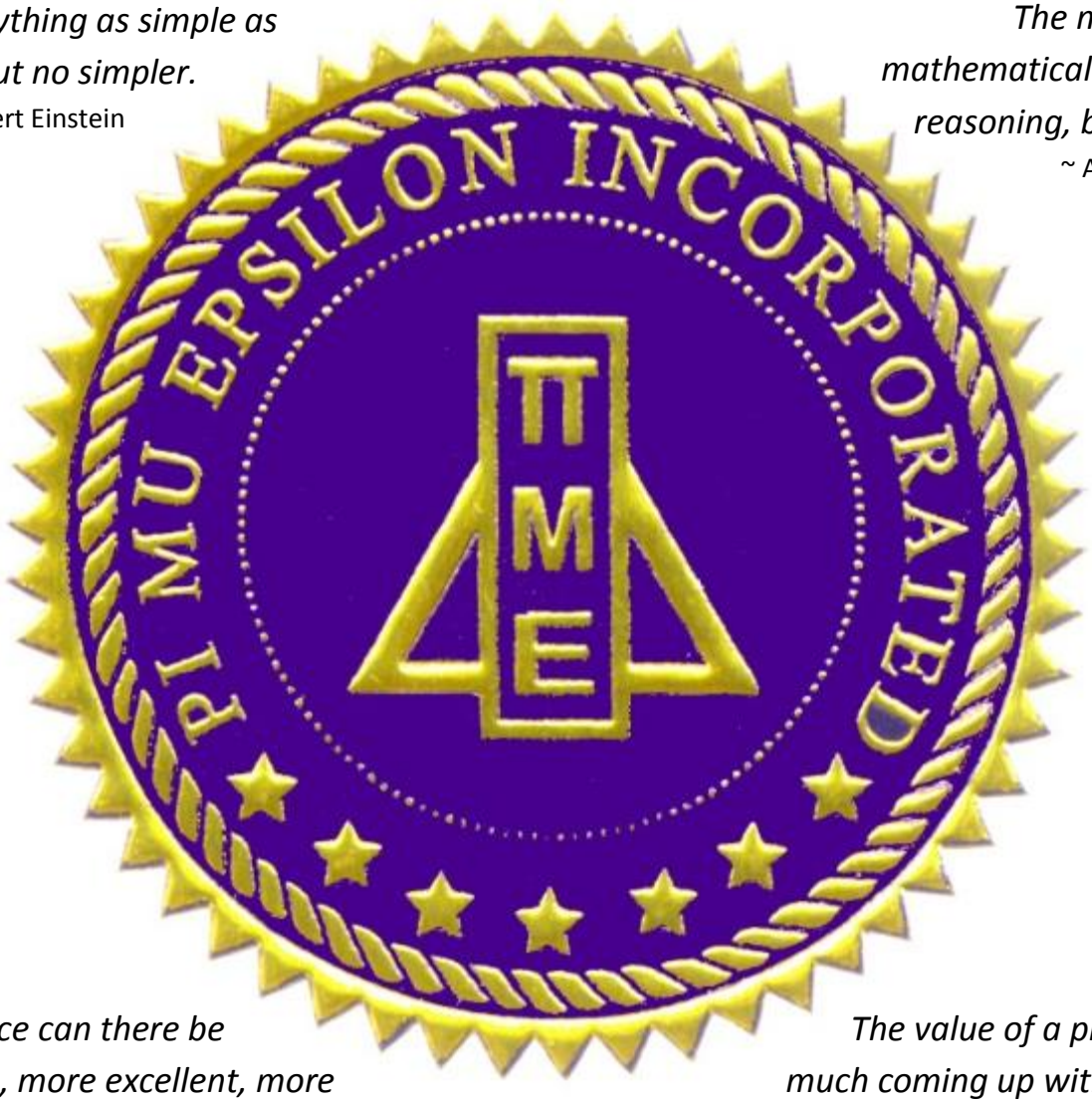
Youngstown State University

Regional Pi Mu Epsilon Conference

February 26, 2011

Make everything as simple as possible, but no simpler.
~ Albert Einstein

The moving power of mathematical invention is not reasoning, but imagination.
~ Augustus De Morgan



What science can there be more noble, more excellent, more useful for men, more admirably high and demonstrative than mathematics.
~ Benjamin Franklin

