Undergraduate Student Paper Session

Friday, November 16, 2007

Session I – CC 413

5:00 PM – 5:12 PM **George Gabriel Stokes**
Ruth Hibbard, Framingham State College

George Gabriel Stokes (1819-1903), an Irish physicist and mathematician, became the leading British authority on the principles of geodesy. His significant mathematical contributions were in the areas of hydrodynamics and optics, utilizing his knowledge of vector calculus. In this presentation, I will delve into his life and times from his boyhood during the relatively peaceful period following the French Revolution to his academic adult life among the British aristocracy.

5:15 PM – 5:27 PM **Mathematics to the Rescue: The Incredible Adventure of Kepler**
Amanda Egan and Jaclyn Haskins, Framingham State College

During the 16th century in Germany, the Counter Reformation threatened Protestants with banishment, civil war, and unlawful rulings but mathematics enabled dedicated Protestant Johannes Kepler to forego much of this unpleasantness. Napier, Maestlin, Galileo, and Brahe encouraged and supported Kepler's education and research during these turbulent years, enabling his exploration of the five perfect solids and allowing him to postulate the birth year of Christ and the laws of planetary motion, the beginning of Kepler's contributions to Mathematics and Physics. In this presentation, we will discuss the adventures, life and times of Johannes Kepler, god-father of planetary motion.

5:30 PM – 5:42 PM **The St. Petersburg Paradox - A Mirror of Modern-Day Risk Aversion**
Richard Andrews, Western Connecticut State University

People make choices, and risk is often a factor in choices. In the 18th century, Daniel Bernoulli measured the value of based in part on a person's current financial status. According to Bernoulli, insurance is just a bet against one's self. Decisions to invest in stocks are also based on the current financial status of investors. Who is more likely to invest in a hedge fund? All of this applies to the St. Petersburg Paradox, and to the economic theory of diminishing marginal utility.

5:45 PM – 5:57 PM **A Topological Presentation on the Classification of Surfaces**
Nathan MacKay, Keene State College

The Classification Theorem states that all closed surfaces, regardless of the many different forms they can take on, are all topologically equivalent to spheres with some number of handles or cross caps (these will be defined during presentation). This presentation will go over Conway's Zero Irrelevancy Proof, or ZIP Proof, of the Classification Theorem as it was presented by George K Francis and Jeffery R. Weeks in the December 28, 2000 issue of American Mathematical Monthly. The proof is highly visual and the presentation will include a number of hand drawn illustrations to be shown as overhead slides.

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Session II – CC 415

5:00 PM – 5:12 PM **A Model of the Drosophila Heart**
Pamela Reitsma, University of Maine

The heart of Drosophila melanogaster is a tubular organ that pumps hemolymph through the body. Ion channels involved in the Drosophila heartbeat have been identified and studied. In this work the Drosophila heart is modeled as a network of excitable cells in order to explore the biophysical mechanisms underlying the generation of the heartbeat. The model cells are connected by gap junctions. Pacemaker cells added at one end of the model generate a wave of contraction down the heart.

5:15 PM – 5:27 PM **Exploring the Logistic Map using a MATLAB GUI**
Chris Bresten, UMass Dartmouth

I made a MATLAB GUI which allows a user to explore the dynamics of the logistic map using numerical convergence analysis, bifurcation, and plotting of individual sequences. The software is freely distributed on the Internet and usable to anyone with MATLAB. This software aims to increase an individual's understanding of this chaotic dynamical system. During the talk, I will demonstrate how to use this software, and explain the results it displays.

5:30 PM – 5:42 PM **Oscillators Coupled by Piecewise Linear Functions**
Joseph Salisbury, Rhode Island College

Models using networks of coupled oscillators provide insight on many natural self-organizing systems from spiking neurons to swarms of fireflies. The Kuramoto model serves as a flexible framework for exploring the dynamics of synchronization and phase chaos seen in these systems. While the sine function is typically used for coupling the phase equations in this model, use of other periodic functions is also possible revealing new behavior. Pairs of oscillators coupled by the square, saw-tooth, and triangle wave functions are analyzed providing new tools for modeling synchronization as well as interesting examples of simple nonsmooth dynamical systems.

5:45 PM – 5:57 PM One Burger with Fries, Hold the Gibbs
Daniel Higgs, UMass Dartmouth

Abstract: In this presentation we discuss a method for finding discontinuous solutions to non-linear problems while avoiding the errors introduced by the Gibbs phenomenon. Using the inviscid Burgers' equation as an example, we will use a technique implemented under the GNU Octave interpreter to visually demonstrate how an accurate approximation can be obtained even in close proximity to a shock by applying two different numerical methods in tandem across a given domain

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Session III – CC 417

5:00 PM – 5:12 PM **The Harvard College Mathematics Review**
Scott D Kominers, Harvard University

An expository journal edited by undergraduates, The Harvard College Mathematics Review (HCMR) publishes articles presenting high-level mathematical concepts at the undergraduate level. The HCMR's primary purpose is to make mathematics accessible to a general undergraduate audience. The HCMR is widely distributed both in print and electronic form; the online edition is freely available (at http://www.hcs.harvard.edu/hcmr).

5:15 PM – 5:27 PM **Two Versions Of The Traveling Salesman Problem**
Rahul Shah, Williams College

There are two versions of the traveling salesman problem. The general version seeks the shortest path visiting n cities, given pairwise distances between them. The easier special version seeks such a path of length at most L. We show that if you can solve the easier special version you can solve the harder general version. Indeed, if you can solve the special version in polynomial time you can solve the general version in polynomial time.

5:30 PM – 5:42 PM **Cheap Ways to Fence Your Backyard on Double Tori, Annuli, and Bands**
Matthew D. Simonson, Williams College

The Isoperimetric Problem seeks to find the least-perimeter way to enclose a given area on a surface. Although the solution is known in R2, S2, the cylinder, and flat torus, many intriguing surfaces do not yet have a formal solution. We will start with new proofs for relatively simple surfaces such as the Möbius band and progress to trickier shapes such as the non-concentric circular annulus and hyperbolic double torus, for which the question remains open.