Abstracts of Faculty Talks

Mathematical Association of America
Allegheny Mountain Section Meeting
Gannon University
Saturday, April 2, 2016

10:15-10:30

Angela Berardinelli, Mercyhurst University **Zurn 129**

A crash course in reflection groups

Reflection groups are abstract mathematical objects that are interesting in their own right, but can also encode the symmetry properties of physical objects. This talk will cover an example-based introduction to reflection groups. If time permits, we may also discuss applications of reflection groups in chemistry and physics. Previous exposure to linear algebra (matrices) and some abstract algebra (symmetric groups, dihedral groups) will be helpful but not necessary.

Tim Flowers, Indiana University of Pennsylvania **Zurn 235**

Counting Hyper m-ary Partitions

An integer partition of n is a way of expressing n as a sum of positive integers called parts. Hyper m-ary partitions are integer partitions whose parts are powers of m and where each part appears at most m times. We examine patterns in the structures of various partitions and give identities that compare the number of hyper m-ary partitions for different values of m.

Douglas Puharic, Edinboro University **Zurn 329**

Exploring the Graph of Euler's Totient Function

Euler's totient function is a function that counts the positive integers less than or equal to a given natural number, n, and are relatively prime to n. In this talk we will explore the graph of Euler's totient function and find equations of lines that contain an infinite number of points from the graph of Euler's totient function.

David Offner, Westminster College **Zurn 439**

Characterizing Cop-Win Graphs and Their Properties Using a Corner Ranking Procedure

Cops and Robber is a two-player vertex pursuit game played on graphs. Some number of cops and a robber occupy vertices of a graph, and take turns moving between adjacent vertices. If a cop ever occupies the same vertex as the robber, the robber is caught. If one cop is sufficient to catch the robber on a given graph, the graph is called cop-win, and the maximum number of moves required to catch the robber is called the capture time. In this talk we introduce a simple corner ranking procedure that assigns a rank to every vertex in a graph. The results of this procedure can be used to determine many properties of the

graph, for example, if it is cop-win, and if so, what the capture time is. We show how corner rank can be used to describe optimal strategies for the cop and robber, and to characterize those cop-win graphs with a given number of vertices which have maximum capture time. Though cop-win graphs and their capture time have previously been characterized, in many cases corner rank gives more streamlined proofs, and allows us to extend known results.

Shelly Bouchat, Indiana University of Pennsylvania **Zurn 445**

Using Mathematics to Model River Blindness

Onchocerciasis, known as "River Blindness", remains an epidemic in Sub-Saharan Africa in spite of the fact that the drug company Merck provides the drug treatment for free. Many factors effect the ability to deliver and administer treatment, including war and rumors of severe side effects. This talk will discuss a mathematical model designed at increasing the efficacy of the treatment program by considering drug distribution timing.

Paul Olson, Penn State Erie **Zurn 447**

Using Laplace Transforms in an applied Diff. Eq.'s Class

When exploring second order, linear, ODE's, students learn about the characteristic equation and homogeneous solution to the equation. The method of undetermined coefficients or the method of variation of parameters is then utilized to solve nonhomogeneous equations. Such problems can be handled using Laplace Transforms . Using Laplace Transforms reinforces polynomial factoring , completing the square, improper integrals and partial fractions. By introducing Laplace Transforms early in our applied diff. eq. course, the students gain valuable time mastering the techniques of Laplace Transforms and using the mentioned topics from calculus.

10:35-10:50

Jen Ulrich and Paul Becker, Penn State Behrend **Zurn 129**

Mathieu Groups and Their Connections to Combinatorics

A group is simple if its only normal subgroups are trivial. With the exception of twenty-six sporadic groups, all simple finite groups fall into a small collection of infinite families. In this talk, we look at the five sporadic groups known as the Mathieu groups. We discuss the historical connection between the Mathieu groups, combinatorial designs, and communications. Using these connections, and a little coding theory, we will describe a simplified geometric view of Mathieus groups. In particular, the Mathieu group known as $M24$ will be constructed in a new and more geometric manner.

James Sellers, Penn State University **Zurn 235**

Characterizing the Number of m-ary Partitions Modulo m

In this talk, we will focus our attention on m-ary partitions which are integer partitions wherein each part must be a power of a fixed integer $m > 1$. Since the late 1960s, numerous mathematicians (including Churchhouse, Andrews, Gupta, Rodseth, and Sellers) have studied divisibility properties of m-ary partitions. After discussing some of these historical

results, I will describe a novel and unexpected conjecture communicated to me by Aviezri Fraenkel which characterizes the divisibility of the ternary partition function $b_3(n)$ based on the base 3 representation of n. I will then discuss a wonderful generalization that follows quite naturally. This is joint work with George Andrews and Aviezri Fraenkel.

