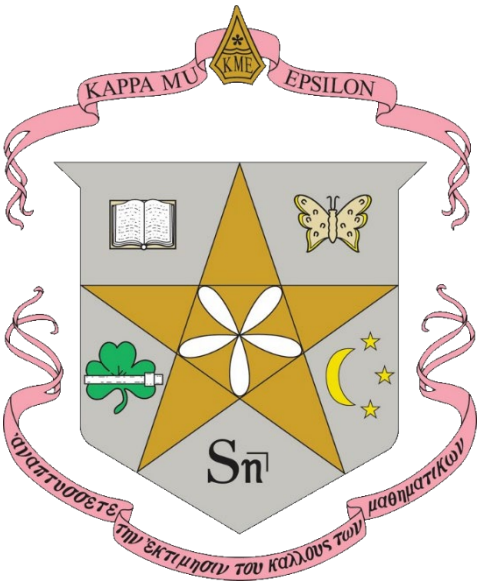

Kappa Mu Epsilon National Mathematics Honor Society

VIRTUAL

South-Central Regional Convention

March 5, 2022

Hosted by the Texas Kappa Chapter at the University of Mary Hardin-Baylor

Participating Chapters

Kansas Alpha, Pittsburg State University, Pittsburg, KS

Maryland Delta, Frostburg State University, Frostburg, MD

Missouri Beta, University of Central Missouri, Warrensburg, MO

Missouri Kappa, Drury University, Springfield, MO

Missouri Xi, William Woods University, Fulton, MO

Missouri Theta, Evangel University, Springfield, MO

New York Eta, Niagara University, Lewiston, NY

Oklahoma Alpha, Northeastern State University, Tahlequah, OK

Texas Kappa, University of Mary Hardin-Baylor, Belton, TX

Schedule

Opening Keynote			
9:00-9:55	Dr. Michael Dorff	Brigham Young University	How mathematics is making Hollywood movies better.

Session One 10:00-11:25			
10:00-10:15	Luan Nguyen	Northeastern State University	The Cayley Type Theorem for Semigroups
10:20-10:40	Dr. Cynthia Huffman	Pittsburg State University	Ringing Math
10:45-11:00	Sean Lowry	Drury University	Implications of Blockchain Consensus Mechanisms
11:05-11:25	Dr. Chuang Shao	Northeastern State University	Nurturing Resilience in Math Students
Group Photo			

Break 11:25-11:50

Session Two 11:50-12:50			
11:50-12:05	Shayna Myshrall	Niagara University	The Baserunning Problem
12:10-12:30	Dr. Sam Ivy	University of Mary Hardin-Baylor	Classifying the Fine Structures of Involutions Acting on Root Systems
12:35-12:50	Kyla Willever	Northeastern State University	The Relationship Between Irreducible and Prime Elements
Group Photo			

Closing Keynote			
1:00-2:00	Dr. Joseph Gallian	University of Minnesota Duluth	Breaking Driver's License Codes

Abstracts

Dr. Michael Dorff, Brigham Young University

How mathematics is making Hollywood movies better

What's your favorite movie? *Star Wars*? *Avatar*? *The Avengers*? *Frozen*? What do these and all the highest-earning Hollywood movies have in common? Mathematics! You probably didn't think about it while watching these movies, but math was used to help make them. In this presentation, we will discuss how math is being used to create better and more realistic movies. Along the way, we will discuss some specific movies and the mathematics behind them. We will include examples from Disney's 2013 movie *Frozen* (how to use math to create realistic-looking snow) to Pixar's 2004 movie *The Incredibles* (how to use math to make an animated character move faster). Come and join us and get a better appreciation of mathematics and movies.

Luan Nguyen, Northeastern State University

The Cayley Type Theorem for Semigroups

We will give a gentle introduction to semigroups. We will provide the audience with several examples of semigroups and introduce the faithful representation, concluding the talk with the Cayley Theorem for semigroups.

Dr. Cynthia Huffman, Pittsburg State University

Ringing Math

Change ringing, the ringing of church tower bells in permutations at important events such as weddings and funerals, dates back to 1610. By 1670, authors of change ringing compositions, such as Fabian Stedman, seemed to be aware of some mathematical concepts at least 150 years before mathematicians. In this presentation, we will look at some of the connections between change ringing and mathematics. A demonstration of ringing mathematics on handbells will be included.

