The Tenth Annual

Harriett J. Walton Symposium

on

Undergraduate Mathematics Research

Program and Abstracts

Saturday, April 14, 2012

The Tenth Annual

Harriett J. Walton Symposium

on

Undergraduate Mathematics Research

Sponsored by

The Mathematical Association of America (MAA) Regional Undergraduate Mathematics Conference Program through National Science Foundation Grant DMS-0846477

The Department of Mathematics
Morehouse College

The Division of Science and Mathematics
Morehouse College

Morehouse College

Saturday, April 14, 2012

Contents

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Robert M. Franklin
President

April 14, 2012

Dear Symposium Participants:

On behalf of the Morehouse College community, I welcome you to our campus to take part in the Tenth Annual Harriet J. Walton Symposium on Undergraduate Mathematics Research. Dr. Walton, a trailblazing mathematics professor, encouraged students to excel in applied and research mathematics and continues to be a great champion of the discipline. Additionally, she provided for us an example of scholarly excellence and dedication to teaching mathematics.

It is our privilege to host the symposium, and we hope that your experience will prove intellectually provocative and inspiring. In the same manner that Dr. Walton approached learning, I challenge you to become fully engaged in this opportunity to share ideas and concepts.

Each of you has my best wishes for an inspiring meeting and an enjoyable visit.

Sincerely,

Robert M. Franklin

Robert M. Franklin

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Willis B. Sheftall, Jr.

April 14, 2012

To Those Attending the Annual Harriet J. Walton Symposium:

It is my great pleasure to endorse the Tenth Annual Harriet J. Walton Symposium on Undergraduate Mathematics Research. I am delighted that the Department of Mathematics has chosen to honor an esteemed colleague in such a manner. Dr. Walton brought skill and enthusiasm to her classroom and touched the lives of thousands of Morehouse men with her dedication and compassion. With its focus on mathematics research by undergraduates, this Symposium helps to ensure the continued intellectual growth of the students about whom Dr. Walton cares so much.

Best wishes for a rewarding experience.

Respectfully,

Willis B. Sheftall, Jr.

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April 5, 2012

Dear Student Presenters and Colleagues:

On behalf of the Division of Science and Mathematics at Morehouse College, I want to welcome you to the Tenth Annual Harriett Walton Symposium. To the students, I would encourage your continued participation in research, whether you intend to pursue a research career or not. It is one of the best means of developing your creative thinking and analytical reasoning skills, both of which are important goals of education. To the faculty, I want to express my thanks for your commitment to providing students with opportunities to engage in active learning through research. In the years ahead, research involving students and faculty will play an increasing role in American higher education. I hope that all of you will continue to be leaders in this important initiative.

For a very long time we, at Morehouse, have sought to enhance interest among our students in careers involving science and mathematics. In light of the fact that African-Americans continue to receive 2% or less of the Ph.D.s awarded in science, engineering and mathematics, it is evident that America and particularly HBCUs must redouble efforts to address this problem. We must continue to nurture and guide our students so that African-Americans can achieve parity in this very rewarding career, which is vital to the national interest. To this end, we established the Division of Science and Mathematics, an administrative unit that will help to remove the walls between departments, so that students in the sciences and mathematics will receive a first-rate, interdisciplinary education, which is consistent with the way that the most exciting scientific research is being done today.

I can think of no better person to honor than Harriett Walton, who over the course of 42 years was an excellent mathematics teacher and valued member of the Morehouse community. I am pleased to count myself among her former students.

I wish all of the students who are sharing the results of their research today, much continued success in your work, and hope that many of you will pursue a career in research.

Sincerely,

J. K. Haynes

J. K. Haynes, Ph.D.
David Packard Professor and
Dean of Science and Mathematics

rc/JKH

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14 April 2012

Dear symposium attendees and presenters:

We are happy to have you participate in this Tenth Annual Harriett J. Walton Symposium on Undergraduate Mathematics Research. During the past decade, this symposium has become a highlight in the academic year for this region's mathematics students and a valuable opportunity for them to synthesize their research experiences, hone their presentation skills, and share the results of their work with each other and with the accompanying faculty and guests.

We in the Morehouse College Department of Mathematics are appreciative of the work you have done and of your travels, in many instances, to join us today. Undergraduate research like that presented at today's symposium serves to motivate and inform students about possibilities beyond the Bachelor's degree and to develop skills and habits of mind that can benefit them in graduate study and beyond.

Thank you for your participation this year, and we hope you will continue your support, joining us again in 2013 and beyond.

Duane Cooper
Assoc. Professor and Chair
Department of Mathematics

Professor Harriett J. Walton

In September 1958, Harriett J. Walton joined the faculty of Morehouse College during the presidency of Benjamin Elijah Mays. She became a member of a team of three persons in the Department of Mathematics where she worked with the legendary Claude B. Dansby who served as Department Chair. Dr. Walton and her two colleagues taught all of the mathematics for the majors as well as the mathematics for non-science students. Dr. Walton relates that two of her favorite courses that she taught during this period were Abstract Algebra and Number Theory. The three-member mathematics department did an excellent job of preparing their mathematics majors for graduate school and the other students for success in their respective disciplines. In fact it was during this period of history that Morehouse gained the reputation of being an outstanding Institution especially for African American men. As the department grew, Dr. Walton shifted her attention away from mathematics majors and began to concentrate on students who needed special attention and care in order to succeed in mathematics. She became an advisor, mentor, tutor and nurturer to a large number of students matriculating at Morehouse College. Because of the caring attitude that she had for her students, some of them to this day refer to her as “Mother Walton.”

