2008 Conference Schedule

9:00-10:00: Registration-Atrium

10:00-10:30: Breakfast and Introduction-Atrium

	Room 1095	**Room 1111**	**Room 1120**	**Room 1062: COMAP**
10:30-10:45	Nicholas Hurl	Bryan Bischof	Moriah Wright	
10:50-11:05	Nick Haught	Lisa Curll	Phillip Snow	MCM - B (YSU)
11:10-11:25	Paul Havens	Krista Foster	Tyler Drombosky	MCM - B (SRU)
11:30-11:45	Alan Hylton	Sarah Ritchey	John Hoffman	MCM - B (YSU)
11:50-12:05	Brian Stewart	Andy Polack	Jeffery Thomas	MCM - B

12:05-1:00: Lunch-Atrium

	Room 1095	**Room 1111**	**Room 1120**	**Room 1062: COMAP**
1:00-1:15	Aaron Meikle	Michelle Cordier	Douglas Wajda	MCM - A (YSU)
1:20-1:35	Jordan Weaver	David Drobnick	Kumnit Nong	MCM - A (WC)
1:40-1:55	David Martin	Kai Ng	Amber Hannold	MCM - A (YSU)
2:00-2:15	Matthew Ward	Allen Cox	Che Bello & Kevin Laylin	MCM - A (YSU)
2:20-2:35		Kevin Kreighbaum	Jared Ruiz	MCM - A

2:40: Closing Remarks-Atrium

10:30-10:45 **Nicholas Hurl** **Room 1095**

Punching Holes in the Plane

Kent State University
Advised by: Dr. Stephen M. Gagola Jr.

I will discuss the Putnam Problem - A paper punch that can be centered at any point of the plane and that, when operated, removes from the plane precisely those points whose distance from the center is irrational. How many punches are needed to remove every point?

10:30-10:45 **Bryan Bischof** **Room 1111**

An Orbital Basis for the Framed Link Vector Space of Chord Diagrams

Westminster College
Advised by: Dr. Barbara Faires

As it is now common to study Vassiliev invariants using the combinatorics of chord diagrams, the algebraic nature of chord diagrams has become interesting. We construct the basis for the vector space spanned by chord diagrams with n chords and m link components, modulo 4T relations. That is, we construct the basis of the dual of the nth summand for the associated graded vector space for the filtered vector space of Vassiliev invariants of m-component framed links, $\left(\mathcal{V}_n^m/\mathcal{V}_{n-1}^m\right)^*$. We reduce the problem to finding a basis for connected chord diagrams, modulo 4T relations and proceed by computer. Previously, this has been known for knots up to $n = 10$, we calculate the basis for links up to $n = 5$. In this presentation, we present these results from the 2007 Kansas State REU.

10:30-10:45 **Moriah Wright** **Room 1120**

Markov Transition Matrices

Youngstown State University
Advised by: Dr. J. Douglas Faires

Markov chains are used to represent evolving processes between a number of possible states of the processes. Matrices that describe the states are called transition matrices. Applications of these matrices used to model population migration in the Youngstown area will be considered.

10:50-11:05 **Nick Haught** **Room 1095**

Symmetric Functions

Youngstown State University
Advised by: Dr. Frank Ingram

We explore using the Schur function and monomial function to relate group actions in combinatorics, topology and algebra.

10:50-11:05 **Lisa Curll** **Room 1111**

Fuzzy Logic

Youngstown State University

Advised by: Dr. Frank Ingram III

A fuzzy set is a generalization of normal sets, where the elements of the set have degrees of membership between 0 and 1. These sets are used to define a range of inputs in fuzzy logic systems and make human-like decisions based on this range. Fuzzy logic creates a definite output for situations where all data put into the system may not be precise. This system has been and is presently being used to direct the actions of machines designed to mimic human intelligence.

The presentation will detail the methods involved in fuzzy sets. We will discuss how to assign values to elements in a set, the steps of the Fuzzy Logic Method, how this method is used in everyday life, and various examples of how this information can be used to make machines more apt to perform as we might when forced to work from fuzzy data.

10:50-11:05 **Phillip Snow** **Room 1120**

A Brief Introduction to Inner Product Spaces and Orthonormal Bases

Cleveland State University

Advised by: Dr. Leah Gold

We will take a look at inner product spaces and their orthonormal bases. We will begin by discussing vector spaces and inner products. Next we will discuss orthonormal bases. We will conclude with a quick finite dimensional example of an orthonormal basis for an inner product space, and then we will examine, in a bit more detail, Fourier series as an orthonormal basis for an infinite dimensional vector space.