Roman Wong, Washington & Jefferson College **Zurn 329**

Connecting numbers whose product is a square, almost

Two positive integers a and b are said to be connected, written $a \sim b$, if $ab + 1$ is a square. The relation $\sim$ results in an undirected graph with vertex set all positive integers and an edge between a and b if $a \sim b$. For instance, $3 \sim 8$ because $3 \times 8 + 1 = 25$ is a square. The distance $d(a, b)$ between a and b is the length of a shortest path that connects them. Thus $d(1, 3) = 1$ since 1 and 3 are adjacent, whereas $d(1, 4) = 3$ because $1 \sim 3 \sim 56 \sim 4$ is a path of length of 3 and it can be shown that no shorter path can connect 1 and 4. In this talk, we investigate an algorithm that can connect any two vertices and find a common upper bound for all $d(a, b)$. We also show that every edge in the graph belongs to a 3-cycle and a 4-clique

John Bukowski, Juniata College **Zurn 439**

van der Pol's Tablecloth: Highlights from the Balthasar van der Pol Collection at Museum Boerhaave

The Museum Boerhaave in Leiden, Netherlands, houses the archive of Balthasar van der Pol (1889-1959), the Dutch mathematician, physicist, and engineer. We will examine highlights of the collection, including correspondence, lecture notes, manuscripts, musical compositions, and a tablecloth based on Gaussian primes.

John Tolle, Penn State DuBois **Zurn 445**

Special Topics Courses at a Small Campus with No Math Majors

What if you have a desire to direct undergraduate research, but your student population contains no takers? What can you do to offer mathematics enrichment if your campus doesn't even support a 4-year mathematics major? Since 2011, PSU DuBois has offered elective special topics courses in mathematics, with great success. But how did we get our students to enroll? In this talk, I share our secrets, with the hope that you, too, can overcome obstacles present at your particular campus, and find some path to offering mathematics enrichment.

Boon Ong, Penn State Erie **Zurn 447**

Oh, the Thinks You Can Think! with Wolfram-alpha

We know how useful Wolfram alpha can be when it comes to doing homework on Calculus and Differential Equations. It can even take over as the "answers on the back of the book". But over the many semesters, I found some common homework problems in Calculus 3 and Differential Equations that Wolfram-alpha cannot handle properly. I will share some of my experience of what I encountered and what to warn our students.

10:55-11:10

Maggie Habeeb, California University of Pennsylvania **Zurn 129**

Applications of Group Theory

With the advent of faster computing and quantum computing,new methods of transmitting information securely is a major concern. In this talk, we will present a new verifiable secret sharing scheme using group presentations and the word problem.

Leandro Junes, California University of Pennsylvania **Zurn 235**

Using Power Series to Count Dyck Paths

Dyck paths are important structures in Combinatorics. They can be viewed as parenthesization of algebraic expressions. We use power series on several variables to enumerate peaks, pyramid weights, and indexed sums of pyramid weights for all for all non-decreasing Dyck paths of length $2n$. We also show a surprising fact about pyramids in these paths.

Joe Previte, Penn State Erie **Zurn 329**

The Beautiful Dynamics of i^z

In this talk, we will explore the dynamics obtained by iterating the complex function $f(z) = i^z$; where the principal branch is used. We explore the basin of attraction of the stable fixed point $i^{i^{i^{\cdots}}}$. We will also show that are periodic orbits of all periods as well as orbits that tend to infinity.

Antonella Cupillari, Penn State Erie **Zurn 439**

The Shape of the Solutions of a Quadratic

Maria Gaetana Agnesi's Instituzioni Analitiche ad Uso della Gioventu' Italiana included most of the mathematical ideas known at that time (1748), from basic arithmetic and algebra to differential and integral calculus. One of the first topics in algebra is the solution of quadratic equations. The solution of the quadratic has a very long history, with geometric representations of the process of completing the square. While working several centuries later, Agnesi still stressed the connections between algebra and geometry and produced geometric representations for the solutions of quadratic equations depending on the coefficients used.