Sean Lowry, Drury University

Implications of Blockchain Consensus Mechanisms

A distributed system is one that has no central authority, i.e. decentralized. The Byzantine Generals Problem illustrates a situation in which a distributed system may fail to reach consensus on state. Computer and blockchain systems attempt to solve this problem by using consensus mechanisms to reach a full agreement on the current state of a distributed network. Cryptocurrencies, such as Bitcoin and Ethereum, use consensus mechanisms to verify transactions on the blockchain. Bitcoin's consensus mechanism, Proof-of-Work (PoW), implements the original Satoshi protocol for maintaining a blockchain. This protocol consists of miners on the network competing to earn the monetary reward for adding a block to the chain. The miners compete by leveraging their computational power against the rest of the network by calculating

cryptographic hash functions as quickly as possible. Validated transactions are added to candidate blocks and must adhere to consensus rules to be recognized by other nodes as legitimate so the block can be added and the creation of the next block can take place. The use of cryptographic hash functions ensures a secure, immutable blockchain that is available to anyone with a full node. However, Bitcoin mining has received widespread attention and criticism for its energy consumption. As a result, alternatives to PoW's computation-heavy protocol have been developed on competing blockchains. For example, the second most popular consensus mechanism, Proof-of-Stake (PoS), features an efficient, energy-inexpensive protocol where nodes participate in validation by staking a portion of their assets. This protocol would also feature on-chain governance, which would enable the network to vote on potential changes in the future. The second largest cryptocurrency, Ethereum, is currently switching from PoW to PoS. This has led to staunch debate between both communities as there are pros and cons to both protocols. In this presentation I will compare these two consensus mechanisms on the grounds of efficiency, security, decentralization, and environmental impact. I will also explore proposed modifications, potential threats, and real-world applications. Finally, I will present this information in a larger context to evaluate state-of-the-art blockchain technology and the direction of blockchain as a whole.

Dr. Chuang Shao, Northeastern State University

Nurturing Resilience in Math Students

We all hope every student had a great experience in math classes and grew into a happy, resilient, confident, and capable math learner. However, as a math professor, I overhear students telling me that they never enjoyed math, even hated math. Is it possible to turn math haters into math lovers? How could we better nurture students in math learning? In this session, I would like to share my thoughts on

- increasing students' buy-in by leading them to view concepts from different angles,
- inviting students to share their thoughts and provide suggestions afterward,
- and providing appropriate challenges to students at varying levels of understanding to help them thrive.

Shayna Myshrall, Niagara University

The Baserunning Problem

Baserunning is an essential part of the game of softball because it is necessary to score runs and win games. In our study, we used the Calculus of Variations in order to derive optimal paths for baserunners. Such optimal paths arise as minimizers of a time integral that represents a runner's time to go around the bases. In an effort to model real-life scenarios, we include parameters in our model that allow us to produce curves with various desired properties. Furthermore, we use a shooting method to compute numerical solutions in the form of coordinates for the optimal paths. Using these curves,

we constructed final baserunning paths all the way around the bases. Our code generates times for these final paths given a runner's velocity. Additionally, we considered alternative scenarios where the runner does not run all the way around the bases. The results of this study allow us to form many different running paths depending on the type of hit a runner gets and the baserunning decisions that a runner makes, and then to compute how long it will take a runner to run these paths. These types of results can be beneficial to both coaches and players because they will help them to determine the most efficient ways to produce runs and win games.

Dr. Samuel Ivy, University of Mary Hardin-Baylor

Classifying the Fine Structures of Involutions Acting on Root Systems

Within Lie Theory, root systems are collections of vectors in Euclidean space. They become a point of interest because they have, encoded within them, much information about their associated Lie algebras and Lie groups—also possessing a neat algebraic and combinatorial structure. This presentation will introduce root systems and special mappings, called involutions, that produce fine structures within these root systems.

Kyla Willever, Northeastern State University

The Relationship Between Irreducible and Prime Elements

Earlier in my college career, I was taught about irreducible elements. Though often similarly described, there are some important differences between prime and irreducible elements. I will strive to prove this important distinction in a way that is concise and understandable.

Dr. Joseph Gallian, University of Minnesota Duluth

Breaking Driver's License Codes

Many states use complicated algorithms or formulas to assign driver's license numbers but keep the method confidential. Just for the fun of it, I attempted to figure out how the states code their license numbers. In this talk I will discuss how I was able to break the codes for Minnesota, Michigan, New York and Missouri. (Minnesota and New York changed their method in the early 2000s.) The talk illustrates an important problem-solving technique used by scientists but is not emphasized in mathematics classes. It also teaches the lesson that sometimes things done just for the sake of curiosity can have applications. The talk is intended for a general audience. No advanced mathematics is needed.