The 93rd Texas MAA Section Meeting 2013

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TTU

Book of abstracts

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Short Course: Mathematics Biology / 113

Workshop: An Introduction to Stochastic Models in Mathematical Biology

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Classic models in mathematical biology describe the growth and interactions within or among populations, such as exponential or logistic growth, predator-prey, competition, or infectious disease spread within a population. These classic models are often formulated in terms of ordinary differential equations, where population sizes change continuously over time. When population sizes reach low levels, the continuous state assumption of these deterministic models is no longer realistic. To more accurately address questions about the probability of species survival, or of species invasion, or of disease outbreaks, stochastic models that take into account the discrete number of individuals are required. In this workshop, we discuss continuous-time Markov chain formulations for some of these classic population and epidemic models and address questions about probability of survival. MATLAB programs are used to illustrate the behavior of deterministic models versus Markov chain models.

Undergrad Session I - Biomath / 58

Investigating the Impact of Alligator Gar on Other Fish Species

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The alligator gar, found only in the Americas, can be traced back through the fossil record to the Cretaceous period. They are now classified as imperiled, endangered or expatriated throughout most of their historic range due to overfishing and loss of breeding grounds [1,2]. Once thought to decrease the population of game fish, and attempts to eradicate the species were ongoing until recently. Now fish and wildlife departments throughout the southern US have begun to recognize and understand the important role alligator gar occupy as an apex predator in the ecosystem, and efforts are underway to learn about the life history of the gar. Now it is believed that alligator gar are beneficial to game fish populations, since gar eat other species which compete with game fish for food and which destroy the nesting site of game fish [2]. In this presentation, a competition-predator-prey model is proposed [3]. Preliminary numerical results will be presented and discussed, along with the direction of future work, including model validation, intermittent breeding opportunities of the alligator gar, and using an age-class structure for all species.

References:
1. Ichthyology Department at Florida Museum of Natural History. (Accessed on March 26, 2013.) Biological Profile of Alligator Gar. http://www.flmnh.ufl.edu/fish/gallery/Descript/AlligatorGar/AlligatorGar.html

2. Spitzer, Mark. (2010) Season of the Gar: Adventures in America's most misunderstood fish. University of Arkansas Press.

3. Allen, Linda J.S. (2006) An Introduction to Mathematical Biology. Addison-Wesley.

Undergrad Session I - Biomath / 64

Two Forms of Leishmaniasis: How PKDL Contributes to the Spread of VL

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Visceral Leishmaniasis (VL) is a fatal disease caused by species of the Leishmania protozoan parasite. VL infection results in the death of thousands and illness of hundreds of thousands every year in countries including India and Sudan. Post-kala-azar Dermal Leishmaniasis (PKDL) is a cutaneous manifestation of Leishmaniasis following the treatment of VL and serves as reservoir for the transmission of VL. This study focuses on the relationship between VL incidence during a given period and the proportion of PKDL cases treated into remission during the same period using a dynamical system to model VL and PKDL infection dynamics over a fixed period of time under the assumption that the infection has reached an endemic state. Here the proportion of PKDL cases treated is defined as the ratio of cumulative number of PKDL cases treated to the incidences of PKDL over the time period. This study indicates that with the current treatments available and considering achievable levels of treatment the impact of treating new PKDL cases on incidences of Visceral Leishmaniasis cases does not diminish at higher proportions of new cases treated, however the ability to treat new cases is precipitously inhibited at high proportions.

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A Mathematical Model Predicting Conversion Between Staphylococcus aureus and Its Small-Colony Variant

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Staphylococcus aureus, known as golden staph, is a Gram-positive bacterium that exists in two forms: a wild-type and a Small-Colony Variant (SCV), exhibits a slower reproductive rate. S. aureus is a very prevalent bacterium in the human body, as is another species, Pseudomonas aeruginosa, which produces a signal molecule that causes S. aureus to transition from wild-type to SCV. The SCV phenotype is resistant to standard antibiotics and notably more immunoevasive, therefore likely to cause recurring infection. A mathematical model is presented for the transition between the wild type and SCV S. aureus in a chemostat culture with a nutrient medium that provides S. aureus with the signal molecule. The corresponding system of differential equations represents the population dynamics of these two variants. Analysis of this system yields two equilibria, one of which is the trivial- a condition in which neither population persists. The stability of the equilibria varies, depending on the supply of the critical nutrient, iron, and the dilution rate of the chemostat. When the nontrivial equilibrium represents a meaningful (positive) population, the population persists at this equilibrium. When the nontrivial equilibrium is meaningless (negative), the population does not persist. All theoretical results are supported by a set of numerical simulations.

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Death 1 Latency and the Effects on Predictability of Zombie Virus Spread

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Zombie diseases provide a means of exploring new tools in virology without the restraints typical of real-life diseases, such as lack of information or lack of control over the experiment. By studying a virus with no real-life context, all of the restraints of real-life diseases can be avoided. The zombie disease model used for this research was the Calhoun-Williams model of the zombie virus. This model employs random walks to imitate the analogous spread of diseases among human populations. A computer simulation was used to create a virtual city and disease wherein specific factors can be observed and manipulated. Among the factors explored by this simulation were infectivity of disease as an expression of the population's resistance, initial population (both total and infected), shape of the city, and latency periods. This researcher focused on the trend between Death 1 latency (a measure of the time between recovering from a disease and becoming infected by the same disease again) and overall predictability of viral spread. This relationship can be seen in the coalescence of population graphs over time when the Death 1 latency period is modified.

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ZOMBIE INTERACTIONS OVER TIME

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Zombie outbreaks are often portrayed in popular movies, books, and games as a way to see who can survive, but there are many more factors than meet the eye. We will describe our work using a computer model, the Calhoun-Williams Model, that implements random walks to simulate zombie outbreaks in a city, and charts the number of interactions between zombies and humans over time. The computer simulation was created to run a virtual outbreak in a generated city. The virus can originate in varying numbers of people, and spread very quickly. We aim to understand the distribution of interactions between infected and healthy individuals over time, in order to discover what parameters play a role in how quickly the virus can spread throughout a population.

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Diversity and Homogeneity Revealed in SSR Analyses of NCGR Cultivars

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The popularity of the well-known home remedy ingredient cranberry (Vaccinium macrocarpon Aiton) has been growing in the past few decades. Previous crosses of cranberry cultivars have produced advantageous offspring therefore the objective of this study was to determine the genetic fingerprinting and to identify the true parents from the pedigrees of cultivars in order to assist in the process of developing new and desirable cultivars. A set of 12 simple sequence repeat (SSR) markers was used to characterize 280 accessions across 54 cultivars from the National Clonal Germplasm Repository (NCGR) by using fluorescent primers in polymerase chain reaction (PCR). Amplified fragments were separated by size and the resultant alleles were scored. Genetic distance was calculated and principle coordinates analyses were performed. We expected that within a cultivar, the alleles of each accession would be identical, and that across cultivars, alleles of different accessions would differ. Many discrepancies were found therefore not all of the pedigrees could be established. However, comparison to previously defined consensus genotypes showed that accessions of the same cultivar were often grouped together near the consensus genotype, suggesting that some V. macrocarpon cultivars are gene pools rather than pure genotypes. This finding suggests a need to change the approach used to determine pedigrees.

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Models for Treatment of Bacterial Infection: Antibiotics and Bacteriophage

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In the medical field, the increase in bacterial resistance to antibiotics in humans has become a substantial problem. Therefore, new methods for fighting bacterial infection are of current research interest. One treatment method that shows promise is bacteriophage therapy. Bacteriophage are viruses that use bacteria as their cloning vector, and eventually cause the bacteria to lyse, or rupture, releasing newly created bacteriophage. To explore the effects of different treatment strategies on bacterial growth, we applied a model for bacterial infection within an individual host. This model is a system of differential equations for the rate of change of bacteria, bacteriophage, immune response and antibiotics, originally formulated by Bull and Levin in 1996. We use a generalized model to explore the effects of bacteriophage on bacterial growth, as well as the benefits in applying bacteriophage therapy to treat antibiotic resistant infections. In conclusion, we can theorize that bacteriophage therapy could be used as a possible treatment for bacterial infections.