11:10-11:25 **Paul Havens** **Room 1095**

Doomsday

Lakeland Community College

Advised by: Dr. Carl Stitz

A description of a form of differential equation that shows asymptotic behavior at a specific time value, the so-called "doomsday".

11:10-11:25 **Krista Foster** **Room 1111**

Too Tall for Volleyball

Youngstown State University

Advised by: Dr. G. Jay Kerns

Volleyball players usually appear to be taller than average. Does height translate to wins, or are other factors more significant? Through statistical analysis of college level volleyball teams, I will determine which factors contribute to a team's overall win percentage. I will discuss the correlations between various team statistics, including average height and division.

11:10-11:25 **Tyler Drombosky** **Room 1120**

The Effective Condition Number

Youngstown State University

Advised by: Dr. J. Douglas Faires

The condition number is very useful when determining the accuracy of solutions to linear systems when using computer solvers. However, recent meshless methods for approximating partial differential equations have been know to create ill-conditioned matrices, yet are still able to produce results that are close to machine accuracy. We consider the relationship between the effective condition number and the accuracy of approximations for ill-conditioned linear systems that arise when using the Method of Fundamental Solutions.

11:30-11:45 **Alan Hylton** **Room 1095**

Fractional Calculus

Cleveland State University

Advised by: Dr. Leah Gold

Fractional Calculus is a generalization of calculus where one can take derivatives and integrals of arbitrary order. This presentation is an introduction to taking derivatives of real orders (first, half, etc.) of polynomials and an overview of how this applies to the tautochrone problem.

11:30-11:45 **Sarah Ritchey** **Room 1111**

An Anthropometric Analysis of a Barbie Doll

Kennedy Catholic HS

Advised by: Dr. Nathan Ritchey

Introduced in 1959, Barbie dolls have been very popular. According to sales figures, about two Barbie dolls are sold every second of every day to someone in the world. Barbie, however, has been at the center of quite a bit of controversy and it has been suggested that the dolls do not represent the average woman.

In this anthropometric research, Barbie is analyzed and compared with female models, athletes, and teenagers. Although the research concludes that Barbie does not represent the average female, it may be surprising to find out which body measurements are the most out of sync.

11:30-11:45 **John Hoffman** **Room 1120**

Fractals and the Cantor Set

Youngstown State University

Advised by: Dr. Roy Mimna

I will discuss fractal dimension in general, with examples, including the Ternary Cantor set.

11:50-12:05 **Brian Stewart** **Room 1095**

Rational Approximation of Irrational Numbers

Cleveland State University

Advised by: Dr. Leah Gold

This talk will discuss Diophantine approximation: the approximation of irrational numbers by rational numbers. The discussion presents topics including the density of the real line and Dirichlet's Approximation Theorem as motivation. Continued fractions are introduced as a mathematically elegant method for finding the best rational approximations. The Golden Ratio and the Liovillian constant are used as illustrations and to provoke discussion of transcendental numbers.

11:50-12:05 **Andy Polack** **Room 1111**

NURBS Curve Interpolation of Artistic Data

Westminster College

Advised by: Dr. John Bonomo

Non-Uniform Rational Basis Spline (NURBS) curves and surfaces have been used in the Computer Aided Design (CAD) industry since the early 1970s. Pixar's first major blockbuster, Toy Story, utilized NURBS to model all of the characters in the movie. While they are clearly highly powerful and expressive constructs, NURBS also are limited in some ways. The most pertinent limitation is that NURBS is an approximate technique which does not guarantee interpolation of a fixed number of data points. This makes converting polygon-specified artistic data into a set of NURBS curves and surfaces very difficult. Typically, NURBS are generated by artists using programs to manipulate the placement of the control points needed to specify the curves and surfaces. There are many existing artistic models which are not specified as a NURBS. How could one convert such a model (automatically, without human intervention) into a NURBS surface? I will explore one such answer to this question by exploring a method of determining a NURBS curve from previously specified discrete artistic data via the analysis of mathematical curvature.