The value of a problem is not so much coming up with the answer as in the ideas and attempted ideas it forces on the would-be solver...
~ I. N. Herstein

Sponsored by NSF Grant DMS - 0846477

A Warm Welcome to the Participating Schools:

- Boardman High School
- Clarion University of Pennsylvania
- Cleveland State University
- Duquesne University
- Dickinson College
- Edinboro University of Pennsylvania
- Gatton Academy
- John Carroll University
- Kennedy Catholic High School
- Kent State University
- Lake Erie College
- Lakeland Community College
- Lorain County Community College
- New London High School
- The Ohio State University
- Penn State Erie
- Slippery Rock University
- University School
- Warren G. Harding High School
- West Liberty University
- Western Kentucky University
- Westminster College
- Youngstown State University

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Funding for this conference is provided by NSF grant DMS-0846477 through the MAA Regional Undergraduate Mathematics Conferences program `http://www.maa.org/RUMC/`. Support from NSF Grant DBI-0827205 is also acknowledged for sponsoring a session in mathematical biology.

Special thanks to the Department of Mathematics and Statistics and the Center for Undergraduate Research in Mathematics (CURMath) at Youngstown State University.

2011 PME Conference Schedule

9:00–10:00: Registration - Third Floor, Room 3427

10:00–10:30: Breakfast & Introduction - Third Floor, Room 3422

	Room 2201	**Room 2204: Mathematical Biology**	**Room 2212**
10:30-10:45	Jessica Gonda & Drew Saluga	Lisa Curll	Stephen Timko
10:50-11:05	Sarah Ritchey	Sepideh Khavari	Jenna Huston
11:10-11:25	Michael Coates	Alexandra DeCarlo, Markus Ernst, & Anthony Bates	Anna Levina
11:30-11:45	Bradley Slabe	Joshua Mike	Greg Clark
11:50-12:05	Henry A. Butler II	Chip Hosie	Tanya Riston

12:05–1:00: Lunch - Third Floor, Room 3422

	Room 2201	**Room 2203**	**Room 2204: Mathematical Biology**	**Room 2212: COMAP**
1:00-1:15	Mario Sracic	Brian Harrison	Tucker Joyce & Ben Howard	MCM-A
1:20-1:35	Matt Alexander	Corey Chadman	Michael Grant & Julia Filiberti	MCM-A
1:40-1:55	David Stolz	Angela Urban	Russell Sundberg	MCM-B
2:00-2:15	Matt Grimm	Ronald A. Balint		MCM-B

2:25: Closing Remarks - Third Floor, Room 3422

Morning Session 10:30-10:45

10:30-10:45 **Jessica Gonda & Drew Saluga**
Actuarial Model of NAT CAT Foundation **Room 2201**
Boardman High School
Advised by: Dr. Thomas Wakefield

The NAT CAT Foundation is responsible for aiding in the repair of damages each year due to national catastrophes. We made a model of the amount of money they will have to spend next year between blizzards, fires, and hurricanes based on past years' data. To find the amount they will have to spend, we used tools and mathematical methods that are similar to what actuaries would use in their field of study.

10:30-10:45 **Lisa Curll**
Stochastic Riparian Ecosystems: A Differential Equation Model **Room 2204**
Youngstown State University
Advised by: Dr. George Yates

Zoar Valley, a riparian ecosystem in New York State characterized by very low human disturbance, is one of the last "old-growth" environments in the northeastern United States. Periodic flooding changes the condition of the canyon floor, occasionally wiping out whole landforms once full of vegetation. Based on data gathered over the last seven years, our model investigates the growth patterns of four categories of trees within the valley: Juvenile and Mature, Early- and Late-Sucessional. Utilizing a system of ordinary differential equations, we can estimate the number of trees of each type present at a given time. The model also contains a term for the stochastic, damaging flood events, based on USGS data.

10:30-10:45 **Stephen Timko**
An Investigation of the Agreement Among Hypothesis Tests for 2x2 Tables **Room 2212**
Duquesne University
Advised by: Dr. John Kern

In this talk, we consider three statistical procedures for making inference on sample data that can be represented in a 2x2 table. We explore similarities and differences among these procedures (or hypothesis tests) via simulation techniques. These simulations suggest discrepancies among these tests behave in a predictable way; this behavior is then confirmed via computational proof.