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Epidemic Models: Controlling Pest Populations with Vertical Transmission and Sterilizing Pathogens

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We analyze the effect of full vertical transmission in several epidemic models involving infectious diseases that cause sterilization in the infected hosts. Under certain conditions on the parameters, we found that the sterilization effect may prevent a susceptible extinction situation regardless of how large the infection rate may be. This effect is studied under several functional forms for the infection transmission term in order to assess its robustness. The implication in pest control measures is also discussed.

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Modeling Optimal Intervention Strategies for the Control of Mastitis in Dairy Cow Populations

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The incidence and spread of mastitis in a dairy cow population is a significant problem in the dairy industry. The spread of mastitis depends upon several risk factors for which some effective preventive measures have been identified. However, many of the cost factors associated with disease incidence are hidden (for example, decreased milk production).
We have developed a mathematical model for the transmission of environmental and contagious mastitis in a dairy cow population. Our model builds upon existing research related to the spread of environmental and contagious pathogens. We will utilize optimal control theory in determining a protocol for the implementation of an integrated control/treatment plan that minimizes associated costs.

Undergrad Session II - Applied Mathematics / 104

Math Bites: A Predator-Prey Model of Various Species

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The predator-prey relationship between two species is modeled using the intrinsic growth rates of each species in a system of differential equations. We have included graphical views of the numerical estimation of solutions with various initial conditions. We also performed stability analysis of the realistic equilibrium for different parameter combinations.

Undergrad Session II - Applied Mathematics / 80

Modeling Nitrate Occurrence in the Middle Trinity Aquifer of Texas

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Changes in federal and state budgets over the last decade have limited the funds allocated to water quality monitoring programs, highlighting the need for optimizing groundwater well monitoring networks. The Middle Trinity Aquifer of Texas underlies a largely rural area characterized by decentralized water supplies and extensive agricultural and dairy farming activities. The aquifer is a major source of water supply for the region and monitoring its quality is imperative to protect public health.

The goal of this study is to develop models using statistical analysis to optimize groundwater monitoring in the Middle Trinity by identifying locations prone to contamination by nitrate, a chemical commonly used in agricultural activities. The exceedance of drinking water standard of nitrate will be modeled using relevant soil and hydrologic variables that are readily available. Models will be developed using Logistic Regression and Decision Tree approaches and integrated into a GIS framework to assess the spatial variability of nitrate levels in the groundwater. The developed models will serve as a decision support tool for well owners, as well as state planners and policy-makers to make risk-based decisions on long-term water resource management.

Undergrad Session II - Applied Mathematics / 69

N-Body Simulations of Late Lunar Forming Impacts

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The giant impact hypothesis is a widely accepted explanation for the unique nature of the Earth-Moon system. Models have been created that can produce a disk of debris with the proper mass and composition to create our moon. Models have also been created that start with a disk of debris and have this disk coalesce into a moon. To date no one model has been created that produces the earth-moon system in a single simulation. In this work two recently published ideas in the field were combined with a new gravity centered model to create a single model that produces an accurate earth-moon system from a giant impact.

Undergrad Session II - Applied Mathematics / 60

Growth Patterns of Ethnic Groups in Bexar County with Modified Leslie Models

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The purpose of this study is to modify the Leslie model with a dynamic matrix for better population projections in Bexar County. A dynamic matrix was used to improve the static Leslie model used in the previous study since human population growth is dynamic and complex. The matrix was constructed with functions that modeled the birth rates and survival rates. This allowed the rates to change from year to year. The population projections using the dynamic matrix were compared to the real population data and the static matrix. The researcher concluded that overall the dynamic matrix produced good population projections for the ethnic groups in Bexar County.

Undergrad Session II - Applied Mathematics / 32

Public Health Policy and Managing Bioterrorism

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The possibility of bioterrorism and experiencing a bioterrorist attack has been steadily increasing throughout history. The use of diseases and infectious agents as weaponry dates back to hundreds and hundreds of years ago. Recently biological advancements and research have made the mutation of infectious agents possible and life threatening. This research uses mathematical modeling to simulate the effects of possible bioterrorist agents on a closed population. By using variations of an SIR model, this research simulates several possible epidemic scenarios caused by a bioterrorism attack with the smallpox virus, as well as the avian and bird influenzas. The parameters of the model were manipulated to demonstrate the effects of various public health policies on minimizing the impact of those attacks. The results convey that public health policies are more effective when both preventative and responsive measures are implemented.

Undergrad Session II - Applied Mathematics / 79

The Logistic Equation

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We are considering the logistic equation, $P' = kP(1-P/N)$, and how it is used to predict the growth of bread mold. We solve the logistic equation and determine values for the carrying capacity,N, and the growth constant,k. By growing bread mold in a controlled enviroment, we were able to approximate the carrying capacityand growth constant.

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Light Curves & Rotational Periods for Main Belt Asteroids

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771 Libera is a Main Belt asteroid with an average distance of 2.7 AU from the Sun, orbital period of 4.3 years, and orbital inclination of 15o. It has a diameter of 29 km and albedo of 13%. A two-night series of FITS images of this asteroid were analyzed using aperture (differential) photometry to measure the light curve. From the light curve a rotation period of ~6h was determined. In addition using the online 0.41-m Schmidt −Cassegrain with CCD camera at the Ironwood North Observatory (Phoenix), a series of FITS images of one other Main Belt asteroid was taken. This, too, was analyzed using aperture photometry to determine its light curve and rotational period.

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Community Structure and Its Effect on Virus Spread

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Though the idea of Zombies invading and destroying a neighborhood may not be too applicable in the real world, virus outbreaks are all too real. Imagining a lifeless, thoughtless virus strain is then as simple as imagining a zombie roaming the neighborhood. This study utilizes the Calhoun-Williams Model, a computer simulation which makes use of random walks to create a virtual city and contagion. By introducing a virus strain into multiple communities, and tracking its progress and success rate in each area, conclusions can be drawn on the effects of the city's shape and inhabitants on the spread of a disease. Population density, human susceptibility, and latency time are explored as well.

Undergrad Session III - Pure Mathematics / 75

Undergraduate Numbers

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In this discussion of the axiomatic definitions of numbers, we use the Peano Axioms and the constructions of the integers, rational numbers, and real numbers as an example of the effectiveness of undergraduate math courses in teaching abstract notions. In these constructions, we see several techniques and ideas that are taught in undergraduate courses such as axioms, integral domains, the field of quotients, and Cauchy sequences which enable the construction of the next superset of numbers. We note all these topics are touched on in undergraduate Discrete Mathematics, Abstract Algebra, and Analysis.

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On Minimal Representations of GL(m,p) as a Subgroup of a Symmetric Group.

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We call a representation of GL(m,p) as a subgroup of the symmetric group S(n) minimal if n is the smallest positive integer for which there exists an injective homomorphism of GL(m,p) into S(n). We give arguments for finding n for various m and p.

Undergrad Session III - Pure Mathematics / 59

Not Your Plane Geometry

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During this presentation we will explore the mathematicians behind spherical geometry and its applications to our globe. Great circles, the properties of triangles, and the definitions of poles will be covered. Through the exploration of right triangles, the distance from one place on the globe to another can be discovered through the creation of triangles. Right triangle formulas, law of sines formula and law of cosine formulas can be used to solve for unknowns. This will be explored through an Excel worksheet and implemented in a website.

Undergrad Session III - Pure Mathematics / 92

Investigations of the Complex Number Derivative

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The number derivative is a mapping on the real numbers which relies on our understanding of the unique factorization of natural numbers. The Complex Number Derivative (CND) extends this concept to include the Gaussian Integers which possess a unique factorization in the complex plane. After defining the CND we discuss its properties with regard to norms and distributions of Gaussian Primes. We also outline ideas for future research that draw from the CND.

Undergrad Session III - Pure Mathematics / 56

Virtual Knot Games

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In this presentation we introduce the virtual knot theory game Much Ado About Virtually Knotting and present the audience with the results of our research. Our work is motivated by the paper A Midsummer Knot's Dream, which describes several games on the shadows of knots and proves that winning strategies exist for certain players partaking in these knot games. Similarly, we are concerned with the existence of winning strategies for players playing our virtual knot game. We present one such winning strategy that applies to an entire family of knots - specifically, the daisy knot family - and present an outline of our proof. We close with further questions motivated by our research and results that may advance our understanding of relationships between certain types of knots.