Dr. Walton has never been satisfied with mediocrity. Throughout her teaching career she demonstrated a love for learning. In 1958 when she arrived at Morehouse College she had an undergraduate degree in mathematics from Clark College in Atlanta, Georgia, a Master of Science degree in mathematics from Howard University, Washington D.C., and a second Master's degree in mathematics from Syracuse University. While at Morehouse teaching full time and raising a family of four children, Dr. Walton earned the Ph.D. degree in Mathematics Education from Georgia State University. After receiving her doctorate, Dr. Walton realized the emerging importance of the computer in education so she returned to school and in 1989 earned a Master’s degree in Computer Science from Atlanta University. She is indeed a remarkable person.

Dr. Walton’s list of professional activities, awards and accomplishments during her career is very impressive and too lengthy to be enumerated here. However a few special ones are her memberships in Alpha Kappa Mu, Beta Kappa Chi, Pi Mu Epsilon, and the prestigious Phi Beta Kappa Honor Society. Additionally she was selected as a Fulbright Fellow to visit Ghana and Cameroon in West Africa. Dr. Walton’s professional memberships included the American Mathematical Society, the Mathematical Association of America, National Council of Teachers of Mathematics (NCTM) and the National Association of Mathematicians (NAM). She served as Secretary/Treasurer of NAM for ten years. In May 2000, Dr. Walton retired from Morehouse College after forty-two years of service.

Foreword

The Department of Mathematics and the Division of Science and Mathematics of Morehouse College would like to thank the student presenters and their advisors for their participation in the Tenth Annual Harriett J. Walton Symposium on Undergraduate Mathematics Research. The Symposium is funded partially though the generous support of the Mathematical Association of America (MAA) Regional Undergraduate Mathematics Conference Program through National Science Foundation Grant DMS-0846477. The purposes of the Symposium are the following:

- to encourage students to do more undergraduate mathematics research
- to introduce students to their peers from various institutions and related fields
- to stimulate student interest in pursuing graduate degrees in mathematics and science
- to give students experience in presenting their research, both orally and in written form.

To all supporters, thank you for your help to make the Tenth Annual Harriett J. Walton Symposium on Undergraduate Mathematics Research a success. We hope to continue this event for many years to come.

Symposium Committee

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The Tenth Annual

Harriett J. Walton

Symposium on Undergraduate Mathematics Research

Saturday, April 14, 2012

Schedule

10:45 am-11:00 am Welcome

11:15 am -12:30 pm Lunch

12:45 pm-4:15 pm Student Presentations

4:20 pm-4:40 pm Closing

Session 1, *Nabrit Mapp McBay Lecture Room 1*

12:45 pm-1:05 pm **Emily Fredericksen and Jessie Mayne**,
Birmingham-Southern College
A Twisted Game:" To Knot or Not to Knot" on a new knot family

1:10 pm-1:30 pm **Hope Harris and Alicia Plotky**,
Birmingham-Southern College
Disentanglement Puzzles in Knot Theory

1:35 pm-1:55 pm **George Hagler,** Georgia Institute of Technology
Incompleteness of Mathematics

2:00 pm-2:20 pm **Huda Qureshi**, Birmingham-Southern College
The Easy Configurations of the Lights Out Cube Game

2:25 pm-2:45 pm **Virginia Seale and Hannah Wirey**,
Birmingham-Southern College
Whispering Jokers and Their Secrets

2:50 pm-3:10 pm **Anthony J. Baker**, Paine College
A Greedy Approximation Algorithm for Minimum CDS in Multihop Wireless Networks with Disparate Communications Ranges

3:15 pm-3:25 pm **Priyanka Yarlagadda**, Paine College
Logistic Equation Using Microbiological Parameters with an Application to Bioremediation

3:30 pm-3:50 pm **Melanie Short and Nino Christopher Yu Tiamco**, Birmingham-Southern College
Primitive Right Triangles and Their Geometric Properties

3:55 pm-4:15 pm **Mike Stonewall,** Birmingham-Southern College
Using Natural Cubic Splines to Model Local Landform

Session 2, *Nabrit Mapp McBay Lecture Room 2*

12:45 pm-1:05 pm **Lauren Dunn, Shurron Green, and Gerald Nicholson**, Albany State University
Computer Security Vulnerability Prediction Algorithms: Is Algorithmic Information Theory a way forward?

