Abstracts for Contributed Talks - TUMC 2010

Zach Anglin and Nina Freeman
Southwestern University
Number Bracelets
Abstract: This talk will discuss how modular arithmetic can be used to create something known as a number bracelet. Definitions and examples will be given along with some conjectures.

Jarrod Alford
Wayland Baptist University
How to Build Your Own Supercomputer without Going Broke
Abstract: Recently, Wayland Baptist University was able to deploy a functional supercomputer at a cost of less than 750 out of pocket. This presentation will demonstrate how this same process can be repeated in a similar environment, providing superior computational power with minimal financial burden. By recycling retired PCs, we constructed a computational cluster which only required the PC towers themselves, a networking switch with adequate cables, as well as physical shelving for storage. Finally, freely available software enabled us, with minimal effort and expertise, to build, deploy, and manage our own computational cluster. This presentation will demonstrate the capabilities of our cluster using code to perform intensive mathematical computations such as matrix operations, which can be easily scaled by increasing the dimensions of the matrices. Overall, the task of making a supercomputer from a modest budget may seem formidable, but ultimately, installing a cluster does not have to be a burdensome or expensive process.

Taylor Asbury
Sam Houston State University
Enumeration of Magic Circles and More
Abstract: Magic circles are mathematical objects with properties similar to those of magic squares. Those magic circles with a given sum have been recently enumerated using techniques from algebraic geometry. The three-dimensional version of a magic circle – a magic cylinder or torus – will be defined, and a description of the techniques used to enumerate these objects will be presented.

Brian Beavers
Stephen F. Austin State University
A 4000-Year-Old Textbook
Abstract: In a world where textbooks are constantly changing, what can we learn from one that is 4000 years old? The Rhind Mathematical Papyrus and other documents preserve the mathematics of the culture that built the pyramids, a mathematics where multiplication was performed by repeated doubling and fractions could only have a numerator of 1. We will examine how the ancient Egyptians performed their calculations and see word problems that are still familiar today.
Regan Beckham
University of Texas at Tyler

Sugar Cubes and Thermodynamics – The importance of mathematics in science

Abstract: In this talk I will present a classic example illustrating the first law of thermodynamics and how it reveals the necessity of mathematics in the physical sciences. This example was originally given by Richard Feynman in his classic “Lectures on Physics” and later expanded by Van Ness in his book Understanding Thermodynamics.

Katie Bryant
Lamar University

Finding a G-graph of a Group

Abstract: For a group $G$ with generating set $S = \{ s_1, s_2, \cdots, s_k \}$, the $G$-graph of $G$, denoted $\Gamma(G, S)$, is the graph whose vertices are the distinct cosets of $\langle s_i \rangle$ in $G$. Two distinct vertices are joined by an edge when the set intersection of the cosets is nonempty. In this talk, we describe how you draw $\Gamma(G, S)$ and give examples.

Valmir Bucaj
Texas Lutheran University

Minimal Surface Transformations

Abstract: A minimal surface in $\mathbb{R}^3$ is a surface whose mean curvature vanishes at each point on the surface. Thus, minimal surfaces look like saddle surfaces and can be modeled by soap films spanning a wire frame. We can parameterize minimal surfaces by using the classical Weierstrass Representation. We will discuss how one-to-one complex-valued harmonic mappings can be used with the Weierstrass Representation to parameterize minimal graphs in $\mathbb{R}^3$. We will then use the shearing technique developed by Clunie and Sheil-Small to construct a one-parameter family of harmonic univalent mappings that lift to minimal surfaces under the Weierstrass Representation. Specifically, we will show that varying this parameter results in a continuous transformation of Scherk’s first surface with $2n$ ends to a minimal surface with $n$ helicoidal ends. Each of the intermediate surfaces will be a minimal graph.