Undergrad Session III - Pure Mathematics / 62

Applying the Omega Function to Primitive Numerical Monoids

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We discuss how far a number, x, is from being prime in primitive numerical monoids by applying the omega function to x. Various authors have studied properties of the omega function, and several general cases have been found of monoids generated by two irreducibles. In our talk, we will discuss results from numerical monoids generated by three irreducibles, and give simple formulas for computing omega(x) for generalized monoids.

Undergrad Session III - Pure Mathematics / 57

An Approach to the Hadwiger-Nelson Problem

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This is an expository presentation of D. Coulson's paper, "On the Chromatic Number of Plane Tilings." In Coulson's paper we find that least 6 colors are needed for a distance D excluding tile based coloring of the plane when convex polygons are used as the coloring tiles. This paper contributes to the Hadwiger-Nelson Problem. The Hadwiger-Nelson problem states, "How many colors are needed so that if each point in the plane is assigned one of the colors, no two points which are exactly 1 unit apart will be assigned the same color?"

Undergrad Session IV - Statistics / 76

Apparel Size Standards within the Fashion World

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The intent of this study was to examine the theory of standardized clothing within the fashion industry. This research concentrated primarily on the apparel size standard of waist measurements of size 12 black-colored, female skirts and size 32 black-colored, male dress pants. Moreover, this study investigated factors Style, Fabric, and Store Category, which affected adherence to the apparel size standard developed in the study. Throughout the investigation additional interactions were discovered and included into the final statistical model. The final statistical model was explored to examine the statistical significances these interactions had on the waist length. The apparel size standard developed within the study was also compared to apparel standards developed by the United States Department of Commerce.

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Using Markov Chains to Compute the Expected Length of Board Games

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This paper analyzes the expected length of the board game Chutes and Ladders based on "Chutes and Ladders for the Impatient" by Cheteyan et al., which defines a Markov chain to calculate the expected game length using uniformly distributed spinners of all possible ranges. In particular, they show that a uniformly distributed spinner of range 15 yields the shortest expected game length of 23.81 turns. In this paper, we investigate optimal distributions of non-uniform spinners of ranges 2 and 3. Specifically, we show that the optimum distribution of a non-uniform spinner of range 2 has probability 86.61% of spinning a 2 and yields an expected game length of 47.28 turns, 13.48 turns less than a uniformly distributed spinner of range 2. For simplicity, non-uniform spinners of range 3 are analyzed on a small 3-by-3 example board on which the shortest game is found when the probability of spinning a 3 approaches 1 and the probabilities of spinning a 1 or a 2 approach 0. However, depending on how the probabilities of spinning a 1 or a 2 approach 0, infinitely many expected game lengths can be approached. The seemingly paradoxical behavior of this non-absorbing Markov chain is discussed.

Undergrad Session IV - Statistics / 45

The Probability that a Matrix of Integers is Diagonalizable

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Diagonal matrices are desirable because they allow for simple computations of matrix powers and display their eigenvalues along their diagonals; therefore, a natural question is: how often can one expect a matrix to be diagonalizable? In this paper, we discuss the research of A. Hetzel, J. Liew, and K. Morrison, who show that the probability that a matrix of integers is diagonalizable over the complex numbers is 1 by the Fundamental Theorem of Algebra. We also present their proof that the probability that a 2×2 matrix of integers is diagonalizable over the real numbers is 49/72. After reviewing their conjectures for the probability that a 3×3 matrix of integers is diagonalizable over the real numbers, we review sample data and explore applications of their techniques for calculating the probability of diagonalizability in the case of 3×3 integer matrices.

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Probabilistic Measure of Convexity

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The convexity coefficient is a way to measure how close a plane figure is to being convex. If D is a plane figure, its convexity coefficient is the probability that randomly selected points in D are visible to each other. A convex figure has a convexity coefficient of 1. In this talk, we compute the convexity coefficient of several non-convex shapes. We examine the effects of transformations on the convexity coefficient and explore applications of this measure. We shall also compare this coefficient to other ways of measuring convexity.

Undergrad Session IV - Statistics / 74

Bridges on a Tile Floor

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Probability problems involving interdependent events can be much harder to solve than problems with independent events. This seminar investigates a probability problem whose complexity comes from the interdependence of its events. The problem, which considers a tile floor of black and white tiles, is simple to understand but challenging to solve. A variety of tools, including recursion and Markov Chains, are used to solve the problem.

Undergrad Session IV - Statistics / 33

Math asks: "Water You Doing,Georgetown?"

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We will present an original model of water demand and its relation to temperature and rainfall in Georgetown, Texas. Data is obtained from a variety of sources. Our model will estimate the amount of water use for irrigation in this area.

Undergrad Session V - Math Education / 96

A Brief Look Into the History of Galois and Galois Groups

Mr. SCHUETTE, Geoffrey [1]

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In this talk we will take a brief look into the life of Évariste Galois and discuss in general Galois groups. We will work through specific examples built from finite fields and explore certain properties of these groups.

Undergrad Session V - Math Education / 84

Collaborative Learning and its Effects Upon Student Achievement in College Geometry

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The research is to determine if there is a statistically significant difference between student achievement when using an individual teaching style and a collaborative learning style in a college geometry course.

Undergrad Session V - Math Education / 10

Project-Based Learning: Construction Engineering

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The focus of this presentation is the application of Project-Based Learning, with the project being Construction Engineering.
The idea is to take an applicable problem that initially seems unmanageable and break it down into steps, set up equations, identify problem areas, and change variables until we arrive at the desired result.
Specifically, the problem required testing values until we reached the desired result, which was when the qualities of a beam allowed it to withstand a certain load.
The primary tool for organization and calculations was Mathematica.

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The Development of the Calculus and its Effect on Mathematical Rigor

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This project investigates the development of the calculus and its heavy impact on the development of rigor in mathematics. As discoveries in mathematics are generally cumulative, rather than the work of an isolated individual, this process may best be observed through a historical exposition of relevant contributions beginning with the Greeks of Antiquity, through the work of mathematicians like Cauchy and Weierstrass nearly two centuries after Newton's discovery of the calculus. Throughout the history of science there are certain types of discoveries that not only add to the pool of knowledge, but force the re-evaluation of key concepts of the field previously considered to be correct. Such revolutionary discoveries are often referred to as paradigm shifts. Within mathematics, a field defined by logical rigor and self-consistence, such discoveries spark a flurry of new work and research in an attempt to regain consistency, and may be referred to as mathematical crises. Though there are several such discoveries that are notable in mathematics, the discovery of the calculus may be the most important of such mathematical crises. The calculus, through its undeniable usefulness, thrust under close scrutiny anomalies in the foundation of mathematics that had previously gone unnoticed or unsolved. It was not until rigorous definitions of continuity, limits, and the real number line were established that the discipline of mathematics could fully explain and support the revolutionary methods of the calculus. Thus the calculus heavily influenced the understanding and rigorous definition of even one of the most fundamental ideas in mathematics: that of number.

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Combinatorics and Musical Dice Games

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It is a widely known fact that mathematics and music are very closely related, whether it be for their unique notations or for the prodigies that each discipline is capable of producing. In this study, a particular case of this mathematics-music relationship is explored and applied; that of the combinatorics behind dice music or "musical dice games" which were made popular in the eighteenth century.

Undergrad Session V - Math Education / 111

Geometry - Discovery Approach with a Tech Twist

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The Discovery Approach to learning/teaching is a fascinating technique. This method of teaching is being used by many professors and teachers in schools and colleges today. It has opened up an avenue to assist students to learn in a whole new way. Furthermore, the addition of computers and software has presented a gateway to learning/teaching which allows instructors a more efficient way of covering some topics. Specifically, we will take a look at both the Discovery Approach and computer software and how it can produce positive results for learning/teaching in the subject of Geometry.

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Mathematics Pre-Service Teachers Design a Concrete Beam

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At Texas A&M University-Commerce, a distinct model for the implementation, dissemination, and institutionalization of Science, Technology, Engineering and Mathematics (STEM) education is currently being developed based on best practices suggested by research studies on teaching and leadership. A sequence of four courses for secondary mathematics and science pre-service teachers taken on the junior and senior years have been created to prepare leaders in STEM education who have field experiences before their student teaching placements.
The present study looks at qualitative data collected for nine students who have taken these courses as an alternative to the traditional coursework offered by the university's Department of Curriculum & Instruction. The study focuses on describing student strategies used when designing a concrete beam with steel reinforcement, and how the students made design decisions based on deep understandings of relevant geometry, algebra and physics content. What the problem required was testing values for design parameters until reaching the desired result, which was when the properties of the beam allowed it to withstand a specified load. The students report having been exposed to relevant, complex and challenging problems is a valuable partial requirement for completing the program in secondary mathematics education.