1:10 pm-1:30 pm **Dieudonna Harris, Maurice Gibson, and Kheri Hicks**, Albany State University
A Study of some Statistical Control Problems arising in Healthcare: Simmulation

1:35 pm-1:55 pm **Chiquita Chapman**, Albany State University
Samples with a Fixed Probability of an Event

2:00 pm-2:20 pm **Anthony Hicks**, Albany State University
Cryptography Techniques in Computer Networks

2:25 pm-2:45 pm **Marcus Bartlett**, Clayton State University
The Wiener Index of a Graph

2:50 pm-3:10 pm **Tranisha Guthridge**, Clayton State University
A Survey of Graceful Labelings

3:15 pm-3:25 pm **Michael Ngo**, Clayton State University
On new bounds for the monophonic number of Cartesian products of graphs

3:30 pm-3:50 pm **Herns Mesamours, Kelvin Williams, and Clarence Spearman**, Albany State University
Approximating Solutions of Nonlinear Differential Equations using the Runge-Kutta-Fehlberg Method

3:55 pm-4:15 pm **Kelvin Williams**, Albany State University
Hermite and Cubic Spline Polynomial Interpolation of Perturbed Elliptic Functions and Their Integrals

Session 3, *Nabrit Mapp McBay Lecture Room 308*

12:45 pm-1:05 pm **James Handley**, Morehouse College
Analysis of the Short Pulse Equation

1:10 pm-1:30 pm **Thomas Coverson**, Morehouse College
An Introduction to the Lorenz System and Data Assimilation

1:35 pm-1:55 pm **Corey Copeland**, Morehouse College
Analytical Solution of the Wave Equation in One, Two and Three Dimensions

2:00 pm-2:20 pm **Reginald D. Bailey**, Morehouse College
The Role of the Vandermonde Matrix in Hermite Interpolatory Polynomials

2:25 pm-2:45 pm **Sean Laster**, Morehouse College
Convergence of the Fourier Series

2:50 pm-3:10 pm **Dwayne Dorsey Jr.,** Morehouse College
Enumeration of Objects Using Polya's Theorem

3:15 pm-3:25 pm **Kristopher Jones**, Morehouse College
Voting in Agreeable Societies

3:30pm-3:50pm **Biliaminu Lawal**, Morehouse College
Biostatistics of Populations of Cancerous Cells

Session 4, *Nabrit Mapp McBay Lecture Room 303*

12:45 pm-1:05 pm **Nii Dodoo**, Morehouse College
Eventual Positivity for Special Types of Adjacency Matrices

1:10 pm-1:30 pm **Charles Watts**, Morehouse College
A Stunning Theorem

1:35 pm-1:55 pm **Charles Wilkes**, Morehouse College
2-1 Achievement Game

2:00 pm-2:20 pm **Terry Henderson and Aaron Ostrander**, Berry College
Exponential Domination of Triangular Grid Graphs

2:25 pm-2:45 pm **Joel Coppadge, Sterline Caldwell (North Carolina A & T) and Sayomi Stallings (U. of the District of Columbia)**, Morehouse College
Two Color Nim

2:50 pm-3:10 pm **Jordan Campbell**, Morehouse College
Vibrant Colorings

3:15 pm-3:25 pm **Joseph Crawford**, Morehouse College
Modular Representations of Graphs

3:30pm-3:50pm **Maxalan Vickers**, Morehouse College
Linear Geometric Constructions: The How, What and Why of Constructing Them

Abstracts

Reginald D. Bailey, Department of Mathematics, Morehouse College
Title: The Role of the Vandermonde Matrix in Hermite Interpolatory Polynomials
Advisor: Dr. Benedict Nmah

In his paper, "The Generalized Vandermonde Matrix", Kalman stated the Vandermonde determinant of order n as an identity. In this paper, we will use the Principle of Mathematical Induction to establish the identity. We will also discuss the role of the Vandermonde Matrix in Hermite interpolatory polynomials.

Anthony J. Baker, Department of Mathematics, Sciences and Technology,
Paine College
Title: A Greedy Approximation Algorithm for Minimum CDS in Multihop Wireless Networks with Disparate Communication Ranges
Advisor: Dr. Lixin Wang

Multihop wireless networks (e.g., wireless ad hoc networks and sensor networks) have been widely used in various civilian and military applications. Unlike wired networks or cellular networks, no physical backbone infrastructure is installed in wireless networks. A communication session is achieved either through a single-hop radio transmission if the communication parties are close enough, or through relaying across intermediate nodes otherwise. Although a wireless network has no physical backbone infrastructure, a virtual backbone can be formed by the nodes in a connected dominating set (CDS) of the corresponding graph. Such a virtual backbone plays a very important role in routing, broadcasting and connectivity management in multihop wireless networks. To simplify the connectivity management, it is desirable to find a minimum connected dominating set (MCDS) of a given set of nodes. Since finding an MCDS for a graph is NP-hard, only distributed approximation algorithms in polynomial time are practical for multihop wireless networks. The MCDS problem has been studied extensively in multihop wireless networks with the unit-disk model where all nodes have uniform communication ranges. However, in practice the networking nodes may have different communication ranges either because of the heterogeneity of the nodes, or due to interference mitigation, or due to a chosen range assignment for energy conservation. With such a generalized communication model, two nodes can communicate with each other if they are within each other’s communication range. In this paper, we present a greedy approximation algorithm for computing a MCDS in multihop wireless networks with disparate communications ranges and prove that its approximation ratio is better than the best one known in the literature. Our analysis utilizes an improved relation between the independence number and the connected domination number.

Marcus Bartlett, Department of Mathematics, Clayton State University
Title: On the Wiener Index of a Graph
Advisor: Dr. Elliot Krop

The Wiener index of a graph G is defined to be the sum of distances between every pair of vertices of G. When G is a k-ary tree, Hua Wang found a surprising relation between this index and the sum of distances between every pair of leaf vertices of G (called the gamma index) and showed a counterexample for another conjectured functional relationship. In this talk, we define two new natural indices (the spinal index and the Bartlett index) which when summed with the gamma index above, yield the Wiener index. We then show analogous relations to that of Wang, produce a counterexample to a functional relation for the spinal index, and state a conjecture about the Bartlett index.