Ruby Chick
University of Texas at Tyler

An Equilaterally 3-Isotoxal Tile

Abstract: A tile is a closed topological disk, and a tiling of the plane is a covering of the plane by tiles without overlap. A symmetry of a tiling is a transformation of the plane that preserves the tiling by mapping tiles to tiles, edges to edges, and vertices to vertices. A transitivity class of an edge in a tiling is the set of edges in the tiling which may be mapped to one another via a symmetry of the tiling. If a tiling has $n$ transitivity classes of edges, it is called $n$-isotoxal. We define a single tile $T$ to be equilaterally $n$-isotoxal if $T$ is equilateral and tiles the plane so that every tiling admitted by $T$ is $n$-isotoxal and edge-to-edge. We will present an equilaterally 3-isotoxal tile.
Kristen Chockley  
University of Texas at Tyler  

On the Relationship Between Minimal Lattice Knots and Minimal Hexagonal Prism Knots  

Abstract: The relationship between minimal lattice knots and minimal cube knots is known in the cubic lattice. The aim of this research is to extend this knowledge into the simple hexagonal lattice, that is, to determine the relationship between minimal lattice knots and minimal hexagonal prism knots. After doing several example knots where we started with a lattice knot and expanded it into a well-formed hexagonal prism knot by increasing the volume using the minimum number of prisms possible, we reached the conjecture that the minimum prism number ($M_K$) is exactly twice the minimum step number ($m_K$); thus, $M_K = 2(m_K)$. To prove this, we broke the statement down into $M_K \leq 2(m_K)$ and $M_K \geq 2(m_K)$. We proved the first inequality by saying that we can “double up” the lattice knot to create a prism knot to show that the volume is at most twice the minimal step number. We will discuss approaches we have taken in attempting to establish the second inequality. Once we can prove both inequalities, we will know the exact relationship between a minimal lattice knot and a minimal prism knot in the simple hexagonal lattice, and we will then extend this work into other lattices.

Kayla Comeaux  
Southwestern University  

The Shuttle is Ready for Launch  

Abstract: Each piece of flight hardware being used on the shuttle must be analyzed and pass NASA requirements before the shuttle is ready for launch. One tool used to detect flaws or cracks that lie within flight hardware is Infrared Flash Thermography. Infrared Flash Thermography is a non-destructive testing technique which uses an intense flash of light to heat up the surface of a material after which an Infrared camera is used to record the cooling of the material. Since cracks and defects within the material obstruct the natural heat flow through the material we are able to detect the cracks when viewing the data from the Infrared camera. Although we can detect how wide a crack is using Infrared Flash Thermography, we needed to find a way to approximate the depth of each crack, so we can determine if the flight hardware meets NASA specifications. This was the focus of our project. We used differential equations in creating simulations of an Infrared Thermography scan of Graphite/Epoxy, the material used in the nose cone of the shuttle, and math modeling to analyze the data received from both the simulations and the actual experiment. Following the analysis of the data we were then able to approximate the depth of defects in Graphite/Epoxy.

Josh Cornett, Chris Davenport, Christina Nieuwoudt  
Sam Houston State University  

Paradoxes in Instant Runoff Voting  

Abstract: Instant runoff voting is a voting system which, unlike the common plurality system, takes into account the full preferences of the voters. However, in instant runoff voting, a group of voters can, paradoxically, help their favorite candidate by voting against him or her. Currently, little is known about how often paradoxes in this voting system occur. In this talk we investigate when and how often paradoxes arise in instant runoff voting.
Bryan Deagle  
Lamar University

Paths and Circuits in the $G$-graph of a Group

Abstract: For a group $G$ with generating set $S = \{s_1, s_2, \ldots, s_k\}$, the $G$-graph of $G$, denoted $\Gamma(G,S)$, is the graph whose vertices are distinct cosets of $\langle s_i \rangle$ in $G$. Two distinct vertices are joined by an edge when the set intersection of the cosets is nonempty. In this talk, we study the existence of Hamiltonian and Eulerian paths and circuits in $\Gamma(G,S)$.

Nick Duplan  
Lamar University

Slipping and Sliding with Regression

Abstract: This study will look at data from oil spills. It will use regression analysis to show statistically significant relationships. It will do regression with one variable and also with more than one variable. We’ll find out which method (univariate or multivariate) is most appropriate for this data. Conclusions will be drawn from the test of regression.