Undergrad Session VI - General / 70

Cops and Robber Focused on 2-Copwin Graphs

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The game Cops and Robber was first introduced in the 1980s by Quilliot and by Nowakowski and Winkler. The game is played on the vertices of a finite graph by moving along the edges of the graph to travel between vertices. The goal of the game is for a cop to catch the robber by occupying the same vertex at some point during the game. If this occurs the graph is considered a copwin graph. In 1983, the variant of k-cop was introduced by Aigner and Fromme, where k represents the minimal number of cops needed in order to achieve a copwin on a graph. During this research we focused on finding graphs that are k=2 copwin, particularly looking at the Möbius Ladder Graph family. In this presentation, we will discuss a brief history of the game and show examples of graphs that are k=2 copwin graphs, including a proof for a Möbius Ladder Graph.

Undergrad Session VI - General / 72

Optimizing the Multi-Jump, Player Strategy, and A.I.

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In many video games, the player has the ability to perform a multi-jump, which is a sequence of jumps where each jump after the first is initiated in midair. We discuss the mathematics behind optimizing multi-jumps. We then use these mathematics to develop player strategies, A.I. strategies, and techniques that game developers can use in designing levels.

Undergrad Session VI - General / 61

Plastic Recycling Under a Mathematical Lens

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As the world population increases significantly, recycling is one of the effective ways to conserve energy and natural resources. In addition, recycling reduces landfill use and the environmental damage from pollutants and greenhouse gas emissions. Plastic is one of the most consumed products worldwide, and this research focuses on modeling plastic recycling and landfill usage in Bangladesh and the United States. We develop a Markov chain model in which state diagrams show the flow of plastic in a recycling system. Linear, exponential, and logistic functions are used to describe the amount of plastic at different stages, including virgin plastic and landfill. In addition, the relationship between landfill growth and plastic consumption are modeled using various mathematical procedures.

Undergrad Session VI - General / 85

The 100 Game: Nim in Disguise

Mrs. BURCHAM, Shalisa [1]

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An interactive demonstration of the logic and methods used to find optimal strategies of the 100 Game and Nim, including some historical background on combinatorial game theory.

Undergrad Session VI - General / 63

Minimum Folding of an Infinite Ribbon

Mr. LEYVA, Jason [1]

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The lower right-hand corner of a page is folded over so that it just touches the left edge of the paper. If the width of the paper is 'a' and the page is very long, find the minimum length of the crease.

Undergrad Session VI - General / 97

Who is the Greatest Player in all the Land?!

Mr. BOYD, Marley [1]

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Baseball as a Markov Chain.

Undegraduate Poster Session I / 108

Chaos and Allee Effect on a Discrete-Time Logistic Population Model

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Chaos is a term used in biological population systems that often carries implications of randomness. Instead, the accepted mathematical consensus considers a system to be in chaos only if this system displays the following three characteristics: topological mixing (different parts of a graph are superimposable on others), a deterministic nature, and sensitivity to initial conditions. Chaos occurs in a discrete logistic system as the growth rate r increases beyond approximately 2.692. Using MATLAB, three programs were developed to model the population size of a discrete logistic model. These programs model population size versus growth rate, time, and previous population size in order to better represent the changing patterns in population size and clearly display each of the conditions of chaos. The values of r for which a discrete logistic system bifurcates into 2 and 3 cycles were numerically derived. An investigation was then conducted that examined how complications like the addition of an Allee effect (positive density dependence) to the system affects the r values at which the system bifurcates. Adding an Allee effect to the system increased the r values at which the system bifurcated, implying increased system stability.

Undegraduate Poster Session I / 101

Short-term Meditation Improves Attention and Emotion

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Life is stressful, and many try to cope with stress using various methods, including smoking. Meditation and relaxation are shown to improve mindfulness and focus due to decreased stress levels. In the past six years, the field of psychology has expanded its interest in meditation and mindfulness, resulting in numerous publications in this area. The researchers are in the process of investigating the effects of short-term meditation on smokers. The participants are students attending Texas Tech University. Two groups, a smoking and a non-smoking group, are subjected to thirty minutes of meditation for ten consecutive nights. The researchers monitored the changes in their sense of wellbeing over the ten day period using the Profile of Mood States (POMS), Mindful Attention Awareness Scale (MAAS), and Positive and Negative Affect Schedule (PANAS) tests. Due to the length of the study and the need for individuals to be present during every session, finding willing and qualified participants is difficult, especially for the smoking group. This affects the random sampling of the population and lengthens the time it takes to obtain statistically significant data. As a result, the data that the researchers present may not all be significant, but previous studies indicate that over time and with a greater sample size, this research should follow the idea that short-term meditation decreases stress levels, heightens attention, and improves emotion.

Student Form / 114

Student Forum: How Math Is Changing The World

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In Oct 2010, an article called "How much math do we really need?" was published in the Washington Post. The author, a mathematician, wrote "Unlike literature, history, politics and music, math has little relevance to everyday life" and "All the mathematics one needs in real life can be learned in early years without much fuss." Is this true? Have you ever been asked "What can you do with a degree in math?" Besides teaching, many people are clueless on what you can do with strong math skills. In this talk, we will talk about some of the exciting things mathematicians in business, industry, and government are doing in their careers and how these things are changing the world. And we will reveal the three things that recruiters say every math student should do to get a job.

Welcoming Address / 115

Welcoming Address: Extreme calculus

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There is more to elementary calculus than may first meet the eye, especially to those of us who teach it again and again. With appropriate help from graphical, numerical, and algebraic computing, well-worn calculus techniques and topics---polynomials, optimization, root-finding, methods of integration, and more---often point to deeper, more general, more interesting, and sometimes surprising mathematical ideas and techniques. I'll illustrate my thesis with figures, examples, and a lot of e-calculation, aiming to take elementary calculus to its interesting extremes.

Faculty/Grad Session I - Biomath / 50

Derivation of stochastic correlated random walk models

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Usually organisms and particles do not move in purely random directions. Often, the current direction is correlated with the direction of prior movement. This type of random walk is called as a correlated random walk. In this study, two well-known correlated random walk models are studied, specifically, the telegraph equation in one-dimension and the linear transport equation in two dimensions. These equations are useful, for instance, in studying animal or particle movement. In the present investigation, stochastic telegraph and linear transport equations are derived from basic principles. In particular, dynamical systems, with time discrete, are studied to determine the different independent changes. As the time interval decreases, the discrete stochastic models lead to certain stochastic differential equation systems. Then Brownian sheets are appropriately substituted for Wiener processes in stochastic systems. When intervals in the secondary variables go to zero, final stochastic models are derived. Comparisons between numerical solutions of the stochastic partial differential equations and independently formulated Monte Carlo simulations support the accuracy of the derived equations.

Faculty/Grad Session I - Biomath / 8

A Differential Equation Model for a Viral Infection with an Immune Response

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Viral infection stimulates the cellular immune response resulting in production of CD4 T cells, cytotoxic T lymphocytes (CTL), and antibodies. CTL attack and kill cells that are infected by viruses. Antibodies are capable of identifying and neutralizing viruses, whereas CD4 T cells stimulate the proliferation of CTL. In addition, antibody production is stimulated by viruses.
We include the cellular immune response in a new model for viral infection of a host which has applications to Human Immunodeficiency Virus and hepatitis C infection. The model consists of four differential equations for healthy target cells attacked by a virus, infected target cells, cellular immune response and free virus. We show the model has three equilibria corresponding to the disease-free stage, the acute stage of infection and the chronic stage of infection. Stability results are summarized and numerical simulations illustrate the model dynamics. Biological implications for control of the infection via the immune response are discussed.

Faculty/Grad Session I - Biomath / 30

Modeling Cell Populations to Address Post Implant Healing by Using Differential Equations

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The development of bio-medical implants for corrective surgeries has given doctors and patients treatment options in numerous fields including dental repair, heart health, and join replacement. However, the failure of these implants, due to the hyperactivity of certain immune cells is an ongoing challenge. We construct a mathematical model (a set of differential equations) that describes the cellular interactions involved in the post implant healing process and analyze the model to gain insights regarding instigators and regulators of the immune response. Specifically we look at the multiple roles of white blood cells as well as the impact of bone marrow-derived adult stem cells on the intermittent and long-term behavior of the system. Through both analysis methods and computer assisted methods we are able to magnify the interworking's of some of the key components of the immune response and determine conditions that will increase the likelihood for a patient's long term recovery to converge to a healed outcome.