Jordan Campbell, Department of Mathematics, Morehouse College
Title: Vibrant Colorings
Advisor: Dr. Rodney Kerby (Morgan State University)

Game theory is the name given to a wide array of mathematical processes that analyze a set of deliberate circumstances, including rules, challenges, and player interaction. The goal of game theorists is to predict the events and outcomes of such games. This presentation will examine a single player game called Vibrant Colorings, in which one player is given a nodule map or grid of $m\,x\,n$ size and is told to color the map or grid in such a way that any four nodes that constitute a sub-rectangle of the entire map or grid are not the same color when given a certain number of colors k. The presentation will explain how to determine a winning strategy as well as how to predict the eventualities of rectangles of size $m\,x\,n$ colored with k colors.

Chiquita Chapman, Department of Mathematics and Computer Science, Albany State University
Title: Samples with a Fixed Probability of an Event
Advisor: Dr. Li Feng

In this paper, we tackle the following problem. Suppose a population contains two different types of objects, say, blue marbles and white marbles. Given that the probability of drawing two marbles without replacement and getting two black marbles is p, find all of the samples in which the probability of such an event (that is, drawing two marbles without replacement and getting two black marbles) remains the same. We will show that the problem is equivalent to find all the triangular numbers that their multiples are also triangular numbers. We present the complete solutions for p=1/2 and p=1/3 as examples.

Corey Copeland, Department of Mathematics, Morehouse College
Title: Analytical Solution of the Wave Equation in One, Two, and Three Dimensions
Advisor: Dr. Tuwaner Lamar

The area is Linear Algebra, Vector Analysis, and Boundary Value Problems. Background of the Fourier series is named in honour of Joseph Fourier. Fourier made important contributions to the study of trigonometric series. Fourier introduced the Fourier Series for the purpose of solving the heat equation in a metal plate. Fourier published his initial results in his 1807 Mmoire sur la propagation de la chaleur dans les corps solides (Treatise on the propagation of heat in solid bodies), and publishing his Thorie analytique de la chaleur in 1822. Research objectives are be able to define one dimensional space, two dimensional space, and three dimensional space in order to explain the Fourier Series. Research outcomes be able to define one dimensional space, two dimensional space, three dimensional space and Fourier Series in great details. I have proved the heat equation. Now I am working on how to prove the wave equation.

Joel Coppadge, Sterline Caldwell (North Carolina A & T) and Sayomi Stallings (U. of the District of Columbia), Department of Mathematics, Morehouse College
Title: Two Color Nim
Advisor: Dr. Kenneth Berg (University of Maryland College Park)

Nim is a mathematical game of strategy where red tokens are placed on a table in one or more stacks and two players take turns removing tokens. Each turn a player may remove tokens from only one stack and must remove at least one token. The player who removes the last red token wins the game. The winning positions known as Class W can be determined using an algorithm based on binary representations of heights of the stacks. No matter how many stacks there, the winning positions and winning moves can be found. Otherwise, it is a losing position known as Class L. The research our group did based on this game is called “Two Color Nim” which introduces a blue token(s) in the game. The rules for the game and how to remove tokens remain the same. The winner of this game is who ever takes the last red token regardless of how many blue tokens are left. The goal of the research is to find all the winning positions and moves of two color Nim. We studied two different cases in our research. The first case was two stacks of red tokens with arbitrary heights with also one stack of blue tokens with an arbitrary height. The second case was having arbitrarily many stacks of red tokens with a maximum height of 2 and one stack of blue tokens of an arbitrary height. We completely solved both cases by determining all the winning positions and winning moves. We were able to find the winning moves by writing out different scenarios by hand or using a formula involving a matrix. This is ongoing research so other cases remained unsolved.

Thomas Coverson, Department of Mathematics, Morehouse College
Title: An Introduction to the Lorenz System and Data Assimilation
Advisor: Dr. Rudy L. Horne

Edward Norton Lorenz (May 23, 1917 - April 16, 2008) was an American mathematician and meteorologist, and a pioneer of chaos theory. He discovered the strange attractor notion and coined the term butterfly effect. He also studied two dimensional convection in a horizontal layer of fluid heated from below. These studies resulted in the Lorenz System. The Lorenz System is made up of three partial differential equations:

$$\begin{cases} \frac{dx}{dt} = \sigma(y-x) \\ \frac{dy}{dt} = rx - y - xz \\ \frac{dz}{dt} = xy - bz \end{cases}$$

where $\sigma, r,$ and b are given parameters.

In this research, these equations will be examined to find the fixed (critical) points of the Lorenz System, determine the stability and instability of the fixed points, calculate the numerical solutions of the Lorenz System using a computer program called Matlab, and applying data assimilation to the Lorenz System.