11:50-12:05 **Jeffery L. Thomas** **Room 1120**

The Spiral Algorithm for Constructing Fullerene Isomers

Edinboro University of Pennsylvania

Advised by: Dr. Douglas Puharic

The Spiral Algorithm is a practical solution to the fullerene isomer problem. We will derive the Spiral Algorithm from conjectures about the construction of fullerenes.

1:00-1:15 **Aaron Meikle** **Room 1095**

The Steiner - Lehmus Theorem

Youngstown State University

Advised by: Dr. Thomas Smotzer

In this presentation, we will prove the Steiner Lehmus Theorem, which states: if 2 angle bisectors for a triangle are equal then the triangle is isoceles.

1:00-1:15 **Michelle Cordier** **Room 1111**

Clever Procedures to Complete the Putnam Exam

Kent State University

Advised by: Dr. Stephen Gagola Jr.

A brief history and statistical introduction of the Putnam proceeds a lively discussion of various modus operandi to overcome staring blankly at the pages of the Putnam exam. We will explore tricks and methodology that have helped the Putnam Practice Team at Kent State University. Example problems from previous exams will be demonstrated during this talk.

1:00-1:15 **Douglas Wajda** **Room 1120**

Introduction to the Hodgkin-Huxley Model

Youngstown State University

Advised by: Dr. Jozsi Jalics

In the early 1950's, Alan Lloyd Hodgkin and Andrew Huxley developed a set of differential equations to effectively model electrical responses in neurons. What the equations do is effectively represent the shape of a spike in the voltage of the neuron membrane. Spikes are caused when the voltage difference across the membrane comes out of balance. This talk will be a presentation using numerical techniques to apply the Hodgkin-Huxley model to various neuron states.

1:20-1:35 **Jordan Weaver** **Room 1095**

Stewart's Theorem

Youngstown State University

Advised by: Dr. Thomas Smotzer

We will discuss the proof and uses of Stewart's Theorem about triangles. An example using the theorem will be done. Also, we will prove a nice result using the theorem that is very hard to prove without Stewart's Theorem.

1:20-1:35 **David Drobnick** **Room 1111**

A Little Graph Theory

Kent State University

Advised by: Julie Christensen

Topics will probably include areas dealing with Complete Graphs, Euler's Equation, Linear Equations, perhaps some generating functions and other topics based on time.

1:20-1:35 **Kumnit Nong** **Room 1120**

Thin Film Evolution over a Porous Media

George Mason University

Advised by: Dr. Daniel M. Andersons

We study the behavior of the aqueous layer on the pre-cornea tear film of a human. The model considers the effect of gravity of the film orientation with the inclusion of the porous media. A fluid dynamic model for the thin film over the porous media is formulated using a nonlinear fourth order partial differential equation with three boundary conditions for the thickness of the fluid layer. By using a numerical analysis scheme, the evolution equation is solved for accurate time and optimized effect of various parameters (actual realistic values) for the rupture of the thin film. The results indicate that the property of the porous media is a dominant effect, unlike the gravity, which is a minor effect to the consequence of the film rupture. Nevertheless, all of the parameters, which affect the outcome of the equation solving process, are included for accurate results for the model simulation.

1:40-1:55 **David Martin** **Room 1095**

Optimizing Quadratic Forms on the Unit Sphere

Youngstown State University
Advised by: Dr. Thomas Smotzer

When the universe of discourse is (or can be transformed into) the set of unit vectors, an elegant manner of determining the extreme values of a quadratic form involves analysis of the associate matrix. In general, this works great for problems of arbitrary dimension.

1:40-1:55 **Kai Ng** **Room 1111**

The Pigeonhole Principle and Ramsey's Theorem

Cleveland State University
Advised by: Dr. Leah Gold

"If n $>$ m pigeons are put into m pigeonholes, there is a hole with more than one pigeon."

The statement of the Pigeonhole Principle sounds so obvious and intuitive that it is considered trivial by some people. However, this subtle principle, when invoked in mathematical arguments, can produce powerful and not-so-intuitive results. This is evident in the proofs of some combinatorial existence theorems. In this presentation, we will consider several versions of the principle. We will use examples to illustrate the application of the principle to mathematical arguments. We will present a combinatorial existence theorem, namely Ramsey's Theorem, along with its proof in which the principle plays an instrumental part.