Faculty/Grad Session I - Biomath / 53

Stochastic Models of Bacteria-Phage Dynamics

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Bacteriophage, more commonly known as phage, are viruses that kill bacteria.
Phage are used to treat food or animals infected with bacteria, thereby killing the bacteria. Phage attach to a bacterium, inject their DNA or RNA, multiply inside the bacterium, then burst from the bacterium, releasing many new phage particles. Mathematical models for
bacteria-phage dynamics that account for uninfected bacteria, B, two stages for phage-infected bacteria, L and I, and phage particles P are formulated and analyzed. The models are deterministic and stochastic, a system of ordinary differential equations, a Markov chain
model, and a multitype branching process. The basic reproduction number in the
deterministic model defines a threshold in terms of model parameters. If this threshold
is less than one, phage cannot persist and will not kill the bacteria. This same threshold applies to the stochastic models. In addition, the branching process provides an estimate
of the probability of successful phage growth when the threshold exceeds one. Numerical results applied to a particular bacteria-phage system illustrate the importance of initial phage density, phage death rate, and phage burst size in controlling bacterial infections.

Faculty/Grad Session II-A - Applied Mathematics / 55

Oscillatory Behavior of Third-Order Delay Dynamic Equations on Time Scales

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One important method for studying the oscillation of higher-order differential equations is to make a comparison with first-order differential equations. The method involves using the monotonicity of the operator. In this talk we show how such a method can be applied to a class of third-order delay dynamic equations on time scales. In particular, it is shown that the nonexistence of an eventually positive solution of a certain first-order delay dynamic equation is sufficient for oscillation of third-order delay dynamic equations.

Faculty/Grad Session II-A - Applied Mathematics / 6

Developing Surfaces Using Nonlinear Schrodinger Equation

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In this work, we developed 2-surfaces in three dimensional Euclidean space arising from the Nonlinear Schrodinger (NLS)equation. They contain a family Weingarten and Willmore-like surfaces. We show that some NLS surfaces solve the generalized shape equation which is derived from a variational principle where the Lagrange function is a polynomial function of the Gaussian and mean curvatures. We also give a method for constructing the position vectors of NLS surfaces by using soliton solution of NLS equation. We plot some of these families of surfaces.

Faculty/Grad Session II-A - Applied Mathematics / 36

Mean stability of stochastic linear difference equations on cones

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Stochastic difference equations, the discrete-time counterparts of stochastic differential equations, have a wide range of applications in the areas such as economics, biology, and communication systems. Motivated by a recent growing attention in control theory, in this talk we will consider the mean stability of stochastic linear difference equations defined over cones. We will outline recent results on the mean stability, including its novel characterization using spectral radius and connection with the stability of deterministic difference equations.

Faculty/Grad Session II-A - Applied Mathematics / 24

Estimate Solutions of Functional Differential Equations by Lyapunov's Second Method

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Since Lyapunov established Lyapunov's Second method to study stability of solutions of ordinary differential equations in 1892, the method has been broadly used in difference equations, function equations, partial differential equations, functional differential equations, and other equations. The author has applied Lyapunov's second to estimate solutions of differential equations since 1986. This talk reviews the development of estimating solutions of functional differential equations. This development can be applied to other types of equations.

Faculty/Grad Session III - Pure Math / 7

A Function, A Fractal, and an Unsolved Problem

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The Hausdorff Dimension of the graph of the Weierstrass function has not been proved rigorously. This talk will be a discussion of Hausdorff measure, dimension, and some of the methods used to find the Hausdorff dimension of Weierstrass-like functions.

Faculty/Grad Session III - Pure Math / 66

Some properties of the Newton map for Rational Functions

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Newton's method is a well known iterative technique for determining roots of complex functions. The corresponding Newton map for polynomials is well understood. Here we will extend these properties to the Newton map for rational functions. In particular we will discuss the degree of these maps and the nature of the fixed points. It is noted that the Newton map of a polynomial $p(z)$, with n unique roots is of degree n. The roots of $p(z)$ are attracting fixed points of the Newton map, simple roots are super-attracting fixed points and ∞ is the only repelling fixed point.

Faculty/Grad Session III - Pure Math / 49

The Only Normal Talk at the Texas Section MAA

Mr. MELTON, Ryan [1]

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Normal families of analytic functions are used in the proofs of the Riemann mapping theorem, the Picard Theorems and other great theorems in complex analysis. Thus, the topic of normal families of analytic functions is a must for all of those who will or have already come across complex analysis. In this talk, the concept of normal families will be discussed, along with normality of a sum of normal families.

Faculty/Grad Session III - Pure Math / 39

Trichotomy of Singularities of 2-Dimensional Bounded Invertible Piecewise Rational Rotations

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It is known that the singularities of 2-dimensional bounded invertible piecewise isometric dynamical systems can be classified as, removable, shuffling and sliding singularities, based upon their geometrical traits; and that the the removable and the shuffling singularities do not generate Devaney-chaos, leaving the sliding singularity as the only candidate for the Devaney-chaos. However, the afore-mentioned classification and the connection had been somewhat incomplete in that the clear distinction between the sliding and shuffling singularities had not been made. In this talk, the speaker will establish the complete trichotomy, by characterizing the self-shuffling behavior of bounded invertible piecewise rational rotations, and lead toward finalizing the necessary and sufficient condition of the Devaney-chaos.

Faculty/Grad Session IV - Statistics / 25

Avoid taxes to pay your medical bills!

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Current law allows employees to contribute pre-tax dollars into 'flexible spending accounts' (FSAs) to be used for allowable health care expenses. There is an annual cap on FSA contributions and unused contributions are forfeited at year's end.
This suggests the problem: given the advantage of using pre-tax dollars to pay health care costs, the risk of forfeiting
unused contributions, the cost of purchasing insurance, and knowledge of expected healthcare costs, what is the optimal contribution to an FSA? We review some existing results, derive some of our own, and discuss ways to adapt these results
to particular situations.

Faculty/Grad Session IV - Statistics / 18

Forecasting rice production using General Regression Neural Network in Sri Lanka

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In this talk I will explain an introduction to neural network, forecasting and GRNN. We will use Sri Lanka's data to forecast both area harvested and productivity using GRNN.

Faculty/Grad Session IV - Statistics / 16

General Regression Neural Network

Mr. PERAGASWATHTHE LIYANAGE, Janaka Suranga Sampath [1]; Dr. BUTAR BUTAR, Ferry [1]

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In this talk I will explain the general idea of GRNN. For example GRNN is useful in missing data and forecasting.

Missing data has struggled reseachers for many decades. Statisticians have put enormous efforts to develop statistical techniques to overcome this issue. In this talk I am focusing on K-Mean and K-Medoid method in handling missing data.

Faculty/Grad Session IV - Statistics / 31

Outliers

Prof. MANSOUR, Hassan Kambiz [1]; Dr. KHOURY, Raja [2]; Prof. PANAHI, Mike [1]

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The Algorithm of detecting outliers within set of data, and comparison of four commonly used methods of detecting outliers.

Faculty/Grad Session V-A - Math Education / 11

Do you see what I see? An examination of self-perception in the classroom

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Teacher self-reports on their instructional practices in the classroom can provide valuable data for assessing changes in classroom practices. However, there is a long-standing concern about the validity of self-report data. This presentation will examine this validity by comparing teachers' perceptions of their classroom practices with third-party observations.

Faculty/Grad Session V-A - Math Education / 44

Modeling the Roles of Working Memory and Strategy Type in Fraction Comparison

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In the present study, I used linear mixed-effects modeling (LME) to investigate the roles of visual and verbal working memory in simple fraction strategies. The choice / no-choice methodology was used to independently analyze the execution of different strategy types. Whereas visual and verbal resources were needed across all conditions, participants who solved fraction comparison problems under concurrent visual load were found to make significantly more errors than participants who were under a verbal load. In addition, an interaction between working memory load and strategy type indicated that procedural strategies were more prone to working memory load effects than were conceptual strategies.

