

Abstracts for the October 25, 2008 Indiana Section Meeting of the Mathematical Association of America

9:00–10:00

Rachel Hall, St. Joseph's University

Asymmetric Rhythms and Tiling Canons

Anyone who listens to rock music is familiar with the repeated drumbeat—one, two, three, four—based on a four-beat measure. However, other popular music (jazz, Latin, African) has different characteristic rhythms. Although much of this music is based on the four-beat measure, some instruments play repeated patterns that are not synchronized with the beat, creating syncopation—an exciting tension between different components of the rhythm. This paper is concerned with classifying and counting rhythms that are maximally syncopated in the sense that, even when shifted, they cannot be synchronized with the division of a measure into two parts. In addition, we discuss rhythms that cannot be aligned with other even divisions of the measure. Our results have a surprising application to rhythmic canons. A canon is a musical figure produced when two or more voices play the same melody, with each voice starting at a different time; in a rhythmic canon, rhythms, and not necessarily melodies, are duplicated by each voice. A rhythmic canon tiles if there is exactly one note onset in some voice on each beat. Upon mapping beats to integers, a rhythm forms a tiling canon if and only if its rhythmic motif and sequence of voice entries correspond to sets A and B forming a tiling of the integers—that is, a finite set A of integers (the tile) together with an infinite set of integer translations B such that every integer may be written in a unique way as an element of A plus an element of B . Although many have studied this problem, the complete classification of such tilings is an open question.

10:15–10:40

Joshua Holden, Rose-Hulman Institute of Technology

Math in Your Hands: The Use of Tablet PCs and Computer Algebra Systems in a Calculus Classroom

In the Fall Quarter of 2008 we explored the use of Tablet PCs in calculus classes in order to foster student engagement by incorporating active learning and collaborative activities. The use of tablets can make many improvements in a classroom, but mathematics classes pose special challenges which have not yet been systematically explored at Rose-Hulman. The most difficult of these from a technical perspective is the integration of computer algebra systems such as Maple with other Tablet PC software. This project explores ways to achieve this integration as well as other pedagogical improvements which the use of Tablet PCs could bring to mathematics classrooms. We will report on the reactions of students as well as the impressions of the professor.

Zsuzsanna Szaniszló, Valparaiso University

Graphs and Radio Channels

Engineers need to assign frequencies to radio towers in a way that the broadcasts do not interfere. This Channel Assignment Problem is modeled in mathematics by labeling the vertices of different graphs. We will present an overview of the history of the problem and talk about some new results.

John M. Cochran, University of Louisville

Linearized Active Contours Without Gradient Model

One of the major models currently in mathematical imaging is the active contours without gradient model developed by Tony Chan and Luminita Vese. The model successfully detects objects that are not defined by gradient and is robust in the presence of noise. A linearized version of the model will be presented which inherits many of the beneficial properties present in the nonlinear model with the added benefit of fast convergence - at least for simple images. Suggestions for possible undergraduate research will also be presented along with several examples of the model in action.

10:45–11:10

Jerome Heaven, Indiana Tech

Integrating Numerical Methods/Analysis Into Undergraduate Math Courses

The speaker will discuss ways he has integrated numerical methods/analysis into several undergraduate math courses serving the needs of a major in software engineering, which is highly project-based.

Daniel Kiteck, Indiana Wesleyan University

Covers of Models

Covers are a type of approximation generalizing concepts from homological algebra. Models (from mathematical logic) can be used to define algebraic objects. This talk presents an introductory example of a cover of a model.

Young Lee, Manchester College

Epidemiological Approach to the South Korean Beef Protests with a Hidden Agenda

Hundreds of thousands of South Korean protesters have staged candlelight vigils and demonstrations against US beef imports. The problems, however, go far beyond that of beef imports. The political party veterans, who lost the presidential election, exploit labor unions that are discontent with the economy and ideological student groups to weaken the majority party. In this study, an epidemiological model is constructed with a system of three nonlinear differential equations. The model seeks to examine the dynamics of the system through stability analysis. Two threshold parameters that spread the protests are identified. The results are also explored by deterministic simulations.

11:15–11:45

Elton Graves, Rose-Hulman Institute of Technology

Classroom Demonstrations that Work (at least for me)

This talk will consist of actual demonstrations (not computer simulations) that are used by the speaker to motivate and illustrate the mathematics that is being taught in the class. The demonstrations will include the cycloid & brachistochrone problem, directional derivatives and Lagrange multipliers, spring-mass systems, and Newton's Law of Cooling, and others as time permits. Audience participation will be requested.

Herb Bailey, Rose-Hulman Institute of Technology

Jeeps crossing a desert

One of several Jeeps is to penetrate a desert as far as possible with the others returning to base camp at the edge of the desert. They share fuel along the way. Previous solutions have tacitly assumed that they all leave base camp together. We show that in a hostile desert they can penetrate further if some remain behind and come out later to help the returning Jeeps. A simple version of the problem was a recent 'puzzler' on Car Talk.

Jonathan O. Brooks, Ivy Tech

A Novel Viable Solution to the Schrödinger Radial Equation

A Bessel function in cylindrical coordinates can be shown to be in correspondence to the Schrödinger equation. The Bessel function defines both the charge densities and radii of any orbital of all atoms of the Periodic Table. The time average portion being zero allows definition of charge density in the form of a quadratic which is a form developed by Euler and d'Alembert in the mid 1700's from a consideration of the Lagrangian. Radii stem from dual solutions to the Bessel function, one for the atomic case and another for the solar case. Since the solar case diverges, the only way to get an increase in atomic orbiting electrons is to do a Lesbegue summation of the converging solution. This is convenient because electrons at greater distance from the center

travel faster; and, planets travel slower. It was necessary to invert Schrödinger's radial variable in a variable of a Taylor series to get compliance.

1:15–1:40

John Lorch, Ball State University

Sudoku and Orthogonality

Since a sudoku solution is simply a special type of latin square, it is natural to transfer questions about latin squares, including those about counting and orthogonality, to the setting of sudoku. In the talk we will focus on methods for producing orthogonal pairs of sudoku solutions as well as results concerning maximal orthogonal families of 'linear' sudoku solutions.

Amos Carpenter, Butler University

Zeros of the Partial Sums of $\cos(z)$ and $\sin(z)$

In this talk, we give new extensions of results by Szegő on the interrelationships between the zeros of the partial sums of e^z , and those of the partial sums of $\cos(z)$ and $\sin(z)$. We also include numerical results and figures which illustrate our new results.

1:45–2:45

Mike Jolly, Indiana University

A French Secret Applied to Invariant Manifolds

In this self-contained talk we will start by explaining what invariant manifolds are, and how they can make the world a better place. We will then run through a brief survey of how to compute them. We will finish with a "new" method which uses some neat stuff from vector calculus (where the secret is revealed). This is joint work with John Lowengrub (UC Irvine) and Sharon Ulery (Bowdoin College).