Joseph Crawford, Department of Mathematics, Morehouse College
Title: Modular Representations of Graphs
Advisor: Dr. Reza Akhtar (Miami University)

A graph *G* has a representation modulo r if there exists an injective map $f: V(G) \rightarrow \{0, 1, \ldots, r-1\}$ such that vertices u and v are adjacent if and only if $f(u) - f(v)$ is relatively prime to r. The representation number of *G*, *rep(G),* is the smallest integer such that *G* has a representation modulo *r*. In this study, we look at the representation numbers of various graphs, such as the complete ternary tree and Harary graphs.

Nii Dodoo, Department of Mathematics, Morehouse College
Title: Eventual Positivity for Special Types of Adjacency Matrices
Advisor: Dr. Ulrica Wilson

A matrix is strongly eventually nonnegative if it is eventually nonnegative and it has a power that is both irreducible and nonnegative. In 2010, Hogben introduced and used eventually *r-cyclic* matrices to establish an algorithm to determine whether a matrix is strongly eventually nonnegative. The project investigates the eventual *2-cyclicity* of special classes of cyclic characteristic matrices.

Dwayne Dorsey Jr., Department of Mathematics, Morehouse College
Title: Enumeration of Objects Using Polya's Theorem
Advisor: Dr. Duane Cooper

In this project, we discuss the enumeration of molecules and other objects using combinatorial mathematics/group theory. More specifically, we use Polya's Fundamental Theorem, which analyzes permutations and equivalence relations to determine the number of non-equivalent arrangements of objects. Important to the development of Polya's Theorem is Burnside's Lemma which computes the number of equivalence classes into which a set is divided by an equivalence relation.

Lauren Dunn, Shurron Green, and Gerald Nicholson, Department of Mathematics and Computer Science, Albany State University
Title: Computer Security Vulnerability Prediction Algorithms: Is Algorithmic Information Theory a way forward?
Advisor: Dr. Robert Steven Owor

In today's sophisticated computer networks, information security is accomplished by the application of several methods to mitigate against information security breaches. These methods include among others: cryptography, authentication through user identification and passwords; antivirus programs, firewalls and challenge response systems; biometric systems, smart cards and intrusion detection systems as well as organizational rules policies and procedures. While these methods are commendable and have achieved success in defending against attacks, there is no known method to predict unknown future attacks. This paper proposes the use of Algorithmic Information Theory as a possible security solution in the design, implementation and deployment of information systems, so that inherent self-awareness is created within computer network systems in order to protect against attacks. The papers examines the foundational mathematical concepts in Algorithmic information theory as outlined by Kolgomorov's Complexity, Shannon's Laws of Communications and Chaitan's conjectures of decidability based on Gödel's theorems and the Turing Computation thesis. These principles are applied in information creation, encryption and decryption during storage and transmission. Measures are proposed for vulnerability detection using Diophantine equations as an example.

Emily Fredericksen and Jessie Mayne, Department of Mathematics, Birmingham-Southern College
Title: A Twisted Game: "To Knot or Not to Knot" on a new knot family
Advisor: Dr. Douglas Riley

Knot games can be used to illuminate properties of knots. Students at the SMALL REU at Williams College developed a game called "To Knot or Not to Knot" in which two players take turns determining the crossing information on a knot projection. In this paper, the game "To Knot or Not to Knot" is played on a knot family that consists of a clasped trefoil and k twists. A winning strategy has been found for the first player on members of this knot family with even twists. It is shown that the first player has a winning strategy due to symmetrical properties if they play their first move on the center position of the knot.

Tranisha Guthridge, Department of Mathematics, Clayton State University
Title: A Survey of Graceful Labelings
Advisor: Dr. Christopher Raridan

We present a history of graph labeling, with a focus on graceful labelings of graphs, by providing a summary of many of the important papers. Also, we will present some of the more important theorems and conjectures concerning graph labelings.
Keywords: Graph labeling, graceful labeling, survey, history

George Hagler, School of Mathematics, Georgia Institute of Technology
Title: Incompleteness of Mathematics
Advisor: Dr. Enid Steinbart

Mathematics is in essence applied logic: we begin with axioms, such as the Axioms of Logic or the definitions of numbers, and proceed to show that other truths logically follow the assumption of these axioms. A mathematician named Hilbert proposed a question about the foundations of mathematics: can all the mathematical truths of the universe be reduced to some set of axioms? In other words, if we assume some countable number of axioms, could we then prove everything?

For many years, the expected answer was yes. However, Kurt Godel proved the two Incompleteness Theorems. These theorems answered the problem negatively: for sufficient logical systems, it is impossible to ever reduce all mathematical (and, thus, scientific) truths to any countable set of axioms. In addition, no such system could prove itself to be consistent (to have no self-contradictions). The method that Godel proved this was by assigning the axioms and logical operators numbers and concatenating them with the separator zero, so that each proposition (and each proof) would be represented by a number. Using this Godel numbering system, he proceeded to show that, no matter what axioms you choose, there will always be some proposition that can be proven neither true nor false; thus, that proposition cannot be broken down into a logical structure. This is true for any such countable set of axioms, thus proving the result.

In other words, the only theoretical mathematical system that could possibly prove all mathematical truths would have to have some uncountably infinite mass of axioms (or assume everything). You cannot define all of the real numbers until you define some uncountably infinite range of real numbers (such as the interval from 0 to 1); in the same way, you cannot logically show all mathematical truths until an uncountably infinite mass of truths is assumed.