Milagro Egeonu  
Lamar University

The Vertex Connectivity of a $G$-graph

Abstract: For a group $G$ with generating set $S = \{s_1, s_2, \ldots, s_k\}$, the $G$-graph of $G$, denoted $\Gamma(G,S)$, is the graph whose vertices are distinct cosets of $\langle s_i \rangle$ in $G$. Two distinct vertices are joined by an edge when the set intersection of the cosets is nonempty. In this talk, we discuss the vertex connectivity of $\Gamma(G,S)$.

Christina Graves  
University of Texas at Tyler

How Many Pentagons are on a Soccer Ball?

Abstract: A soccer ball has the same basic structure as the carbon molecule C60. In general, one can model carbon models by a graph composing of only hexagons and pentagons. A theorem by Euler shows that no matter how big the carbon molecule is, it must always have the same number of pentagons.

Yang Han  
Lamar University

Boltzmann distribution in calculation of statistical entropy of thermodynamics

Abstract: Thermodynamics is a branch of statistical physics that uses statistical tools for calculating with the large number of population and approximation. As a part of statistical mechanics, thermodynamics also provides a framework for dealing with microscopic motion such as molecules vibration. Entropy is a measure of statistical model to estimate the random motion within the system. In other words, entropy is the measure of the amount of the energy which doesn’t do work during the microscopic motion. It is defined base on Newton’s Second Law. The purpose of the talk is that by using Boltzmann distribution and a large amount of population data to find the entropy. Boltzmann distribution is used when the system is large and it is an approximation. The large population will be generated in different cases such as temperature difference, pressure difference and volume difference. Then we are able to use Boltzmann distribution to estimate the entropy.
Kathryn Hardey
Centenary College of Louisiana

Location of the Baseball Bat 'Sweet Spot'

Abstract: The sweet spot of a baseball bat is the spot which maximum energy is transferred to the baseball, resulting in the best hit for a baseball player the ball has a high speed, but little vibration is felt in the hands. Using the location of maximum torque of a bat, it can be assumed that this spot would be at the end of the bat, but this is incorrect. Using a variety of equations and models, the location of the sweet spot was demonstrated for ash bats. The effectiveness of bat corking was examined, and it was determined that the best reason to use a corked bat is the increase in time a batter may look at an incoming ball. Using knowledge of vibration waves, the advantages to aluminum bats were speculated. This MCM model was created by Kathryn Hardey, Jacob Jennings, and Robert Poole.

Keith Hubbard
Stephen F. Austin State University

Tax Progressivity: How do we compare the taxes of the rich and the poor?

Abstract: Tax Progressivity is the degree to which those who make higher incomes pay a higher percentage of their income in tax. But since total income, total tax, and the distribution of both vary from year to year and from country to country, it can be challenging to determine how progressive a particular situation is. We will look at the mathematics, and the controversy, behind deciding how progressive a particular tax scheme is.

Hanling Jia
Lamar University

Approximating the Hyper-Geometric Distribution

Abstract: In an examination of successful events in a population, a random sample can be obtained to make inferences upon the population probability of success. The sampling can be conducted with or without replacement. The probability distribution of success for the sample is therefore contingent upon these two methods. In the first case with replacement, the probability of success can be found to be a binomial distribution; in the latter case without replacement, the probability of success can be found to be a hyper geometric distribution. This study investigates the fact that if the sample size is significantly smaller than the population size, then the finite population correction factor of the hyper geometric distribution approaches one, which yields a binomial distribution that closely approximates the hyper geometric distribution.