1:40-1:55 **Amber Hannold** **Room 1120**

Snell's Law and Calculus Methods as a General Illustration of the Phenomenon of Rainbows

Edinboro University of Pennsylvania
Advised by: Dr. Emily Sprague

The occurrence of rainbows in nature offers much more than an aesthetically pleasing phenomenon. Specifically, the occurrence and characteristics of the rainbow phenomenon is illustrated through a variety of mathematical concepts. The current paper discusses the physical and optical characteristics of the rainbow phenomenon through the application of Snell's Law of Refraction, as well as the Closed Interval Method for locating extrema, along with the methods corresponding theories.

2:00-2:15 **Matthew Ward** **Room 1095**

Varieties of Topological Groups

Youngstown State University
Advised by: Dr. Angela Spalsbury

A variety of topological groups is a class of topological groups that is closed under taking arbitrary products, subgroups, and quotients. We examine some examples and fundamental properties of these varieties.

2:00-2:15 **Allen Cox** **Room 1111**

Edge Disjoint Paths in Complete n-Partite Graphs

Kent State University
Advised by: Dr. Stephen Gagola

Over the summer, I researched properties of complete n-Partite graphs. A complete n-Partite graph is a graph with n disjoint sets of vertices, such that each vertex $v \in A_i$ is connected to every vertex $w \notin A_i$. One of these particular properties is the number of edge disjoint paths that a complete n-Partite can possess. A theorem concerning this will be stated and proved. Also, time permitting, a brief introduction will be given to what the *congestion* of a graph is, and why it is important. No familiarity with graph theory is needed for this talk.

2:00-2:15 **Che Bello and Kevin Laylin** **Room 1120**

Finite Linear Games

Lakeland Community College
Advised by: Dr. Paul Zachlin

The topic is Finite Linear Games and their applications. A finite Linear game can be used to solve a physical system with a finite number of states. By using a set of vectors to represent state changes, a system can be solved to get a specific result.

2:20-2:35 **Kevin Kreighbaum** **Room 1111**

Can You Spare a Square?

Mount Union College
Advised by: Dr. Sherri Brugh

Catalan numbers are a sequence of natural numbers found in various counting problems. The sequence begins: 1, 1, 2, 5, 14, 42... and can be defined recursively. Find out how to derive these numbers by simply entering a bathroom stall.

2:20-2:35 **Jared Ruiz** **Room 1120**

Predicting Presidents

Youngstown State University
Advised by: Dr. Angela Spalsbury

When it comes to running for President of the United States of America, a lot of variability and questions occur. Using statistical and probabilistic procedures, this talk will present several different scenarios regarding the Democratic primaries. Afterwards, we will examine which candidate (Democratic or Republican) has the best chance of winning the General Election, and decide who will most likely be the President of this great nation.

2008 MCM / ICM - COMAP Modeling Problems

Continuous Modeling (Problem A)

Consider the effects on land from the melting of the north polar ice cap due to the predicted increase in global temperatures. Specifically, model the effects on the coast of Florida every ten years for the next 50 years due to the melting, with particular attention given to large metropolitan areas. Propose appropriate responses to deal with this. A careful discussion of the data used is an important part of the answer.

Discrete Modeling (Problem B)

Develop an algorithm to construct Sudoku puzzles of varying difficulty. Develop metrics to define a difficulty level. The algorithm and metrics should be extensible to a varying number of difficulty levels. You should illustrate the algorithm with at least 4 difficulty levels. Your algorithm should guarantee a unique solution. Analyze the complexity of your algorithm. Your objective should be to minimize the complexity of the algorithm and meet the above requirements.

2008 PME National Meeting at MAA MathFest

Please join us at this year's meeting to be held July 31 through August 2, 2008, in Madison, Wisconsin. Students are invited to give fifteen minute talks on any mathematical topic or application in areas such as statistics, computing, or operations research. Topics including expository research, interesting applications, problems, etc. are also welcome. Transportation reimbursement is also available to those who qualify. Visit the National Pi Mu Epsilon website at http://www.math-pme.org for more details.

A Warm Welcome to the Participating Schools:

- Clarion University of Pennsylvania
- Cleveland State University
- The College of The Bahamas
- Edinboro University of Pennsylvania
- George Mason University
- Kennedy Catholic High School
- Kent State University
- Kent State University Tuscarawas Campus
- Lakeland Community College
- Lorain County Community College
- Mount Union College
- Pennsylvania State University
- Slippery Rock University
- United Local High School
- University of Toledo
- Westminster College
- Youngstown State University

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