Faculty/Grad Session V-A - Math Education / 40

Extensions of the Golden Apple Problem

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The Golden Apple problem is a problem rich in developing algebraic thinking. It can be solved both symbolically (suitable for grades 7 and above) and pictorially (suitable for grades 3 - 6). Developing extensions of the problem over the set of natural numbers raises interesting patterns in number theory.

Faculty/Grad Session V-A - Math Education / 99

In Search of the Fundamental and Accessible Definition of Prime Numbers

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Various definitions for prime numbers are examined and their accessibility to various learner audiences are analyzed. A definition for prime numbers based on a partitioning of the natural numbers based on the relation: ▯is a divisor of▯and the equivalence relation ▯R: has the same number of distinct divisors▯and the equivalence classes of (N;R) is presented and its learner-level accessibility is analyzed.

Faculty/Grad Session VI - General / 81

The Symbols of Leibniz and Algebra

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A highly visible aspect of the work of Gottfried Wilhelm Leibniz was his lifetime obsession with designing the "universal characteristic," a system of ideas and symbols that would render logic computable. The paper establishes the universal characteristic as an important connecting element in the work of Leibniz and asserts its relevance to the place of algebra in the school curriculum.

Faculty/Grad Session VI - General / 17

The Arithmetic-Geometric Mean Inequality in Precalculus

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The Arithmetic-Geometric Mean Inequality is not traditionally used in Precalculus courses. We will demonstrate its use in optimization problems which are usually solved with calculus methods. This allows Precalculus students the opportunity to be exposed to calculus problems before learning calculus techniques.

Faculty/Grad Session VI - General / 94

Darth Vader, Zucchini, and more in Multivariate Calculus

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A Darth Vader 3D puzzle is a great visualization of contour plots as well as whether a surface is a function. Zucchini can be used to demo partial derivatives and a tangent plane. A "pin art" toy can show the intersection of two cylinders. These class-tested demos will be shared.

Faculty/Grad Session VI - General / 26

Mathemagics

Mr. PATTERSON, Joshua [1]

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We will perform and discuss some counter-intuitive math tricks. These tricks are every bit as amazing as magic, but unlike magic, they do not rely on deception but rather rely on the axioms of mathematics. Come and be part of the fun!

Faculty/Grad Session II-B - Applied Mathematics / 82

Mathematical Model of a Contact Lens and Tear Layer at Static Equilibrium

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We propose a mathematical model of a tear meniscus around a contact lens that is at static equilibrium using a calculus of variations approach, and study the static stability of a spherical cap lens and a tear layer. The contact angle of the tear meniscus with the cornea and contact lens may have a range of values due to capillary effect hysteresis. As the lens is in static equilibrium all the forces and moments sum to zero. The forces acting on the lens are its weight, force due to hydrostatic and atmospheric pressures, and surface tension on the periphery of the lens due to the tear meniscus. The fixed parameters in the model are weight of the lens, coefficient of surface tension, magnitude of gravitational acceleration, density of the tear liquid, and physical parameters of the lens such as the diameter and base curve radius. The adjustable parameters in the model are contact angles of the tear meniscus with the cornea and contact lens respectively and the position of the lens on the cornea. Numerical experiments suggest that there exists a range of values for the adjustable parameters that lead to physically reasonable solutions, for lens position; extent of overlap of the lower lid on the lens; pressure due to the lid on the lens; and the thickness of tear layer between the lens and the cornea.

Faculty/Grad Session II-B - Applied Mathematics / 22

Hysteresis

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Abstract: In an 1894 study of ferromagnetism James A. Ewing coined the term hysteresis, which means ``to lag behind'' in Greek. Hysteresis, as a nonlinear, nonlocal memory effect, presents itself in diverse disciplines ranging from physics to biology, from material sciences to mechanics, and from electronics to economics. We will the discuss mathematical modeling of hysteresis and provide examples. The talk will conclude with opportunities for further research in this area.

Faculty/Grad Session II-B - Applied Mathematics / 27

Modified Kalman Filter Integrated with Shrinking Active Contour for Object Motion Tracking in Video

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The Kalman filter is conventional tracking method used in numerous application areas such as computer & robot vision, multimedia, surveillance systems, etc. We modified the Kalman Filter in order to optimize its fusion with shrinking active contour to track an object through image sequence. Experimental results are presented to validate the theory.

Faculty/Grad Session II-B - Applied Mathematics / 103

Bubble Markets and Study of the Emu's Bubble in Texas in 1990's

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This paper presents evidence of Emu market failure in Texas in 1990's. There are several examples of bubble markets in economics literature. The Dutch tulip market in 17th century, the Florida land bubble in 1925, and the technology bubble (also known as dot-com bubble) in 2000 are just some controversial examples of such bubble markets. The paper briefly explores these bubbles, and in particular the Emu bubble and provides some explanation of what caused the bubble and why it burst. In this regard, we tried to suggest a model for the Emu market crash.

Faculty/Grad Session V-B - Math Education / 110

Educating Elementary Educators

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We will describe the Proyecto EL SMEd program and our successes in increasing both the mathematical knowledge and the comfort with mathematical ideas of in-service elementary teachers.

Faculty/Grad Session V-B - Math Education / 41

A Fast Track Course at A&M-Commerce

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Texas A&M University - Commerce was the recipient of a Developmental Education Demonstration Project (DEDP) grant. Through this grant, A&M-Commerce has been attempting various approaches to developmental education, including different modalities and learning interventions. This talk will discuss one particular way in which we have worked with our students through the DEDP grant: a Fast Track course that combines both Intermediate Algebra and College Algebra in an effort to accelerate students through both courses in a single semester.

Although the student population that utilized this course option in the Spring 2012 semester was small, the results were positive. This talk will include a discussion of the course setup (agendas, schedules, testing process, and how grades were assigned for both courses), outcomes from the courses, student perspectives, and faculty feedback.

Faculty/Grad Session V-B - Math Education / 90

An Investigation on the Effect of Participation in Intensive Calculus Workshops on Students' Ability to Identify and Critique Solutions to Calculus Exam Questions

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Calculus is widely viewed as a gateway to science, technology, engineering, and mathematics (STEM) fields; however, success rates in calculus continue to be a concern nationwide. Students' ability to produce or recognize correct, well-written, robust solutions to calculus problems directly affect the latter, yet little research exists that examines this. Using sample student work on calculus exam questions, we created an instrument requiring participants to critique and rate the effectiveness of the solutions presented. UT-Arlington offers students pursuing degrees in STEM fields enrolled in first-semester calculus the opportunity to participate in the Arlington Emerging Scholar's Program (A-ESP). In this intervention program partially supported by NSF (DUE #0856796), students work in small groups on challenging calculus problems for four hours weekly in addition to attending regular lectures and labs associated with the course; as a result, these students actively collaborate in the creation of a greater number of worked examples connecting many topics. Findings based on the responses of fourteen students participating in A-ESP and 34 non-A-ESP students from the same section of calculus suggest that students participating in A-ESP communicated their views in a more clear, concise manner and demonstrated stronger skills for providing feedback on peer work and correctness of solutions than their non-A-ESP counterparts.

Faculty/Grad Session VII - Outreach and Retention / 34

An Analysis of Admissions Standards Based on High School Rank and SAT Scores

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An important problem in university admissions is predicting a student's academic performance or retention probability based on various characteristics. Using exhaustive searches of historical data is one method for attempting to determine an optimal admissions policy. We will discuss the results of one such search for an admissions policy based on high school rank and SAT scores. The talk will conclude with a comparison of high school rank and SAT scores as retention predictors.

Faculty/Grad Session VII - Outreach and Retention / 15

Summer Bridge Programs

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This talk will compare Summer Bridge programs from three different Institutions of Higher Education: Texas A&M University-Commerce, Truckee Meadows Community College (located in Nevada), and Danville Community College (located in Virginia). Outlines of the programs, success rates, and challenges will be discussed.

Faculty/Grad Session VII - Outreach and Retention / 38

Linking Mathematics Research to School Classrooms: The NSF GK-12 MAVS Program

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We outline the structure of the NSF GK-12 MAVS Program at The University of Texas at Arlington; a project funded by the National Science Foundation in the United States. Now in its fourth year of implementation, this program pairs classroom teachers with mathematics graduate students (fellows) in developing vertically aligned mathematics lessons that fit seamlessly into the school curriculum and maintain the integrity of the link to the mathematical research of the fellow. This university-school partnership deliberately focuses on schools with high enrollments of economically disadvantaged students and students from historically underrepresented minority groups in the United States. Goals of the program include developing future mathematicians who can communicate mathematics to a broad audience and fostering school students' interest in attending college and continuing study of mathematics. Lessons implemented in both middle school and high school lessons will be shared and discussed as well as the overall program concept and implementation.

