Winter 2007

2007 (Winter)

University of Dayton. Department of Mathematics

Mathematics Colloquium Schedule: Winter 2007
Department of Mathematics

Convergence and stability of a nonconforming finite element method for fluid-structure interaction problems

Dr. Edward Swim

Abstract: In many scientific applications, such as surgical planning or aeroelastic simulation, efficient and accurate simulation of fluid flow near a structure whose deformation defines the interface between the two are desired in order to facilitate rapid evaluation of the stability of different configurations. Previous algorithms have established nonconforming finite element methods to solve transient systems of partial differential equations which model the interaction between two fluids or two elastic structures. In order to couple a viscous incompressible fluid and an elastic membrane, an arbitrary Lagrangian-Eulerian (ALE) formulation is often employed for the fluid equations in order to avoid excessive distortion of the mesh near the interface. This talk describes a nonconforming finite element method for a model two-dimensional fluid-structure interaction problem in which we apply an ALE scheme to produce a consistent and stable numerical approximation for the fully coupled system. A three-field approach, whereby solutions computed locally on each subdomain are coupled efficiently using Lagrange multipliers, is used to enforce appropriate interface conditions.

Time Periodic Solutions of Korteweg-de Vries (KdV) Equation

Muhammad Usman

Abstract: Waves occur in the natural world in many situations. Oceans waves and ripples on a pond are commonly observed by everyone. But an example of the amazing wave phenomena observed by Scott Russell 1834 known as a “solitary wave” led to a mathematical description in 1895 by Korteweg and de Vries, and gave birth to not only so-called KdV equation but also to modern studies of integrable partial differential equations. This equation has applications from particle physics, molecular biology, quantum mechanics, geology, oceanography, optical fibers to meteorology, astrophysics, cosmology, the great red spot of Jupiter and blood flow in arteries (McDonald 1974).

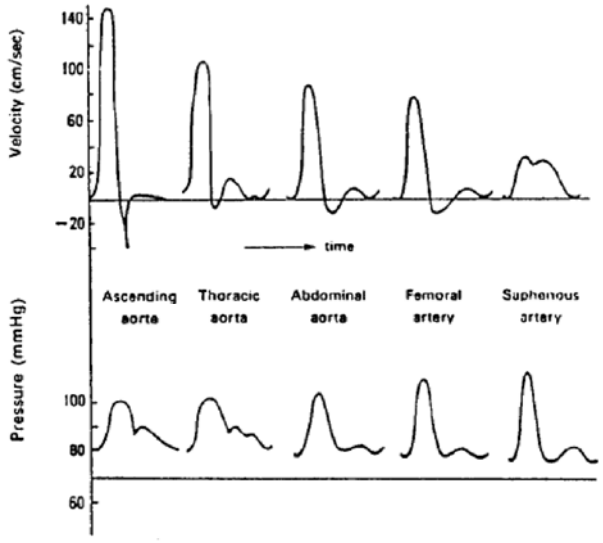


FIG. 1. A diagrammatic comparison of the behavior of the flow velocity and pressure pulse.

In this talk I will discuss the Korteweg-de Vries equation posed on a finite interval with the time periodic boundary forcings. It will be demonstrated that if the amplitude of boundary forcings are small, then the system admits a unique time periodic solution. Moreover the time periodic solution is exponentially stable.

The Interplay of Prospective Secondary Mathematics Teachers' Mathematical Thinking and Use of Dynamic Geometry Software

William Sargeant

Abstract: I will report on the pilot study for my dissertation. In this study, the interplay of mathematical thinking processes used/developed by prospective secondary mathematics teachers taking a college geometry course and their use of dynamic geometry environment (DGE) software was examined. What factors influence DGE use when working on open-ended geometry problems? How does the thinking of pre-service teachers begin, shift and grow when working with DGE and what factors are involved? How is this revealed by their DGE use?

The main study included non-participant observation of the class and (three individual, two small-group) semi-structured task-based interviews with a sample *(n = 6).* Data came from classroom observation field notes and audio-taping, video-taping, saving of DGE files, collection of anything written on paper and field notes during interviews. Audio/video data was transcribed. The method of analysis was grounded theory building. Pirie and Kieren's (1989, 1994) Recursive Theory of Mathematical Understanding was used to trace growth of thinking. The dragging modalities framework of Arzarello et al. (1998) and Olivero (1999, 2002) was used to complement this with a theory relating cognition and DGE use. Harel and Sowder's (1998) proof schemes model was used to analyze the reasoning used to justify a conjecture.