James Handley, Department of Mathematics, Morehouse College
Title: Analysis of the Short Pulse Equation
Advisor: Dr. Rudy L. Horne

The short pulse equation:

$$u_{xt} = u + \frac{1}{6}\left(u^3\right)_{xx}$$

was recently derived by Schäfer and Wayne to model ultrashort optical pulses. In this presentation, we will derive a one-loop soliton solution for the short pulse equation (spe) and examine this solution given certain parameter values. Also, we will solve the spe using an exponential time-differencing numerical method.

Dieudonna Harris, Maurice Gibson, and Kheri Hicks, Department of Mathematics and Computer Science, Albany State University
Title: A Study of some Statistical Control Problems arising in Healthcare: Simmulations
Advisor: Dr. Zephyrinus C. Okonkwo

Statistical Process Control (SPC) has many and varied applications in manufacturing systems, service sectors, and any sectors where quality control and optimization are essential. SPC applications have even become more important today as quality control is essential for cost minimization, profit maximization, customer satisfaction, competitive advantage, and enhancement of product market share. This paper focuses on statistical process problems arising in health: statistical process control problem for outpatient doctor visits, statistical process control problems for dental visits, and statistical process control problems for obstetrics and gynecological visits. Solutions to these problems have ramifications on efficient scheduling of patients, optimal use of resources and infrastructure, and optimal use of manpower resources at care centers, and other trade-off issues. Multifaceted optimal activities jointly impact on improvement of services, minimization of cost, improvement of the image of the hospitals, clinics, and care centers, and insurance companies whose goal is to attract more customers in order to increase their profit margins. We present simulations, run charts, and interpret results.

Hope Harris and Alicia Plotky, Department of Mathematics, Birmingham-Southern College
Title: Disentanglement Puzzles in Knot Theory
Advisors: Dr. Douglas Riley

Given the four disentanglement puzzles Cowboy's Hobble, Coiled Again, Heart String and Three Triangles, we try to solve them topologically using sequences of Reidemeister moves. This proves to be quite difficult since the constraints on the puzzles are geometric which do not apply to knots and links in topology. In order to do this, we model the puzzles using knot diagrams and perform Reidemeister moves to produce the unlink. We show that any solution to Cowboy's Hobble requires the ring-hook move and we generalize Coiled Again to any number of coils which will require the same amount of twists as the number of coils to solve the puzzle. In addition, we show that one end of the string on the Heart String must be free in order to obtain the unlink. We also show the solution to Three Triangles and how it is similar to the Heart String.

Terry Henderson and Aaron Ostrander, Department of Mathematics and Computer Science, Berry College
Title: Exponential Domination of Triangular Grid Graphs
Advisor: Dr. Jill Cochran

A number of real-world networks can be modeled using graphs whose vertices exert influence over one another. These networks are usually treated in terms of *domination* of graphs, and recently work has been done where the domination that one vertex can have on another decreases exponentially with the distance between the two vertices. We consider the case where a *dominating vertex,* v, contributes a factor of $2^{1-d(u,v)}$ to the *domination* of u for $u \neq v$. We say $S \subset V(G)$ *exponentially dominate G* if every vertex in $V(G) \setminus S$ has domination greater than *1*. The *exponential dominating number* of *G,* $\gamma_e(G)$, is the least number of dominating vertices needed to exponentially dominate a graph. We say $S \subset V(G)$ *totally exponentially dominates G,* if every vertex in $V(G)$ has domination greater than *1*. The *total exponential dominating number* of *G,* $\gamma_{te}(G)$, is the least number of dominating vertices needed to totally exponentially dominate a graph. We explore $\gamma_e(G)$ and $\gamma_{te}(G)$ for triangular grid graphs, providing exact values and methods for generating inequalities.

Anthony Hicks, Department of Mathematics and Computer Science, Albany State University
Title: Cryptography Techniques in Computer Networks
Advisor: Dr. Khalil Dajani

Secure communication link has widely become the most important method of today's modern society and their developments are increasing dramatically. The use of secure link has relied on the confidentiality and security of its data transmission. The emergence of e-commerce including electronic funds transfer, internet marketing, online transaction processing and electronic data interchange are widely used to serve the convenience to users. The communication between both user and system administrator using insecure (public) channel to exchange data are easy enough to the intruders who wish to get the information about the exchanged data.

This paper explores current techniques and protocols of cryptography and their opportunities and challenges that are concerned with the security and authenticity of exchanged messages for secured communication. Detection schemes for conventional communication and insecure networks as well as protocols efficiency and implementation are discussed.

Kristopher Jones, Department of Mathematics, Morehouse College
Title: Voting in Agreeable Societies
Advisor: Dr. Duane Cooper

Voting can be expressed mathematically in a one-dimensional or multi-dimensional space. Platforms and voters are represented by points in a space, more accurately, referred to as a spectrum or policy space. The focus of my research is on one-dimensional or linear societies. Foundational knowledge of set theory, analysis, and graph theory is important for full comprehension of the research concepts, theorems and proofs presented. My objective is to provide proofs of the Agreeable Linear Society Theorem and Super-Agreeable linear society theorem along with others to answer the following question: Given any political spectrum when can we guarantee that some fraction of the population will agree on some candidate or platform? Concepts from graph theory are applied to describe voting in linear societies and to prove additional theorems.