Faculty/Grad Session VII - Outreach and Retention / 89

Math clubs: a new paradigm for extending grassroots efforts to national initiatives

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For a number of years, Texas Tech University has organized after school math clubs in local middle schools. These were primarily driven on a local level by individual outreach mathematicians. Modest funding enabled graduate student assistance. Later, increased institutional-scale funding facilitated the hiring of administrators for outreach efforts, with an expectation that activities such as the math clubs could grow. However, the mathematical faculty expertise cannot be replaced by administrative staff. As a result new models have been proposed. Primary among these is the distance delivery of content through webinars, followed by online interaction with remote sites. The Texas Tech University Math & Science Club connected with more than 300 students in 2012. The extended reach of the webinars is a substantial benefit; however, this is partially offset by the limited capacity for personal interactions with participants.

Faculty/Grad Session IV - Statistics / 47

Fit Points with Two Linear Lines

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There are various researches on Linear Regression and it has become a systematic and thus important subject of statistics. However, almost all of the researches focused on regression with only one line, and few of the researchers are concerning about fitting the scatter points with more than one lines, for example, two lines. The key point of this problem is that we have to figure out a method to generate two lines that at least locally minimize the sum of squared distances from the points to the nearest line. The method is given by fitting regression lines for two updating sets of points.

Faculty/Grad Session IV - Statistics / 67

RANDOM WALK AND LINEAR SWITCHING SYSTEMS

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In this paper we address the question "for a deck of cards, how many times a top-in shuffle should be performed before the top card goes back to the original position?" This problem has been studied in the literature but we are interested in the implications for linear switching systems. We simulate top-in shuffling for 6 cards and extend the simulation to 12 cards, obtaining conjectures about the relations that the data satisfies. Finally we consider a deck of 52 cards and determine the underlying statistics that characterize of the top-in shuffle. Finally we pass to the limit and show the connections to the exponential distribution.

Faculty/Grad Session IV - Statistics / 83

Saddlepoint-Based Bootstrap Inference for Spatial Dependence in the Lattice Process

Dr. TRINDADE, Alexandre [1]; Dr. PAIGE, Robert [2]; Ms. JEGANATHAN, Pratheepa [1]

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We present a saddlepoint-based bootstrap (SPBB) method to make inference for spatial dependence parameter in the spatial lattice regression models such as simultaneous autoregressive (SAR), conditional autoregressive (CAR) and simultaneous moving average models (SMA). The inference based on these parametric models is generally more powerful than the non-parametric and method-of-moments based approaches which tend to dominate due to ease of computation. The SPBB method works with the root of a monotone quadratic estimating equation (QEE) of which the maximum likelihood estimator (MLE) for spatial dependence parameter is the unique solution. Under the normality, this QEE has a closed-form expression for moment generating function (MGF) which is then inverted via SPBB to produce an approximation to the cumulative density function (CDF) of the MLE. This approximate CDF is then pivoted to form a confidence interval for spatial dependence parameter in the lattice models. Simulation studies show that SPBB confidence intervals outperform the standard asymptotic-based ones in terms of coverage probability and length, both in small as well as large sample size settings.

Faculty/Grad Session II-A - Applied Mathematics / 102

Stopping time for switching systems

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In this study, stopping time is applied to switched systems. I am trying to find a stopping time for a switched system such that data until the stopping time are enough to get all the information and no additional information will be obtained from the data after the stopping time.

Faculty/Grad Session II-A - Applied Mathematics / 87

Comparison of Optimal and Geometric Control Methods for regulation of distributed parameter systems

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This work is concerned with several aspects of set-point control for distributed parameter systems. We first present the geometric design methodology for set-point control. We then demonstrate this methodology for a multi-input multi-out set-point control problem for a two dimensional nonlinear convection diffusion heat equation. Next we consider the main point of this work, to investigate the relationship between the geometric design method and the classical method of PDE constrained minimization from optimal control. We show that for a linear stationary system the geometric method produces an optimal control gain. Then we consider the special case in which the number of control inputs is less than the number of measured outputs, in which case we obtain an ``overdetermined system''. With fewer control inputs than outputs we do not expect to achieve exact asymptotic tracking so we seek a solution with smallest least-squares error. In this case we employ the Moore-Penrose pseudo-inverse in the geometric design strategy to obtain the smallest least-squares error with smallest possible gain. Two examples are given to demonstrate this method. The first example is a stationary control problem for a Laplace equation and the second example involves temperature control of a two dimensional thermal incompressible Navier-Stokes flow.

Faculty/Grad Session II-A - Applied Mathematics / 95

Smoothing Splines on Projective Space

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In this paper, smoothing splines on projective space are constructed using natural metric on projective space. Alternative treatments are compared. And this method is applied to projective line by setting up the distance formula.

Faculty/Grad Session V-A - Math Education / 13

The Mathematics Background of Students

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One assumes that every student entering an undergraduate mathematics classroom has learned and mastered basic computational skills. An arithmetic test given to eight classes during a recent academic year at a public university provides food for thought.

Faculty/Grad Session V-A - Math Education / 54

MET2 and CCSS: A Texas Response

Dr. HENDRICKS, David [1]; Dr. YAREMA, Connie [1]

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Last year, we presented on a draft of the Mathematical Education of Teachers II (MET2) document which was proposed. Since then the MET2 document has been finalized and the Common Core State Standards (CCSS) are still being held as the standard for the nation's public schools. MET2 and CCSS both present challenges to higher education mathematics departments in Texas. In this presentation, we describe some of these challenges and how the ACU mathematics department is adapting.

Faculty/Grad Session V-A - Math Education / 9

Facilitating Success in Calculus

Prof. MANSOUR, Hassan Kambiz [1]; Prof. PANAHI, Mike [1]

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Facilitating success in Calculus

Abstract: We will outline how we structure the Calculus course with the online software component of the course along with the follow up problems

Faculty/Grad Session VI - General / 106

Spreading of Charged Microdroplets

Prof. IAIA, Joseph [1]

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We will discuss the spreading of a charged circular microdroplet. This leads to a nonlinear fourth order pde. Assuming that the radius of the drop is of the form $a(t) = At^b$ for some b, and that we look for a spherically symmetric solution we will see that this reduces to a nonlinear third order ode. We will seek solutions using the shooting method and also attempting to find power series solutions.

Faculty/Grad Session VI - General / 52

Infinite Sets

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A definition of "infinite" set which allows us to
prove that the cardinal of N, the set of natural numbers, is
the "least" transfinite cardinal. That is, every infinite set
contains a countably infinite subset. The result is
well-known, but is presented in an unfamiliar format which
includes some interesting proofs about the natural numbers.
Existence of the natural numbers is is assumed, but their
infinitude is not.

Faculty/Grad Session VI - General / 120

The Terrible Persistence of Bad Information

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This studies the updated prior distribution of a traditional economic model which investors assume as they enter the market. From averaging the posterior distribution, there is a slowly diverging total losses for some of the investors at the expense of the others. A new market would still be created when investors are betting against others instead of the market price. In the process of evaluating the Bayesian updating model an effective approximation was used to simplify the moment generating function, the error of this approximation was estimated using the Berry-Esseen Theorem and was also tested by computer simulation.

Faculty/Grad Session II-B - Applied Mathematics / 46

Interior Dynamics of Generalized Forchheimer Flows in Porous Media

Mr. KIEU, Thinh [1]; Dr. HOANG, Luan [1]; Dr. PHAN, Tuoc [2]

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We focused on qualitative properties of solutions to generalized Forchheimer equations for slightly compressible fluids in porous media subject to the flux condition on the boundary. The De Giorgi and Ladyzhenskaya-Uralsetva iteration techniques are used to obtain $L^\infty(Q_T)$, $W^{1,s}(Q_T)$, and $W^{2,2-\delta}(Q_T)$ bounds. The continuous dependence on the boundary data and coefficients of the Forchheimer polynomials are also obtained.