I will also report on possible implications for classroom teaching and how the pilot study informed my current dissertation study.

A partnership between a middle school mathematics teacher and a university researcher centered on the content and teaching

Anthony Fernandes

Abstract: This talk will outline a case study between a middle school mathematics teacher and a university researcher as we had discussions centered on the mathematics content and teaching. This study seeks to understand the nature of this partnership, how it evolved over time, the constraints on the partners, the benefits to the teacher's work, and the evolution of the cognitive demand of tasks. In the talk I will share the background of my study, selected literature, preliminary results and future directions of this research.

The role of research in mathematics teaching: the case of counting

Virginia Keen

Abstract: The extension of Ohio teaching licensure and student standards to the preschool level obliges a similar revision of the mathematics coursework for prospective early childhood teachers. One early mathematics concept rarely dealt with in any depth, as reflected in standard textbooks, is counting. This leaves students with limited appreciation for both the informal knowledge children bring to school and the formal knowledge required for expert counting. To remedy this, I investigated research on counting

and initiated the inclusion of five counting principles and other research on learning to count into classes for prospective early childhood teachers. To assess student understanding of counting, students were asked to create children's book that examined and explicitly addressed some aspect of learning to count. In this presentation, I will share research bases and evidence from students' products demonstrating aspects of meaningful counting as well as suggestions for future research and curricular enhancements based on cutting-edge research in early mathematics learning.

Two Variants of the Tuŕan Problem

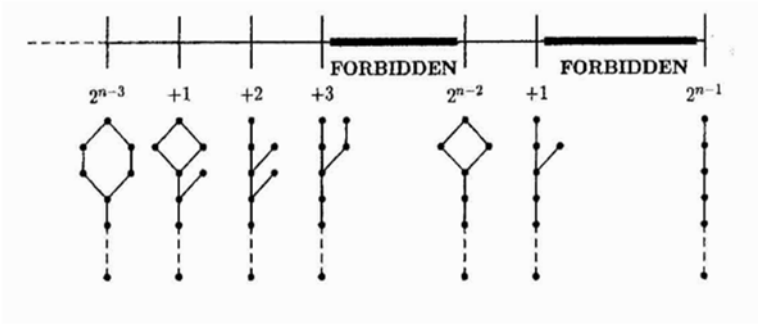
Mike Ferrara

Let H be a graph. The extremal (or Tuŕan) number of H, denoted $ex(n, H)$ is the minimum number of edges needed to assure that every graph G with n vertices and at least $ex(n, H)$ edges contains H as a subgraph. Often, the problem of determining $ex(n, H)$ is called the Tuŕan problem. In this talk, we will discuss two variations of this classic extremal problem: Potentially $H -$ graphic sequences and $H -$saturated graphs of minimum size. The parameter $\sigma(H, n)$ is defined to be the smallest even integer m such that every $n -$term graphic degree sequence π with degree sum $\sigma(\pi) \geq m$ has some realization that contains H as a subgraph. We will discuss some techniques used to determine $\sigma(H, n)$, focusing specifically on the case where H is an arbitrary union of disjoint cliques. We will also develop a general lower bound on $\sigma(H, n)$. A graph G is $H -$saturated if G does not contain H as a subgraph but, for any nonadjacent vertices u and v, $G + uv$ contains H as a subgraph. The parameter $sat(H, n)$ is defined as the minimum number of edges in an $H -$saturated graph of order n. The number of graphs H for which $sat(H, n)$ is know is quite small. We determine $sat(H, n)$ when H is a union of cliques of the same order, an arbitrary union of two cliques and a generalized friendship graph. We will also give a conjecture relating the parameters $sat(H, n)$ and $\sigma(H, n)$.

Forbidden Pebbling Numbers

Christopher Cabanski

Abstract: Consider a finite connected graph G with a distribution of pebbles, represented by nonnegative integers, on its vertices. A pebbling move on a graph *G* is defined as the removal of two pebbles from one vertex followed by the addition of one pebble to an adjacent vertex. The pebbling number *f(G)* of a connected graph is the least number of pebbles such that any distribution of *f(G)* pebbles on *G* allows one pebble to be moved to any specified but arbitrary vertex through a sequence of pebbling moves. It is known that for a connected graph *G* on n vertices, *n ≤ f(G) ≤ 2n-1*. We define an integer to be a forbidden pebbling number if that integer cannot be the pebbling number of any connected graph on n vertices. We will show that over half of the integers between *n* and *2n-1* are forbidden pebbling numbers. We also provide some observations regarding the distribution of pebbling numbers around powers of 2.



