**Abstracts**

**Invited Talk: “Is Everything Predictable? A Mathematical Discussion of Free Will and Determinism”**

Dr. Matt Wright, Missouri State University

Has the course of the universe already been determined by events of the past, or can the future be influenced by some unpredictable action via free choice or random chance? This question continues to be contested among philosophers and theologians, but it also has a great impact in science by influencing the very methods we use to learn about the universe. Can everything be predicted given enough information? Or does God "play dice with the universe?" This talk will offer a mathematical viewpoint on the issue by focusing on a few counter-intuitive results that seem to offer evidence for each side of the argument.

**“Extending a Complex Fractal”**

Luke Abbott, Southwest Baptist University

Faculty Advisor: Dr. Steve Bowling

The purpose of this presentation is to illustrate the generalizing of complex fractals, specifically the Mandelbrot Set, into hypercomplex space. This presentation will explain and illustrate how complex numbers in fractal expressions can be replaced with hypercomplex numbers (such as quaternions, bi-complex numbers, octonions, etc.) expanding the dimensions of the fractal far beyond the original two. Using dimensional slicing these hyper-dimensional shapes can be displayed in three-dimensional space, creating a wide variety of three-dimensional representations of any fractal. This generalization could very easily lead to the discovery of extraordinary hyper-dimensional fractals that have never before been encountered.

**“Subgroup Lattices of Genus One”**

Jeremy Berry, Missouri State University

Faculty Advisor: Dr. Les Reid

Extending the work of Bohanon and Reid in their paper titled "Finite groups with planar subgroup lattices", one might ask when does a group have subgroup lattice that is embeddable in a surface of genus equal to one? That is to say, which subgroup graphs can be drawn on the surface of the torus (oriented surface of genus one) or in the projective plane (non-orientable surface of genus one)? We completely investigate and classify subgroup graphs of cyclic, abelian and non-abelian groups of the latter with partial results for the former. After introducing the necessary background information, we discuss the process and techniques which were used to classify said subgroup lattices.

**“Minimum Exponential Dominating Sets of Connecting Cycles”**

Mandy Bright, Westminster College

Faculty Advisor: Dr. Erin Martin

The purpose of this research is to explore the behavior of minimum exponential dominating

sets of connecting separate and equal cycles. A minimum exponential set is a subset of

vertices of a graph that have the property to give weight to all other vertices in the graph.

It is well known that the size of a minimum exponential dominating set for a cycle of size *n*

is  for  and 2 for *n* = 4. When two cycles of size *n* are connected at one vertex, we

can prove that the size of the minimum exponential dominating set is  for  and 2 for *n* = 4. We can also prove that the size of the minimum exponential dominating

set of two cycles of size  connected at two vertices distance *d* apart is given by



We will further look into connecting additional cycles to make a conjecture to generalize the

behavior of the minimum exponential dominating set.

**“A Particle in a One Dimensional Box”**

Jonathan Dannatt, Lyon College

Faculty Advisor: Dr. Megan Powell

In this presentation we will discuss the postulates of quantum mechanics, what it means to be quantized, and the energy associated with a particle in a one dimensional box. The simplest quantized model is found by placing a particle in a one dimensional box. Contrary to intuition, the particle does not have equal energy at every point in the box, therefore, does not have equal probability of being everywhere in the box. I will discuss this result as time permits.

**“Schur Orthogonal Decomposition of Matrices and Applications”**

Heath Gemar, Missouri State University

Faculty Advisor: Dr. Jorge Rebaza

Orthogonal matrices are known to be very useful in all areas of linear algebra, matrix computations, as well as in physics and dynamical systems. A Schur factorization of a given square matrix A is a very powerful and useful tool, which provides a way to compute and associate eigenvalues with orthogonal sets of vectors that span the corresponding invariant subspaces. This is an essential tool in boundary value problems in physics, and dynamical systems in general, when we are trying to compute orthonormal sets of vectors that span stable or unstable subspaces. We will discuss some details on the proof of existence of such factorization, and some basic applications.

**“The Mathematics of Bicycles”**

William A. Jones, Missouri State University

Faculty Advisor: Dr. William Bray

The bicycle has been a part of our society for a very long time and has typically been seen as a more efficient way than walking to get to where you need to go.  I intend to delve into the mathematics behind this machine an calculate the amount of work a cyclist will have to do in order to travel between two points.

**“The Greatest of Women Mathematicians”**

Sarah E. Kramer, Missouri State University

Faculty Advisor: Dr. William Bray

A brief history of the life and work of Emmy Noether, the woman the New York Times calls "The Mighty Mathematician You've Never Heard Of".

**“Kermack McKendrick Epidemic Model : A New Approach”**

Matthew McCoy, Drury University

Faculty Advisor: Dr. Bob Robertson

The Kermack-McKendrick Epidemic Model attempts to represent a population responding to an epidemic. The population is split up into three classes: those that are either susceptible (S), infective (I), or removed (R). We give a new derivation of the SIR model using a Taylor expansion of one and two variable functions. This paper analyses some properties of the SIR model such as proving positivity of solutions and an analysis of stability properties.

**“Minimizing a Sum of Trigonometric Functions”**

Wesley Perkins, Lyon College

Faculty Advisor: Dr. Megan Powell

I will present a problem from the 2003 Putnam Exam, wherein the absolute value of the sum of the six trigonometric functions is to be minimized.  I will discuss multiple ways to approach the problem and show my approach using Lagrange multipliers.

**“Characteristics of Tangent Lines in ℤ*p*[*x*]”**

John Pope and Rafeh Qureshi, Lyon College

Faculty Advisor: Dr. Jeremy Chapman

In undergraduate mathematics, calculus is primarily studied in the infinite field, ℝ. In our research, we have shifted this focus from ℝ to the finite field, ℤ*p*. In particular, we have researched polynomials and their behaviors in ℤ*p* [*x*] while comparing these discovered behaviors with the well-known characteristics of polynomials in ℝ[*x*]. We will present a proof by induction that demonstrates that, similar to polynomials in ℝ[*x*], the tangent line passing through any given point on a polynomial of degree *n* in ℤ*p*[*x*] can intersect that polynomial at most  times where .

**“Pi”**

Ashley Russell, Missouri State University

Faculty Advisor: Dr. William Bray

This talk will discuss the history of the irrational number pi, ancient methods for approximating it, and the numerous formulas for finding digits of pi.

**“Prime Graphs and Their Properties”**

Ali Soliman, Missouri State University

Faculty Advisor: Dr. Les Reid

The prime graph associated to a finite set of positive integers is the graph whose vertices are the integers and an edge is drawn between two vertices if their sum is prime. We will demonstrate some of their basic properties and pose a handful of questions that present themselves for further exploration.