High School Visiting Lecture Program

2009-2010 Talks

Sponsored by the Michigan Section of the
Mathematical Association of America

Lawrence Technological University, Southfield 48075

Ruth Favro

1. The chaos game (Students play the Chaos Game and display the results. Analysis covers generating fractals, some discussion of probability, and a computer program. Grades 9-10 and 11-12.)
2. Matrices, computer graphics, and fractals (Simple matrix operations form the basis of computer graphics. Systems of matrices can generate fractals, using iteration. Grades 10-12.)
3. Binary and ternary arithmetic (Learn base two and base three integers and fractions, too. Applications to computers and fractals make this both useful and interesting. A handout with all examples accompanies the talk. Grades 8-9 and 10-12.)
4. Symmetry-yrtemmyS (How many different wallpaper patterns are there? How many strip patterns? This talk will focus on the rotation and reflection symmetries of objects. Starting with geometry, we analyze symmetries of objects. Then, leading into algebra, we can classify symmetry types. Grades 6-12, tailored to the audience.)

Christopher Cartwright

1. How do calculators work? (the mathematics behind calculators) Topics would vary depending on grade level. Emphasis would be on the types of calculators students are currently using in class. Topics would be selected from: how does the calculator compute trig functions, logs, exponents, reciprocals, roots, fraction conversion. Additional topics for students using graphing calculators include: how does it draw a graph? Maxes and mins?

2. Solve this math problem and you could win a million dollars. The millennium problems in Mathematics are problems that no one has been able to solve for decades and carry a prize of a million dollars each. This talk will discuss one of those problems, the P=NP problem. This talk will discuss how much time it takes to solve a problem and which problems take more time than others. This is known as complexity theory. The growth rates of polynomials and exponentials will be compared. (Grades 9-12)

Oakland University, Rochester 48309

Eddie Cheng

1. Greedy Algorithms (Many operational problems such as scheduling problems require the manager to look for optimal solutions. These types of problems are usually very difficult. However a simple procedure called greedy algorithm will give an optimal solution for a special type of optimization problems. In this talk, we will look at examples of this type of problems. Grades 9-12.)

Jerrold Grossman

1. How to create more numbers than you ever thought existed out of absolutely nothing (Starting from the empty set, we will construct the surreal numbers and look at some of their fascinating properties. These numbers include all the rational and irrational numbers, infinities, infinitesimals, and much, much more. Grades 9-12.)
2. What day of the week is that? (Can you figure out quickly, in your head, what day of the week you were born on, or what day of the week any given date falls on? We will explore some easy algorithms for carrying out these

calculations. You'll never need to carry around a calendar again. In the process, we'll learn about the fascinating branch of mathematics called number theory. Grades 7-12.)

3. A panoply of partition problems (How many different ways are there to distribute 50 cookies among your 12 friends? We'll look at some fascinating patterns that emerge when one tries to count such things, in this branch of mathematics called combinatorics. Grades 9-12.)
4. Mathematical games for fun and profit (Almost everyone has analyzed the game of tic-tac-toe and realized that if both players use perfect strategies, then the game will end in a tie. We will study some more complex games, such as Nim, Chomp, Split, and Sprouts, and the fascinating mathematical patterns that emerge in trying to perform a similar analysis for them. In the process, we'll encounter many unsolved problems. Grades 10-12.)
5. What's the area? (There is more to calculating areas than "one-half base times height" or "pi r squared." We'll look at Pick's formula, Heron's formula, problems of round-off error, infinite areas, and higher dimensional analogs of area. Grades 9-12, especially appropriate for geometry or trigonometry classes.)
6. Dividing a cake: Beyond "I cut, you choose." (How can three or more people divide a cake among them so that all of them believe that they got a fair shake? We will look at how to define "fair" in this context and what algorithms might accomplish this efficiently. An entire book has been written on this subject. Grades 8-12.)
7. The mathematics of infinity. (Infinity comes up in mathematics in many contexts, such as decimals that go on forever, calculus, geometry, and set theory. It's an appealing topic that almost everyone thinks about at some point. This talk explores various aspects of infinity, appropriate to grade level. Grades 7-12.)

University of Michigan-Flint 48502

Robert Bix

1. When parallel lines meet (Projective geometry is introduced by projecting between planes. Grades 10-12.)
2. Frieze Patterns (Symmetries of designs repeating horizontally. Grades 10-12.)