Sean Laster, Department of Mathematics, Morehouse College
Title: Convergence of the Fourier Series
Advisor: Dr. Joseph Eyles

Joseph Fourier introduced the series that now carries his name in order to solve the equation for heat transfer in a metal plate. A Fourier Series is an expansion of a periodic function f(x) in terms of an infinite sum of sines and cosines. This paper will examine and explain the behavior of the Fourier Series when it meets the Dirichlet Conditions. Under the Dirichlet Conditions, the Fourier series converges to f(x) if x is a point of continuity and converges to some value if x is a point of discontinuity.

Biliaminu Lawal, Department of Mathematics, Morehouse College
Title: Biostatistics of Populations of Cancerous Cells
Advisor: Dr. Chuang Peng

This paper in Biostatistics proves how the chi-squared and normal distributions are derived for each degree of freedom using the beta function. The paper also uses the Odds and Risk Ratio to prove the Wald and Likelihood tests of Homogenity through the Hypothesis Test. It first uses a reasonable sample population to properly test the experiment; then extends, under these conditions, to a larger sample population to calculate the sample mean. The paper then tests the hypothesis under a 95$\%$ interval and rejects or accepts the hypothesis depending where the data lies. The data is graphed using the chi-square distribution, which is the normal distribution squared, and was obtained by using the Z-test. These distributions are representations of the data and are determined by the degrees of freedom. The degrees of freedom are derived from the gamma and beta functions, where alpha and beta are greater than zero and are uniform distributions.

Herns Mesamours, Kelvin Williams and Clarence Spearman, Department of Mathematics and Computer Science, Albany State University
Title: Approximating Solutions of Nonlinear Differential Equations using the Runge-Kutta-Fehlberg Method
Advisor: Dr. Zephyrinus C. Okonkwo

In this paper, we study the Runge-Kutta-Fehlberg method, a numerical technique used to find approximate solutions to nonlinear first order ordinary differential equations. Examples are presented for illustration. The classical Runge-Kutta Method of Order 4 (RK4) is applied to the same initial value problems and the results of both methods are compared. Furthermore, error analyses of these methods are discussed.

Michael Ngo, Department of Mathematics, Clayton State University
Title: On new bounds for the monophonic number of Cartesian products of graphs
Advisor: Dr. Elliot Krop

Given two vertices $u;v$ in a graph *G*, a chordless path from u to v is also known as a *monophonic path*. Let $JG[u;v]$ be the *monophonic closed interval* consisting of all vertices on all monophonic paths from u to v. For any subset of *S* of vertices of *G*, let $JG[S]$ be the set of all monophonic intervals for every pair of vertices from *S*. A set *S* is called a *monophonic set* of *G* if $JG[S]$ is the set of all vertices in *G*. The minimum cardinality of *S*, for all *S* subsets of vertices of *G*, so that $JG[S]$ is a monophonic set, is called the *monophonic number of G* and is denoted $mn(G)$. In this talk, we further describe these concepts, beginning with an introduction of basic graph theoretic terminology. We then discuss some new bounds discovered by A.P. Santhakumaran and S.V. Ullas Chandran on the monophonic number of graphs *C* which are Cartesian products of two graphs *G* and *H*. Finally, we mention some open problems in the subject. This talk will be self-contained and aimed at a general audience.
Keywords: monophonic path, monophonic set, monophonic number, Cartesian product of graphs

Huda Qureshi, Department of Mathematics, Birmingham-Southern College
Title: The Easy Configurations of the Lights Out Cube Game
Advisors: Dr. Douglas Riley

Lights Out was an electronic game released by Tiger Toys in 1995. The object of the game was to turn off a given light configuration, under a certain set of restrictions. An ``easy'' configuration of the game is one in which turning off all the initially lit lights on the Lights Out game turns off all the lights and wins the game. Through Linear Algebra techniques, the research of Bruce Torrence and Jacob Tawney, and MATLAB code, I was able to find the easy configurations of the Lights Out Cube to be 2^{4n} possible easy configurations for a cube game of side length *n.*

Virginia Seale and Hannah Wiley, Department of Mathematics, Birmingham-Southern College
Title: Whispering Jokers and Their Secrets
Advisors: Dr. Douglas Riley

Mathematics is often used to examine the functionality of card tricks. We aim to mathematically examine a family of tricks involving reference cards and generalize a specific trick to an infinite number of cards and an infinite number of reference cards. The trick examined in this paper is called Whispering Jokers. In the process of examining this specific card trick we were able to develop mathematical formulas to represent the two permutations performed in this trick. It was found that Whispering Jokers could be generalized to an infinite number of cards while still using two reference cards. In generalizing this trick to an infinite number of reference cards, the permutations were studied and it was found that the trick could only be generalized to an even number of reference cards but not odd. In proving this, we were able to show that even though a spectator may handle the cards during the trick, the mathematics behind the trick is actually in control.

Melanie Short and Nino Christopher Yu Tiamco, Department of Mathematics, Birmingham-Southern College
Title: Primitive Right Triangles and Their Geometric Properties
Advisor: Dr. Douglas Riley

We investigate geometric properties of primitive right triangles. We begin by outlining results concerning a triangle's semiperimeter and relating a triangle's area to its perimeter. We conclude by proving that for every natural number n where n has k distinct odd primes in its canonical factorization, there exist exactly 2^k distinct primitive right triangles whose area equals n times its perimeter.