Faculty/Grad Session II-B - Applied Mathematics / 93

A Monolithic Multigrid Domain Decomposition Algorithm for Incompressible Fluid Structure Interaction

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In the last decades a great attention has been paid to the study of Fluid-Structure Interaction (FSI) problems because of a large number of applications ranging from biology to civil engineering and aero-elasticity.
In particular, the numerical solution of the equations of Fluid-Structure Interaction is of great interest because of the increasing demand from the medical community for scientifically rigorous and quantitative investigations of cardiovascular diseases. In this work we present the results of Fluid-Structure Interaction computations of an incompressible elastic solid object and a laminar incompressible viscous flow using the Finite Element Method (FEM). The mathematical problem consists of the Navier-Stokes equations
in the ALE form coupled with a non-linear
incompressible structure model (Neo-Hookean).
Since we are interested in solving FSI problem where the added mass effect is significative,
the coupling between the Structure and the Fluid is enforced inside a Monolithic framework
which computes simultaneously for the fluid and the structure unknowns within a unique solver.
This kind of problem can be tackled efficiently by domain decomposition techniques. Our strategy is to solve several small local sub-problems over sub-domain patches using Vanka-smoothing procedures within a Multigrid algorithm.

Faculty/Grad Session II-B - Applied Mathematics / 68

Super Computing For Under $1,000

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Prior to recent advances in electronics, fine grained supercomputing required a vector machine, which cost millions of dollars. Today, thanks to the gaming industry and the ability to write code to Prior to recent advances in electronics, fine grained supercomputing required a vector machine, which cost millions of dollars. Today, thanks to the gaming industry and the ability to write code to General Purpose Graphics Processing Units (GPGPU), practical supercomputing can be executed on your laptop. In this talk, we will give a quick overview of NVIDIA's Compute Unified Device Architecture (CUDA). CUDA is a parallel computing platform released in 2007 by NVIDIA that allows scientific programmers to write code to a computer's graphics cards. These cards have hundreds of processors onboard that allow the programmer to mimic a vector machine but cost well under $1,000. We will then demonstrate some of the Particle Modeling (PM) work being done at Tarleton State University.

Faculty/Grad Session V-B - Math Education / 91

Inquiry Based Learning in Undergraduate Real Analysis

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A model for implementation of inquiry based learning in the form of a modified Moore method approach in an introductory Real Analysis course will be presented. Balance of emphasis on critical reading as well as proof writing/development, and approaches to effective assessment and student engagement will be discussed.

Faculty/Grad Session V-B - Math Education / 12

Using Adobe Connect for Instructional Activities

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This presentation will discuss what Adobe Connect is and how instructors can use it as a tool for distance education and face-to-face courses. The basic functions of Adobe Connect will be demonstrated and the experience of how the presenters use it in her dual credit distance education and face-to-face college level classes will be shared. This presentation will be presented through Adobe Connect with the assistance of Dr. Pamela Webster on site.

Faculty/Grad Session V-B - Math Education / 71

Inverted Classrooms: the what, the why, the how.

Dr. ABBASIAN, Reza [1]; Dr. SIEBEN, John [1]

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The authors will explain their vision of the inverted classroom and offer evidence that the inverted design will help our students achieve the skills that the faculty in our partner disciplines have told us are important. We will also tie the inverted classroom to George Khu's "High Impact Practices" and recent findings from learning theory.

The inverted classroom makes a sharp distinction between passive and active learning. These two phases of learning will be discussed with practical examples of how a faculty member can move the passive learning out of the classroom, freeing up time to turn the classroom into a laboratory for active learning. Our presentation will address existing resources for the passive learning activities as well as suggestions on creating your own assignments.

Our presentation is intended for mathematics and/or statistics educators with interest in technology-based teaching and innovative use of Web resources in classroom.

Faculty/Grad Session VII - Outreach and Retention / 88

Mentorship in Undergraduate Mathematics

Mr. JOHNSON, Levi [1]; Dr. DWYER, Jerry [1]

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Undergraduate students present an inherently different set of assets, objectives, and needs from that of graduate students. As such, mentorship efforts intended to support undergraduates cannot be expected to fit the traditional mold established in graduate programs. Through a series of National Science Foundation supported initiatives, investigators at Texas Tech University have explored a wide range of mentorship constructs for undergraduate mathematics students - many of which focus specifically on supporting first generation and underrepresented populations. We will survey a number of mentorship initiatives and development efforts undertaken by the TTU Math Department over the past five years with an emphasis on exploring strategies and tools developed to enhance mentor-protégé interactions.

Faculty/Grad Session VII - Outreach and Retention / 28

Tapping the Research Experience for Undergraduates in Mathematics and Biology

Dr. JANG, Sophia [1]; Dr. WILIAMS, Brock [2]; Dr. CANAS, Jaclyn [1]; Dr. DWYER, Jerry [1]; Dr. MCINTYRE, Nancy [1]

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In this talk, we describe the NSF funded project TTU PRISM
``Proactive Recruitment in Introductory Science and Mathematics'',
which recruits students to pursue and complete degrees in the
mathematical and biological sciences.

All of the PRISM scholars are teamed up with faculty members to
work on a variety of projects integrating mathematics and biology
during the two-weeks intensive summer research programs. Freshmen
take formal courses on Calculus I for Life Sciences and
Computational Biology to enhance their understanding of the
interplay between mathematics and biology. Sophomores engage in
research projects with TTU faculty during the regular semesters.
These scholars attend weekly seminars and present their new
discovery. They also participate in both regional and national
meetings to expose them to all aspects of research in
biomathematics. We
briefly discuss students' research projects and our mentoring practices.

Faculty/Grad Session VII - Outreach and Retention / 109

Directing Undergraduate Research: Pitfalls, Paradigms, and Possibilities

Dr. WILLIAMS, Brock [1]; Dr. JANG, Sophia [1]

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We will describe our experiences directing undergraduate research. In particular, we will discuss managing a team of undergraduates, leveraging graduate resources, and maximizing the positive effects of research on retention.

Faculty/Grad Session III - Pure Math / 112

The Fibonacci and Lucas Triangles

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A construction of two numerical triangles, which we call the Fibonacci and Lucas Triangles, is sketched. These triangles allow us to deduce formulas for sine and cosine of multiple angles. These triangles play a role similar to the role Pascal's Triangle plays in the expansion of a power of a binomial.

Faculty/Grad Session III - Pure Math / 23

Proper Subspace Inherited Properties

Dr. DORSETT, Charles [1]

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In this talk proper subspace inherited properties are introduced and used to further investigate and characterize separation axioms and counting properties in topological spaces.

Faculty/Grad Session III - Pure Math / 5

The Rota Method for Solving Polynomial Equations: A Modern Application of Invariant Theory

Dr. JORGENSON, Kristofer [1]

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Methods using algebraic invariants for gaining insights into the structure of polynomials will be examined. Particular attention will be given to methods that aid in the solution of cubic and quintic polynomial equations.

Award Address / 116

Award Address: My Favorite Tools for Teaching and Learning Mathematics

EPPERSON, James [1]

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The teaching and learning of mathematics involves attending to student thinking, choosing the right tasks and examples, and recognizing strategies that enhance active participation and making connections. Some of my favorite tools for engaging students in their learning come from a toolbox of extended problem analyses, dynamic animations, empathy, discipline, and grouping strategies. I discuss a few of my favorite tools that I use to address the following: How can we use a mathematical task to bring forward student thinking or illustrate connections for inservice teachers and graduate students? How can we get a classroom of 120 students to participate in making mathematical conjectures? How can we help future mathematics teachers make mathematical connections that span many years of mathematics? How can we use technology to enhance our teaching and student understanding? What can we do to help students feel empowered in their learning? Over the years, I continue to tinker, find, and invent new tools as I strive to improve myself as a teacher and learner of mathematics.

Plenary Address / 117

Plenary Address: From Classroom to Contest

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We are going to talk about a few interesting contest problems (up to the USA/International math Olympiad level) that arise from regular high school math classroom discussions. For example, how does the fact that of 1-16+64 = 1+16+32 being perfect lead to IMO 2006 problem 1, and how do Pythagorean triples lead to families of infinite triples of equal length, pairwise orthogonal vectors in the 3-D space.

Closing Address / 118

Closing Address: Ethical and Responsible Conduct of Research

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Research ethics involves the application of moral rules and professional codes of conduct to a variety of topics involving scientific research. The importance of adherence to ethical norms in research will be discussed, with emphasis on the key issues of scientific misconduct, publishing practices and responsible authorship. Numerous examples from the current mathematics literature of plagiarism, self-plagiarism and various questionable publishing practices will be provided.