Noureen Khan
University of North Texas at Dallas

Introducing 4-moves

Abstract: A 4-move is a local change in the link diagram. In general perspective, 4-move is a class of tangle replacement moves called rational moves. The long standing problems in the knot theory are been solved by invariants of 4-moves. In this paper, we introduce 4-moves and its importance in the knot theory with some interesting examples.
Investigating the Derivative of a Number

Abstract: Number theory is a branch of mathematics devoted to the study of the properties of integers. Leopold Kronecker once remarked that, “Number theorists are like lotus-eaters; having tasted this food they can never give it up.” Number theory is just so. In this paper the derivative of a number in terms of its prime factorization of n will be examined for natural, rational, and irrational numbers. The patterns that form from the derivative of such numbers will lead to conjectures about the derivatives. Ways to determine the behavior of derivatives will be speculated. Like the lotus plant such derivatives are narcotic and addictive. There are patterns that seem real, yet are a fool’s query to seek after. Yet, the behavior of such derivatives is fascinating to such a point one might say it’s easy to obsess over.

Exact Solutions to the Camassa-Holm Equation

Abstract: The Camassa-Holm equation is a nonlinear partial differential equation used in modeling surface waves in shallow waters. In the special case when a parameter in the Camassa-Holm equation is zero, the resulting equation belongs to a unique class known as the class of integrable evolution equations, and it exhibits certain special solutions known as peakons, surface water waves with sharp peaks. Our goal is to verify analytically peakon solutions with n peaks for any positive integer n, analyze their properties, and animate them by using the symbolic software Mathematica.

The Mathematics of Sandpiles

Abstract: The Abelian Sandpile Model is a mathematical model for the physical process of diffusion that has captivated physicists and mathematicians since its introduction in 1987. Although the model is simple to describe, its evolution is difficult to predict. The intricate structures that arise in mathematical sandpiles have been called a “visual feast” by at least one author (M. Creutz, 1990). In this talk we examine how such structures arise and we discuss the mathematical aspects of the model. We also discuss some recently solved questions and open questions.

Heesch Numbers of Edge-Marked Polyforms

Abstract: The author presents the more interesting results of an extensive computerized search for the Heesch numbers of edge-marked polyforms. The Heesch number of a tile is the maximum number of layers formed from copies of the tile in a patch which may surround a centrally placed copy of the tile. A polyform of order n is a tile formed from n equilateral triangles, squares, or regular hexagons. In this study, the edges of polyforms were marked in various ways (matching colors, matching bumps and nicks, directed edges, and combinations thereof).
Christopher Mitchell  
University of Texas at Arlington  

Reintroducing an Infection into a Population  

Abstract: Swine flu hit the population hard last year. The reason the outbreak was so bad was because it affected a generally lower susceptible class (ages 20 and under) rather than the usual highly susceptible class (people ages 55 and over). An agent-based mathematical model was created to track an outbreak of swine flu in which we tracked susceptibility, infected, recovered and death classes. We then modeled a typical immune response and hit the population again with a set amount of immunity lost each year. Our goal is to explain some of the problems related to the issue of partial immunity. Immunity to a specific infection decreases over time by the adaptive immune’s system’s way of producing memory cells for infections we see everyday. This would lead to the immune system essentially tossing out old memory cells for diseases we never come in contact with. Our results show that an outbreak of an infection could in turn be as bad or worse than the initial infection if our immunity is lost over time. Practical applications of this could lead to producing more vaccinations for a particular infection if that infection has not been seen in a very long time.

Jessica Nguyen  
Lamar University  

Driving Down the Road Geometrically  

Abstract: The Bonus Malus System (BMS) is a merit rating system used by insurance companies (particularly in European and Asian countries) to reward good drivers by reducing their premium (bonus) and to penalize bad drivers by increasing their premium (malus). In this study, we investigate the optimal BMS under which the premium is set by taking into account both the severity of the claims and the frequency of the claim of each policyholder. In which, the number of claim is assumed to follow Poisson distribution with given parameter (lambda), where (lambda) denotes the differing underlining risk of each policyholder having an accident. If we assume that (lambda) is distributed accurately to exponential distribution then well show that the unconditional distribution of the number of claims follows a geometrical distribution.