Morning Session 10:50-11:05

10:50-11:05 | **Sarah Ritchey**
Putting Some Harmony in the Harmonic Series | **Room 2201**
Kennedy Catholic High School
Advised by: Dr. Nathan Ritchey

It is well known that the harmonic series diverges. The question as to whether convergence is possible for series that are defined by removing terms of various types from the harmonic series will be explored in this presentation. For example, when all of the terms of the harmonic series whose denominator is not a prime number are removed, the resulting series surprisingly still diverges. This series and other series that are created by "thinning" the harmonic series will be discussed. Finally, a startling consequence of one resulting convergent series will be presented.

10:50-11:05 | **Sepideh Khavari**
Modeling of Regulation of Gene Expressions in the Presence of Toxic Selenite in *E. coli* | **Room 2204**
Youngstown State University
Advised by: Dr. George Yates

The regulation of gene expressions for a wild-type Selenite-resistant strain and several mutants of E. coli is investigated. A system of differential equations is used to model the expression of certain genes in the presence of toxic Selenite. This system of differential equations can help identify the phase of growth when specific genes are expressed in the presence of Selenite.

10:50-11:05 | **Jenna Huston**
Friendly Partitions of Graphs | **Room 2212**
Westminster College
Advised by: Dr. David Offner

A graph has a friendly partition if there exists some partition of the vertices into two parts such that each vertex has at least as many neighbors on its side of the partition as on the other side. In this talk, we will examine the structure of graphs that have friendly partitions. We will prove that some families of graphs do not have friendly partitions, while others do.

Morning Session 11:10-11:25

11:10-11:25 | **Michael Coates** | **Room 2201**

Anomalous Cancellation

Warren G. Harding High School and Youngstown State University

Advised by: Dr. Nathan Ritchey

Many are familiar with the fact that one can perform the correct division $64/16 = 4/1$ by incorrectly "canceling the sixes." We examine the number theory behind this phenomenon and explain when it can be done in various number bases.

11:10-11:25 | **Alexandra DeCarlo, Markus Ernst, & Anthony Bates*** | **Room 2204**

A Mathematical Model for the Interaction of MMPs and TIMPs in Wound Healing

Western Kentucky University

* Gatton Academy

Advised by: Advised by: Dr. Richard Schugart

So far, there are no mathematical models for the interactions of MMPs and TIMPs in the healing of wounds. Our research is to formulate and evaluate mathematical models of these interactions by comparing our model simulations with data. In this talk, we will present a steady state analysis of our first mathematical model with simulations. We will also present an extended model, for which we will analyze and conduct simulations using Matlab.

11:10-11:25 | **Anna Levina** | **Room 2212**

A Sierpinski Snippet

Kent State University

Advised by: Dr. Stephen Gagola

This talk gives a small glimpse into the exhilarating world of calculus on fractals! We will begin by exploring the construction of the Sierpinski Gasket (SG). We will then introduce harmonic functions, measure, and integration on this strange space, and discuss the importance of this machinery in the search for a mean value property on SG.

Morning Session 11:30-11:45

11:30-11:45 | **Bradley Slabe**
How many primes are less than n?
Youngstown State University
Advised by: Dr. Doug Faires | **Room 2201**

There are infinitely many prime numbers, as shown by Euclid more than two millennia ago. Although there is no function that tells exactly how many primes are less than a given positive integer n, there are asymptotic formulas for approximating this number. In this talk, I will derive such a formula using only calculus. The result will not only tell us the expected number of primes less than a positive integer n, but also give the probability that n is prime.

11:30-11:45 | **Joshua Mike**
Mathematical Modeling of Cardiac Action Potentials and Associated Arrhythmia Vulnerability
Youngstown State University
Advised by: Dr. Joszi Jalics | **Room 2204**

Sex and apex-base differences in cardiac L-type calcium current (ICa-L) levels were found to affect susceptibility to arrhythmogenic early afterdepolarizations (EADs) in adult rabbit left ventricular cardiac myocytes. Now, we have investigated the role of ICa-L in EAD formation in right ventricular myocytes using the patch clamp technique to ascertain the properties and apex-base distribution of the L-type calcium current in adult males and females. Utilizing our data, we performed numerical simulations with a modified version of the Luo Rudy mathematical model of cardiac action potentials (APs). Under 50% suppression of the rapidly inactivating delayed rectifier potassium current used to model Long QT Syndrome Type 2 (LQTS2), female base myocyte simulations exhibited longer APs and increased EAD vulnerability as compared to male base myocytes. The biophysical data and mathematical simulations together support the hypothesis that higher levels of ICa-L contribute to EAD genesis.