Mehrdad Simkani

1. A computer workshop on ruler-compass geometry. (Using modern computers, students will explore geometry the way the masters explored it over two millennia ago. Using virtual ruler and compass, provided by a Java applet that is available on the World Wide Web, students will construct solutions to the geometric problems of Euclid's Elements. This workshop requires a modern computer lab. For the details on necessary hardware/software please contact the speaker simkani@umich.edu. In the event such a facility is unavailable, the speaker and the coordinator will explore options to find a nearby site for the workshop. Grades 10 - 12)

Kettering University, Flint 48504

Brian J. McCartin

1. Math Makes the World Go 'Round (Find out: Why the wind is always blowing somewhere on Earth. Can you hear the shape of a drum? Why a striped animal cannot have a spotted tail. Did Romeo and Juliet ever really have a chance? About the math of a human heartbeat. What do Mozart and the Beatles have in common?) Grades 10-12. Please allow at least 45 minutes for this presentation.

Northwood University, Midland 48640

Melvin Billik

1. Coupons, duels, and encounters (Some interesting problems in probability. Grades 11-12.)

Michigan State University, East Lansing 48824

Charles R. MacCluer

1. Several Industrial Mathematics Problems (MSU provides a problem-solving service to Michigan industry) --- teams of three mathematics graduate students obtain class credit by donating several hours per week for 4 months to resolve questions posed by industry or government. Many of these projects have proved to be extremely interesting and successful, where mathematics has resolved significant business, regulatory, and production problems. The speaker will describe several of the past and on-going projects described at the site http://www.math.msu.edu/Academic_Programs/graduate/msim/ProjectPage.aspx. The talk will demonstrate the wide range of problems faced by a mathematician working in industry. Suitable for a high school math club meeting or grades 11-12.
2. The Classical Problems of the Calculus of Variations. One of the earliest uses of the calculus was to attack "variational problems," where the objective is to minimize certain path integrals. These first problems were proposed by Johann Bernoulli, Newton, von Leibniz, and others --- in certain cases as challenges to smoke out their competition. We will tour (but not solve) a collection of these early problems on least time of descent, geodesics, bluff bodies, isoperimetric problems, hanging cable, etc, as well as the modern Nobel-winning Mirrlees formulation of optimal tax structure. (Reference: C. R. MacCluer, Calculus of Variations, PrenHall, 2004.) Prerequisites: An exposure to integral calculus.

Central Michigan University, Mount Pleasant 48859

Tom Miles

1. Careers in mathematics and mathematics in careers (This talk can be directed toward either part of the title. The second part, mathematics in careers, lists a number of reasons for continuing with high school mathematics. Grades 8-12.)
2. The Alabama paradox (This talk examines how many representatives each unit (state) in a representative body (House of Representatives) should have. After the 1880 census, Congress found that in a House with 299 members, Alabama would have 8 members, while in a House with 300 members, Alabama would have only 7 seats. The talk uses basic arithmetic and, perhaps, inequalities to explore various historical methods of apportioning. It is particularly relevant since Michigan has just lost a seat after the 2000 census. Grades 9-12.)
3. The Marriage Problem: Given a set of men and a set of women, all unmarried, is it possible to arrange marriages so that all the marriages are stable? What does stable mean? Can it be done? In what other contexts does the problem arise?

Western Michigan University, Kalamazoo 49008

John Petro

1. The Intriguing Sierpinski Triangle. Ever since Waclaw Sierpinski introduced in 1916 a new triangular construction, now called the Sierpinski gasket or the Sierpinski triangle, the mathematical world has been fascinated by this most intriguing fractal and its many generalizations. In this talk we shall discuss three quite different constructions of this fractal and show how they are related to each other. Moreover, we will show that the Sierpinski Triangle also has a rather surprising association with the classical Tower of Hanoi puzzle. We shall briefly discuss some of the many generalizations of the Sierpinski Triangle.
2. Old and new questions about triangles. It is well known that a triangle is completely determined, up to congruence, by the lengths of its three sides. Moreover, the classical Hero formula gives us the area of the triangle in terms of the lengths of the three sides. The proof of Hero's formula involves some interesting elementary algebra and highlights the well known requirement that no one of the sides may be longer than the

sum of the lengths of the other two sides -- a restatement of the well known principal that a straight line is the shortest distance between two points. Now, let us pose two related questions. (1) Do the lengths of a triangle's three medians determine the triangle? (2) Do the lengths of a triangle's three altitudes determine the triangle? The answer in both cases is yes and we encounter some interesting surprises concerning the conditions on the numbers and how one would go about constructing the triangle from the given numbers. We shall discuss a variety of generalizations.