Mike Stonewall, Department of Mathematics, Birmingham-Southern College
Title: Using Natural Cubic Splines to Model Local Landform
Advisor: Dr. Douglas Riley

Little is known about calculations used to describe the Birmingham-Southern College area of land mass. We confirm the accepted figure of 192 acres by utilizing simple land surveying techniques. First, we collect geographical location data via smart phone remote sensing. Next, we use natural cubic splines to interpolate the campus boundary. And finally, we integrate across a bounded region. Missing our mark by approximately 3 percent shows the accuracy of natural cubic splining as an effective method for line interpolation.

Maxalan Vickers, Department of Mathematics, Morehouse College
Title: Linear Geometric Constructions: The How, What, and Why, of Constructing Them
Advisor: Dr. Lawrence Smolinsky ~(Lousiana State University)

Our research will discuss and give examples of two ways to create geometric constructions and the tools needed to produce these constructions. One way uses a

straightedge and compass, while the other uses a straightedge with two notches and a compass, otherwise known as the neusis construction. Also, we will discuss those numbers that are constructible using these two ways, such as $\sqrt{2}$, and those that we cannot currently construct, such as $\sqrt[5]{a}$, where a is a constructible number. Last but not least, the research also introduces the key terms, *fields* and *towers*, and establishes connections between these key terms and our linear geometric constructions.

Charles Watts, Department of Mathematics, Morehouse College
Title: A Stunning Theorem
Advisor: Dr. Ulrica Wilson

A square matrix $A = (a_{ij})$ is positive, denoted $A > 0$ if $a_{ij} > 0$ and eventually positive if there exists k_0 such that for all $k \geq> k_0$, $A^k > 0$. Eventually positive matrices were introduced in 1978 by S. Freidland. We present some results about the eventual positivity of adjacency matrices of several classes of graphs including cycles and zero divisor graphs.

Charles Wilkes, Department of Mathematics, Morehouse College
Title: *2-1* Achievement Game
Advisor: Dr. Curtis Clark

Let *F* be a graph with no edges. The *2-1* achievement game, namely *F*, is a two-player game that moves alternately. The board consists of n vertices. Player A moves first connecting two vertices, making an edge. Player B connects two different vertices, making an edge. Players then alternate moves. The graph F is achievable on K_n if Player A can successfully achieve graph *F*. The minimum *n* such that *F* is achievable on K_n is its *2-1* achievement number, $a2(F)$. The minimum number of move to achieve *F*, donated $m2(F)$ is the least number of moves played by Player A to make *F* on the complete graph with $a2(F)$ vertices. It was proved that $a2(C5) = 5$ and that $m2(C5) = 5$.

Kelvin Williams, Department of Mathematics and Computer Science, Albany State University
Title: Hermite and Cubic Spline Polynomial Interpolation of Perturbed Elliptic Functions and Their Integrals
Advisor: Dr. Zephyrinus C. Okonkwo

In this paper we examine derive Hermite and Cubic Splines polynomial approximations of perturbed elliptic functions and subsequently evaluate their integrals on closed intervals of the real line. Continuity of such elliptic functions is assumed but obtaining closed form integrals solutions of such integrals are challenging, hence, adoption of numerical integration techniques will be in order. The results are compared with Taylor polynomial approximation and Maclaurin polynomial approximation obtained from a Binomial series generated from the elliptic integrals. Using Weierstrass approximation theorem, the absolute error is computed in each case. Examples are presented for illustration.

Priyanka Yarlagadda, Department of Mathematics, Sciences and Technology, Paine College
Title: Logistic Equation Using Microbiological Parameters with an Application to Bioremediation
Advisor: Dr. C.P. Abubucker, Dr. C. R. Nair and Dr. Bibekananda Mohanty

Microorganism has remarkable ability to degrade environmental pollutants. Certain microbes, like *Bacillus Sphaericus* use Cr- VI as a source of energy and efficiently convert this hazardous chemical into less harmful Cr-III. Microbial capabilities for biodegradation vary widely. Many mathematical models are used to describe the microbial growth. One such model is the logistic equation, $X(t) = \frac{a}{1+e^{b-ct}}$. This equation contains the mathematical parameters a, b and c. In this paper we explore how these abstract mathematical parameters are related to the microbiological parameters, maximum specific growth μ_m, lag time λ and the asymptotic value A. We prove that, a = A; $b = c\lambda + 2$ and $c = \frac{4\mu_m}{A}$. These relations are used to derive an equation involving μ_m, λ and A from the logistic equation. The derived logistic equation using the microbiological parameters is $y = \frac{A}{1+e^{\frac{4\mu_m}{A}(\lambda - x)+2}}$. This model is applied to the data collected from the experiment by the authors through a grant funded by the United States Department of Energy. A study was undertaken through this grant to examine the potential of *Bacillus sphaericus* in the reduction of hexavalent chromium in a liquid suspension culture. *Bacillus sphaericus* cells were grown in a liquid fermentation medium containing sodium acetate, yeast extract, magnesium chloride, and calcium chloride. The kinetic parameters of this bacterial growth were calculated and the growth was modeled by the logistic equation. [This study was supported, in part, by a grant from the Department of Energy awarded to Paine College.]

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