11:30-11:45 | **Greg Clark**
Tessellations: Properties and Periodicity
Westminster College
Advised by: Dr. David Offner | **Room 2212**

A plane figure (A) tessellates the plane by translation if the plane can be covered by translated copies of (A) with no gaps or overlaps. In this talk, we investigate tiles that are subsets of the rectangular grid. We will present a proof that a certain type of tile tessellates in a periodic fashion, and give additional information on the periodicity of the tiling.

Morning Session 11:50-12:05

11:50-12:05 | **Room 2201**

Henry A. Butler II

Graphs and Round-Robin Tournaments

Kent State University

Advised by: Dr. Stephen Gagola

This is a presentation of basic results regarding complete, directed graphs.

11:50-12:05 | **Room 2204**

Chip Hosie

No Pain, No Gain - A Closer Look

Edinboro University of Pennsylvania

Advised by: Dr. Frank Marzano

"No Pain, No Gain" is a common saying, especially in exercise venues. This talk stems from research into using differential equations to model a human's growth reaction to applied physical stresses. The idea that you can't get what you want without some type of sacrifice is a truism throughout life. If this saying is true, how can it be quantified and explained?

The project quantifies the saying "No Pain, No Gain", and questions if pain is in fact necessary for growth. We begin by looking at the logic behind the statement. "No Pain, No Gain" is interpreted into a proposition and a truth table developed. The arbitrary sensory experience, "pain", will be defined as a "Stressor" function. Translating the abstract into the concrete allows for manipulation and clarification. Then we examine the human body as if it were a (homogeneous) population of cells. We combine the data predicting lean muscle mass in a population of cells with the stressor function in some common growth models. We look at an exponential growth model, a logistic growth model, and a Lotka-Volterra Predator/Prey growth model based upon these data. Once the models are defined, conclusions are then drawn.

11:50-12:05 | **Room 2212**

Tanya Riston

Investigating the Convergence of an Approximate Solution to a Nonlinear, Nonlocal, Elliptic B.V.P.

Penn State Erie

Advised by: Dr. Daniel J. Galiffa

Authors J. R. Cannon (U. of Central Florida) and D. J. Galiffa (Penn State Erie) have recently published papers on a class of nonlinear, nonlocal elliptic boundary value problems. In their most recent work entitled *"On a Numerical Method for a homogeneous, nonlinear, nonlocal elliptic boundary value problem,"* they proved that the solution to their model exists and is unique. This boundary value problem has a coefficient that is dependent upon the integral of the solution over the domain of the solution as seen below:

$$-\alpha\left(\int_0^1 u(t)dt\right)u''(x)+[u(x)]^{2n+1}=0,\ \ x\in(0,1),\ \ u(0)=a,\ \ u(1)=b.$$

In addition, the authors discretized the analytic problem by using a finite-difference approximation for the derivative and the Trapezoid Rule for approximating the integral. The resulting approximate solution converges to the analytic solution with rate $\mathcal{O}(h)$. We have recently conjectured that this rate can be increased to $\mathcal{O}(h^2)$ by utilizing the Simpson's Rule, as opposed to the Trapezoid Rule. In this talk, we discuss the equation above, as well as the current and future plans regarding the testing of our conjecture.

Afternoon Session 1:00-1:15

1:00-1:15 | **Mario Sracic**
Putnam Problem A1: A Review and Variation of Functions on Squares in a Plane | **Room 2201**
Youngstown State University
Advised by: Dr. Doug Faires

From the 2009 Putnam Exam, we will consider problem A1:

> Let f be a real-valued function on the plane such that for every square ABCD in the plane, $f(A) + f(B) + f(C) + f(D) = 0$. Does it follow that $f(P) = 0$ for all points P in the plane?

By first reviewing a simple solution to the problem, we will then consider whether the problem can hold for squares of integer side length and determine if there exists a real-valued function, $f : \mathbb{R} \to \mathbb{R}$ that is *not* identically 0 for all P. In the process, we discover an interesting property of squares in the plane under the function.