Katherine Reed and Souad Sosa  
University of Texas at Arlington  

General Model of Innate Immune Response  

Abstract: Within the human body, pathogenic bacteria can invade the bloodstream or adapt to an intracellular or communal environment. To counteract bacterial invasion, the bodys defense system elicits an immune response, and phagocytic cells are sent to destroy the pathogens. Although phagocytosis of pathogens is one of the most important defense mechanisms against infection, little is known about the kinetics of this process. A mathematical model has been constructed in terms of phagocytes and two types of pathogenic bacteria: free bacteria susceptible to phagocytosis and bacteria with an intracellular or biofilm refuge that cannot be phagocytized. The mathematical analysis of the dynamics of bacteria-host cell interactions led to the result that in the presence of a bacterial refuge state, a constant input of phagocytes to the infection site is required for an infection to clear.
Growth cycle as a function of Motility within Algal Mixotroph Prymnesium Parvum

Abstract: Harmful Algal Blooms (HAB) have been a topic of recent studies due to their impact on many aquatic ecosystems. Specifically, the ubiquitous mixotrophic haptophyte, Prymnesium parvum, has become a model species for study because it releases potent toxins into its environment. P. parvum are understood to have a motile state which produces toxin and a much less metabolically active state which does not produce much toxin, which may be a cyst formation. Our research attempts to provide a mathematical model for the conversion between the motile and non-motile states of P. parvum, in Chemostat and Batch environments. Our model follows the Michaelis Menton-Monod model in respect to algal growth. Through an analysis of differential equations, we observed the rate and time at which P. parvum populations (both motile and non-motile) reach equilibrium after nutrient exhaustion, in the batch culture. In the chemostat culture, we observed that rates at which P. parvum motile and non-motile populations are formed must be higher than the dilution rate of the vessel in order to propagate.

An Aperiodic Tile

Abstract: An example of an aperiodic tile recently discovered by Taylor and Socolar will be presented. A tiling of the plane is a covering of the plane (by topological disks called tiles) without overlap or gaps. The set of distinct shapes which form the tiling is called the protoset of the tiling. A tiling is said to be periodic if it is preserved under translation in two non-parallel directions. In 1963, Wang conjectured that every finite protoset admitted at least one periodic tiling. However, in 1966, Berger exhibited a protoset containing over 20,000 shapes which admitted only non-periodic tilings of the plane - the first aperiodic protoset to be discovered. This number has since been reduced to 6 (by Robinson in 1971) and then to 2 (by Penrose in 1974). In 2010, the first example of a single aperiodic tile was exhibited by Taylor and Socolar.

Mathematical Population Dynamics and Resource Competition

Abstract: A new model for two-species chemostat with allelopathy will be presented. The model incorporates an assumption that toxin-production carries a metabolic load, inflicting a poison-production penalty on the growth of the environment-poisoning species. Examining the local asymptotic behavior the parameter ranges were found for the four stable states: extinction of both species, survival of poison-producer, survival of poison-susceptible, coexistence. Simulations will be presented with parameters coming from P. Parvum.
Mathematical Interpretation of Monty Hall Problem

Abstract: One application of Bayes Theorem is the ability to solve, mathematically, the Monty Hall Problem. The problem consists of a host offering a player a choice from three separate doors; one of which hides a car, and the other two each hide a goat. The contestant makes his choice from the three doors and the host opens one of the other two doors, revealing a goat. The host then offers the player to either switch his decision or stay with the door the player originally chose. Several dynamics are present in the contestant's dilemma; one of which being that the host, knowing which door hides the car, could be trying to trick the contestant into switching his selection. Possibly the most important dynamic, being that it is in the player's best interest to switch his choice or stay with his previous selection? One can formally show through Bayes Theorem that by switching his choice, the contestant increases his probability of winning from $1/3$ to $2/3$!

On Seymour’s Second Neighborhood Conjecture

Abstract: A second outneighbor of a vertex $v$ in a directed graph is a vertex whose distance from $v$ along a direct path is exactly two. Paul Seymour conjectured that every directed graph has at least as many second outneighbors as first outneighbors. This presentation will introduce the conjecture, advance proof strategies for specific classes of graphs, and summarize the results of previous work on this open problem.