This work is part of Chris Cabanski's Honors thesis project. He gratefully acknowledges the generous support of the University of Dayton Honors Program and the Department of Mathematics.

About the speaker: Chris Cabanski is a life-long resident of Toledo, Ohio. He is an alumnus of St. Francis de Sales High School, in Toledo, Ohio. Chris will graduate in May 2007, after only three years in college, with a major in mathematics and a minor in entrepreneurship. Although Chris always intended to join the work force after graduation, he has recently embraced the idea of graduate school, where he intends to study either operations management or statistics. Chris was the recipient of the 2006 Pi Mu Epsilon Award of Excellence in Mathematics in the Sophomore Class. He presented preliminary results of his research in a Pi Mu Epsilon session at Mathfest in Knoxville, TN in 2006. Chris is fond of the water – he was on his high school swimming team, he is a member of UD's water polo team, and he is a lifeguard in the summers. He is actively involved with Flyer Enterprises, working in various capacities, including being the Staff Accountant for the ArtStreet Cafe.

On the relationship between DECA students' achievement on the Measures of Academic Progress test and their performance on the Ohio Graduation Test

Karen Eckberg

Abstract: The Dayton Early College Academy (DECA) is an early college high school that helps each student identify his or her strengths and talents, and helps personalize his or her own academic plans based on them. In the fall and spring each year, the academy administers the Measures of Academic Progress (MAP) standardized test in several curriculum areas. The MAP test is "a state- aligned computerized adaptive assessment program that provides educators with the information they need to improve teaching and learning" (www.nwea.org). With the results from the MAP exams, teachers can help students design personalized academic plans. In addition to the MAP exam, students at DECA must pass the Ohio Graduation Test (OGT) in various categories in order to receive a high school diploma. This thesis examines the results from the MAP tests to determine if the test predicts the students' performances on the OGT.

Karen Eckberg is originally from Holmdel, New Jersey, and she is a graduate of Red Bank Catholic High School. Karen will graduate from the University of Dayton at the end of this semester with a Bachelor of Science in Mathematics. Her Honors Thesis was completed under the direction of Dr. W. Diestelkamp in the Department of Mathematics.

* DECA is located on the third floor of the former NCR building at 1529 Brown Street. You should enter the building from the entrance at the north west-side right next to the American flag (from the parking lot on the corner of Stewart Street and Brown Street). You will need to check in with the receptionist, Ms. Moss, downstairs before coming up to the third floor.

Uniform *k*-distant even trees are harmonious

Dan Roberts

Abstract: A vertex labeling of a graph is a function that assigns certain numeric value to each vertex such that certain conditions are met. Graceful and Harmonious labeling are examples of such vertex labeling. Graceful labeling has been widely studied, but its additive counterpart, harmonious labeling, has not. We present a new class of graphs which are harmonious, and we hope this sparks interest in the field.

About the speaker. Dan is from Arcanum, Ohio where he graduated from Arcanum-Butler High School. He attended University of Tampa for two years. He is finishing his B.Sc. in Mathematics from The University of Dayton. In Fall 2007, Dan will begin graduate school in Mathematics at Auburn University.

Place of the Talk: Science Center 323, Department of Mathematics
Time of the Talk: 11:30 PM-12:30 PM, Friday, April 27, 2007

Exploiting Options on Futures Mispricing for Trading Profits

Mike Thornton

Abstract: Option prices are typically priced based upon a partial differential equation known as the Black-Scholes option pricing model. This equation can be manipulated to solve for the implied volatility, given the markets price for an option. The implied volatility of corn has a seasonal trend, which can be explained by the uncertainty of the harvesting period that occurs in the late spring and summer months. This volatility spike is usually not priced into the market until those harvesting months. One can take advantage of this mispricing by constructing a strategy known as a calendar spread, where one could simultaneously buy and sell two options, with everything constant except the time to maturity. This strategy attempts to take advantage of the mispricing that occurs from the seasonal volatility trend and can be very profitable if done correctly.

Place of the Talk: Science Center 64, Department of Mathematics
Time of the Talk: 1:30 PM- 2:30 PM, Tuesday, May 1, 2007