1:00-1:15 | **Brian Harrison**
From Primes to Polygons | **Room 2203**
John Carroll University
Advised by: Dr. Barbara D'Ambrosia

While I was trying to discover my own proof that there are infinitely many primes, I noticed a pattern in the multiplication table. This pattern is that, if a rhombus, specifically oriented, is overlaid on the table, the sum of the values along one diagonal, and of those along the other, are equal. I will explore a generalization of this property in the Cartesian plane, and present a related result about regular polygons in the plane.

1:00-1:15 | **Tucker Joyce & Ben Howard**
A Mathematical Model to Analyze Treatment of a Wound Against Bacterial Infection | **Room 2204**
Western Kentucky University
Advised by: Dr. Richard Schugart

A mathematical model was developed focusing on using oxygen therapy to fight bacterial infection in chronic wounds. The model is a set of ordinary differential equations, which describes the relationship among neutrophils, bacteria, inflammatory cytokines, and reactive oxygen species (ROS). A quasi-steady-state assumption was made for the inflammatory cytokines and ROS by setting the derivative equal to zero for all time. This reduces the model to a system of two equations – neutrophils and bacteria. A steady-state analysis was conducted on the neutrophil/bacteria system to evaluate what happens when time goes to infinity. Model parameters were estimated from both values found in the literature and the steady-state analysis. Model simulations were conducted using Mathematica. The results from the steady-state analysis and computer simulations will be presented in this talk.

Afternoon Session 1:20-1:35

1:20-1:35 | **Matt Alexander** | **Room 2201**

Cracking the Sudoku

Youngstown State University

Advised by: Dr. Doug Faires

Sudoku puzzles can be created by a program using the same logical processes needed to solve them. By knowing how many times it is necessary to use each method we can rate the puzzle's difficulty. All puzzles created using this method will be unique and solvable using logic.

1:20-1:35 | **Corey Chadman** | **Room 2203**

Peano Space-Filling Curve

Kent State University

Advised by: Dr. Laura Smithies

The space filling curve is from $[0, 1]$ to the unit square on $[0, 1] \times [0, 1]$. The curve is surjective but not injective. We will give the sequences in which its limit is the space filling curve. Using some analysis and topology techniques, we will prove the space filling curve is surjective by using metrics and uniform convergence of the sequence.

1:20-1:35 | **Michael Grant & Julia Filiberti** | **Room 2204**

Statistical and Computational Methods in Microarray Data Analysis

Dickinson College

Advised by: Professor Jeffrey S. Forrester

The HL-60 human leukemia cell line can be induced in culture by a variety of compounds to differentiate toward several different cell types of the myeloid lineage. The observed phenotypic changes are caused by the differential expression of a large number of genes. Using DNA microarrays, our group has identified thousands of genes that are differentially expressed at various times after the induction of differentiation by the phorbol ester PMA. The complexities of the resulting data sets require advanced mathematical and computational tools for their analysis and organization. Our talk will outline the methods we have used to examine these data sets and describe our experiences working as a team with students from the biological sciences.

Afternoon Session 1:40-1:55

1:40-1:55 | **Room 2201**

David Stolz
Prime Producing Polynomials
Lakeland Community College
Advised by: Dr. Carl Stitz

This talk will present a brief introduction to univariate polynomials that generate primes for consecutive integer inputs. Specifically, we will discuss polynomials that generate infinite numbers of primes and arbitrarily large numbers of primes.

1:40-1:55 | **Room 2203**

Angela Urban
The Euclidean Group
Youngstown State University
Advised by: Dr. Thomas Wakefield

The Euclidean Plane consists of the isometries of a plane and forms a group under composition. Translations and orthogonal transformations make up the Euclidean Plane which can be described as translations by vectors, rotations through an angle and reflections in a line. Each isometry can be described as an ordered pair obtained by a special group of the Euclidean Plane. A description of the isometries of the Euclidean Plane and how these ordered pairs can be obtained will be discussed.