Victoria Czarnek, University of Pittsburgh at Johnstown **Zurn 445**

Effective Use of WebAssign with Calculus I

Some faculty members fear that incorporating technology into a class will eventually obviate the need for the traditional classroom, and others worry that it will diminish the quality of teaching. The role of the instructor is perhaps more important than ever in a well-organized class that includes a technology component. Benefits and drawbacks of the online instructional system WebAssign will be discussed with a focus on using it effectively in a Calculus I class.

Gary Thompson, Grove City College **Zurn 447**

Mathematica Madness

When the first calculators came out the calculation $1/3 = *3 =$ would yield .99999999. Over time, both calculators and CAS programs have strengthened their processes to avoid such silly problems. There are still ways to fool these machines, and generating unexpected results can provide both motivation to understand how the programs work and a fruitful discussion to understand such results. I will be discussing 7 such phenomena with Mathematica.

11:15-11:30

Daniel Galiffa, Penn State Erie **Zurn 129**

Hypergeometric Relations for Jacobi Polynomials

In this talk, we first discuss the Jacobi polynomials and variations thereof. From there, we define hypergeometric functions and some preliminary definitions. We next develop several relationships involving the Jacobi polynomials and their special cases. We then discuss how these relations play a role in establishing various types of results in the field of orthogonal polynomials and special functions. We conclude the talk with some future research ideas.

Jared Burns, Seton Hill University **Zurn 235**

Porous Sets

Quite often we are concerned with smallness in mathematics, and a porous set is a concept like the concepts of meagre and measure zero sets, giving a notion of "small" or "lacking bulk". However, some of the definitions may not be intuitively motivated for a newcomer to the topic. In this talk, we discuss one particular refinement of the definition of porous used in the speakers work, and how it is a natural and intuitive extension of meager. In the process, we give some easy to understand examples of porous sets using this new definition and way of considering porosity.

John Hoggard, Edinboro University **Zurn 329**

Waiting on an infinite candy bowl

Consider a candy bowl with two different types of candy, from which we withdraw samples at random. Every time we draw a sample, we will randomly replace the candy based on the current distribution of candy in the bowl. We can show that this is equivalent to a random walk along the different possible distributions, and that eventually we will end in a state where the bowl contains only one type of candy. Using analytic techniques and numerical simulations, we will discuss how long we should expect to wait for the distribution to become uniform.

Ivko Dimitric, Penn State Fayette **Zurn 439**

Where the center of mass weighs in

Starting with the law of the lever one can formulate geometrical mechanics of the point-masses and apply it to various problems in geometry. The main operation of collecting two masses to their center of mass is introduced, which, because of its commutative and associative properties, allows for regrouping of the point-masses in various convenient ways to

prove the concurrence of certain line segments in a given geometric configuration, moreover giving the ratio into which each of the segments is being divided by the common point. By loading vertices of a quadrilateral (or a general polygon) with appropriate masses it is possible to demonstrate some interesting non-trivial results, such as the Newton's theorem about a tangential quadrilateral, stating that the center of the inscribed circle belongs to the segment that joins the midpoints of the diagonals. An important subsequent shift is then allowing some masses to be negative, which extends the use of the concept to some additional geometric situations, including those in 3-space. Three useful concepts of the center of a mass of a polygon may be discussed: the vertex center of mass, the contour center of mass, and the area center of mass.

Andrew George, Penn State Behrend **Zurn 445**

Mixing First-year Students and Online Math Courses: A Recipe for Disaster?

Upon request of Engineering, we now offer a two-semester sequence of pre-calculus courses for Engineering Technology students entirely online. Despite a high level of student satisfaction with these courses (as measured by mid-semester surveys and end-of-course evaluations), the level of student achievement (as measured by course grades) has been alarmingly low. I will present ways I have strengthened the structure, scaffolding, and social/teaching/cognitive presence in these online courses over the past four semestersalong with the sobering results in student performance. The disconnect between student satisfaction and performance has striking implications when considering online instruction for first-year students.

Anne Quinn, Edinboro University **Zurn 447**

Using Apps to Visualize Graph Theory: Planar Graphs and Kuratowskis Theorem

I consider how two graph theory smartphone apps can be used in the classroom. Examples include showing that two graphs are isomorphic, that a graph is planar, that a graph is not planar by use of Kuratowskis theorem, determining a graphs crossing number, and determining whether a graph is bipartite. Examples from my talk can also be seen in the Mathematics Teacher (April 2015) and in an article in the College Mathematics Journal (coming out this month).