, a class of symmetric polynomials where different variables are interchangeable. In this case, combinatorial proofs can be simple and elegant, and often give insight into the basic structure of the polynomials.

Undergraduate Student Abstracts by Author

Sophia Novitzky (Senior), Virginia Tech
Mahalia Sapp (Senior), Virginia Tech
Performance Sensitivity in Vertical Geothermal Energy Harvesting Systems
9:15 AM, Annapolis Room, Student Center
Residential geothermal energy systems have the potential to provide a cost-effective, low carbon footprint technology for heating and cooling. The systems use the soil beneath a residence to store thermal energy in the summer and harness energy in the winter. The soil exchanges heat with the coolant that flows through a pipe inserted into a vertical bore. The energy transfer in the soil changes the coolant temperature, setting the efficiency of the residential heating/cooling system. We are interested in finding how the cross-sectional arrangement of pipes in the bore affects the temperature of the coolant as a function of depth. For a given cross-section, we describe the temperature functions of the coolant and the surrounding soil through a system of time-dependent partial differential equations. From these equations, we find a Sturm-Liouville eigenvalue problem in each cross-sectional variable, whose eigenvalue determines the decay rate of the eigenfunction over depth. We find a numerical solution via the finite element method for the eigenpair corresponding to the lowest decay rate. Our results can be used to determine the borehole depth necessary to meet the energy needs of a residence given a desired geometry of the system.

Katie Sipes (Junior), James Madison University
Salt Flux Concentration in the Kidneys
11:05 AM, Annapolis Room, Student Center
The kidneys are an organ in the body that filters the components of the blood plasma. Ions, sugars and salts are the main components filtered out by the glomerulus. Salt is a component that the body has a more challenging time to make the correct concentration to remain in allostasis. The kidneys can either produce a small quantity of very concentrated urine or a large amount of very dilute urine. This process can be modeled mathematically to understand the semipermeability of the kidneys.