1:40-1:55 | **Room 2204**

Russell Sundberg
Nitric Oxide Diffusion and Reaction
Cleveland State University
Advised by: Dr. Leah Gold

Ever since the discovery of nitric oxide (NO) as an important signaling molecule in higher order life forms, scientists have attempted to produce mathematical models to describe and predict its behavior. This discovery process has had limited success because nitric oxide is not only very reactive but there are numerous pathways of production. The most well-documented production site is in the endothelial cells that line the arteries, but it has also been discovered that NO can be produced chemically under certain physiological conditions. The ramifications of non-endothelial NO production suggests that reaction rates may have to be interpreted to include a reaction factor which puts NO back into the system after it has been removed. In this paper we describe the use of *in vitro* experiments to find the rate of diffusion, and the partition constant using linear reaction equations. We then use these parameters in an attempt to discover non-linear vascular consumption rates.

Afternoon Session 2:00-2:15

2:00-2:15 **Room 2201**

Matt Grimm
Minkowski Length of 3-D Polytopes
Kent State University
Advised by: Dr. Jenya Soprunova

The Minkowski sum of two polytopes is the set pairwise sums of their points. We will look at the Minkowski length $L(P)$ of a lattice polytope P. We will explain an algorithm for computing $L(P)$ and look at indecomposable polytopes. Our result extends a previously known result with polygons. Our methods are substantially different from those used in the two-dimensional case.

2:00-2:15 **Room 2203**

Ronald A. Balint
The Wonderful World of Pi
Youngstown State University
Advised by: Dr. Richard Goldthwait

This presentation is brief summary into the world of pi. We will discuss proofs about the existence and irrationality of pi.

2011 MCM / ICM - COMAP Modeling Problems

Continuous Modeling (Problem A)
Snowboard Course

Determine the shape of a snowboard course (currently known as a "halfpipe") to maximize the production of "vertical air" by a skilled snowboarder.

"Vertical air" is the maximum vertical distance above the edge of the halfpipe.

Tailor the shape to optimize other possible requirements, such as maximum twist in the air.

What tradeoffs may be required to develop a "practical" course?

Discrete Modeling (Problem B)
Repeater Coordination

The VHF radio spectrum involves line-of-sight transmission and reception. This limitation can be overcome by "repeaters," which pick up weak signals, amplify them, and retransmit them on a different frequency. Thus, using a repeater, low-power users (such as mobile stations) can communicate with one another in situations where direct user-to-user contact would not be possible. However, repeaters can interfere with one another unless they are far enough apart or transmit on sufficiently separated frequencies.

In addition to geographical separation, the "continuous tone-coded squelch system" (CTCSS), sometimes nicknamed "private line" (PL), technology can be used to mitigate interference problems. This system associates to each repeater a separate subaudible tone that is transmitted by all users who wish to communicate through that repeater. The repeater responds only to received signals with its specific PL tone. With this system, two nearby repeaters can share the same frequency pair (for receive and transmit); so more repeaters (and hence more users) can be accommodated in a particular area.

For a circular flat area of 40 miles radius, determine the minimum number of repeaters necessary to accommodate 1,000 simultaneous users. Assume that the spectrum available is 145 to 148 MHz, the transmitter frequency in a repeater is either 600 kHz above or 600 kHz below the receiver frequency, and there are 54 different PL tones available.

How does your solution change if there are 10,000 users?

Discuss the case where there might be defects in line-of-sight propagation caused by mountainous areas.

2011 PME National Meeting at MAA MathFest

Please join us at this year's meeting to be held August 4 through August 6, 2011, in Lexington, Kentucky. 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.

Ohio Section of MAA Spring Meeting at YSU

The Ohio Section of the Mathematical Association of America will hold its annual spring meeting at Youngstown State University on Friday, March 25 and Saturday, March 26, 2011. The meeting consists of talks by mathematics faculty, graduate students, and undergraduates from around the state. The Section especially welcomes talks and participation by undergraduate students. In addition to student talks, there is an undergraduate problem solving competition with cash prizes, and a pizza party. This year's activity during the pizza party is sponsored by the YSU chapter of Pi Mu Epsilon and will consist of a showing of the Great pi/e Debate. We encourage you to give a talk at the meeting or participate in the competition or pizza party.

We ask that if you plan to attend any or all of the conference (including the pizza party), please register at

`http://www.ohiomaa.org/register/`

More information about the conference is available in the Spring newsletter of the section, available at

`http://www.jcu.edu/math/OhioFocus/FocusSpring2011.pdf`

and at the local arrangements site

`http://www.ohiomaa.org/`

If you have any questions, please do not hesitate to contact Tom Wakefield by phone `330-941-1395` or by email `tpwakefield@ysu.edu`.