Grand Valley State University, Allendale 49401

Matt Boelkins

1. Fibonacci's Garden: By 300 BC, Euclid and other Greek mathematicians were aware of a number with special properties linked to proportion in geometric figures. Specially divided line segments, aesthetic rectangles, and regular pentagons all exhibited an amazing number that later came to be known as "the Golden Ratio." The Golden Ratio has since made many appearances in surprising places in mathematics, including rather recently in symmetries in Penrose tilings, and has also manifested itself in curious ways in art, architecture, and the natural world.

   Around 1200 AD, Leonardo of Pisa (known to us today as Fibonacci) began experimenting with a sequence of numbers that has since come to bear his name. The list of numbers generated by starting with 0 and 1 and then adding the two previous numbers to find the next term results in
   0,1,1,2,3,5,8,13,21,34,55,89,...
   and is called "the Fibonacci Sequence." This collection of numbers has been discovered to have a seemingly unlimited list of interesting properties that fascinate mathematicians to this day. Like the Golden Ratio, Fibonacci numbers arise naturally in some startling places. One example is seen in pine cones, where the numbers of spirals exhibited on the pine cone in opposing directions normally turn out to be consecutive Fibonacci numbers.

   Perhaps even more remarkably, the Golden Ratio and the Fibonacci Sequence are inextricably linked with each other. After an introduction to some of the history and mathematical ideas surrounding each of these concepts separately, we will explore how the development of seeds in flowers demonstrates some of these connections between the Golden Ratio and the Fibonacci Sequence. (This talk is accessible to any student in grades 9-12.)

2. Student Research with Polynomial Functions: Polynomials are among the most fundamental functions in all of mathematics. While students typically begin to encounter such functions as early as junior high, and mathematicians have proved a remarkable number of sophisticated results on them, new results continue to emerge and a surprising number of open questions that involve polynomials persist. Many of these are accessible to undergraduates.

   A relatively recent result is the Polynomial Root-Dragging Theorem, proved by B. Anderson in 1993, which states

   If one or more roots of a polynomial with all real zeros are shifted to the right, then all of the critical points of the new function will lie to the right of the respective critical points of the original function.

   Over the past five years, several different students and I have used the Polynomial Root-Dragging Theorem as a central tool to investigate patterns in polynomial functions. In this talk I will summarize some fundamental results and ideas share some of the many new results these undergraduates have proved. (This talk is ideally suited for students in a calculus course, though students with experience in precalculus can appreciate the ideas present.)

3. Careers in Mathematics (this talk can be delivered jointly with Paul Fishback): What types of careers do college mathematics majors pursue? What important job-related skills does the study of mathematics promote? Why

do employers value having mathematics majors as employees? The goal of this talk is to answer these questions and to address common student misconceptions regarding career possibilities for those who study mathematics. Examples discussed include specific mathematics-related careers, particular companies that hire mathematics majors, and names of individuals ranging from doctors to actuaries to economists to lawyers who majored in mathematics while in college. A list of Internet resources will also be provided. (Best suited to grades 11-12)

Jon Hodge

1. Surprises and Paradoxes in Mathematical Voting Theory (Have you ever wondered why elections sometimes produce results that are displeasing to many of the voters involved? Would you be surprised to learn that a perfectly fair election can produce a result that is the last choice of every single voter? In this talk, we'll use mathematics to study a variety of different systems for deciding the winner of an election. We'll see how these systems can produce vastly different outcomes, and we'll try to understand what these differences tell us about the search for a perfect voting system.)

Hope College, Holland 49423

Tim Pennings

1. Do dogs know calculus? (A standard calculus modeling problem is to find the quickest path from a point on shore to a point in a lake, given that running speed is greater than swimming speed. Elvis, my Welsh Corgi, has never had a calculus course. But when we play "fetch" on the shore of Lake Michigan, he appears to choose paths close to the optimal one. In this talk we reveal what was found when we experimentally tested this ability. (Elvis will be available for follow-up questions.)

Lake Superior State University, Sault Sainte Marie 49783

Randy Suggitt

1. The mathematics of the Mackinac Bridge. (The Mackinac Bridge is not a static structure; it swings, it sways, it actually changes shape under the influence of such factors as winds and varying traffic loads. This talk investigates one of the changes that can occur in the shape of large steel suspension bridges in response to temperature changes. The material presented will be accessible to anyone with an understanding of algebra, geometry, and quadratic equations.)

For more information contact:

Professor Kimberly Muller
Director, Michigan MAA HSVLP
Department of Mathematics and Computer Science
Lake Superior State University
Sault Ste. Marie, MI 49783

Telephone: (906) 635-2170
Email: kmuller@lssu.edu