MAA So Cal-Nev Spring Mtg/Pacific Coast Undergraduate Mathematics Conference

California Lutheran University
March 14, 2015

POSTER SESSION: ABSTRACTS

Pre-college

1. **Kyle Kishimoto** (Pre-college) Fairmont Private Schools and Fullerton Mathematical Circle
   A Game of Squares

   We discuss several solutions to problems proposed in recent issues of Gazeta Matematica. One of our solutions uses multivariate calculus to obtain an extremum value, while another solution explores properties of integers.

2. **Joshua Park** (Pre-college) Fullerton Mathematical Circle
   Solving Algebraic Equations: A Discussion Inspired by Problem S: L14.281 from Gazeta Matematica

   When we solve algebraic equations with radicals, what are the conditions we need to consider? We solve a problem from Gazeta Matematica, using a technique inspired by the classical Schönemann-Eisenstein Theorem. Then, we look at two other examples of equations with radicals.

3. **Ariana Perez** (Pre-college) John Tynes, Placentia
   History of Pie

   My poster covers the collision of waves using the transverse motion formula and the Principle of Superposition. We graph the resulting waves from two collisions and show how noise reduction technology uses these theories in various industries.

4. **Henry Zeng** (Pre-college) Holly Avenue Elementary School and Fullerton Mathematical Circle
   Explorations in Advanced Euclidean Geometry

   We present our solutions to several geometry problems proposed in recent issues of Gazeta Matematica.

Frosh/Sophomore

5. **Christopher Ibbotson, Mirna Miksi Kalayjian, Raziel Kohanbash, Roben Ohev Shalom**
   (Frosh/Sophomore) Los Angeles Pierce College
   Resonance Applications

   Our project focuses on resonance and its applications to buildings, such as during an earthquake or in heavy wind. We create a model that you can vibrate at different speeds to see the impact of resonance frequency on a model building. We calculate the frequencies and discuss our calculation methods. We hope for our poster to interactive.

6. **David May** (Frosh/Sophomore) Bakersfield College
   The Mayan Number System

   Have you ever wondered why or how the Mayans could have predicted the end of the world to be December 21, 2012? The Mayan civilization had a detailed numerical system for their time, and is credited as one of the first ancient civilizations to use the number zero. Their understanding of numbers was integrated into many aspects of their society. This project investigates both the Mayan calendar and their system for computations.

7. **Evan Mladina** (Frosh/Sophomore) Los Angeles Pierce College
   Identifying a Flatland Neighbor on a Clear Day

   In *Flatland*, by Edwin Abbott, the only time a flatlander may know the shape of another flatlander is on a foggy day. The flatlander must ask his fellow flatlander (all of whom are regular polygons) to turn his pointed side to him, and depending on how rapidly the line he sees loses opacity, due to the interference of fog, he is able to infer the angles of any regular polygon. Thus, for example, the opacity of the line he would see when examining a triangle would very rapidly diminish away from the center. Clearly the very opposite would happen for a polygon of 100 sides. The only problem is that when it is not foggy out, there is no way for a flatlander to tell what shape he may be encountering. Here, I show an alternative way of knowing the shape by examining how the "viewing angle," i.e. the angle with which the flatlander sees his neighbor, changes as he rotates about him.

8. **Anthony Resendiz** (Frosh/Sophomore) CSU Channel Islands
   When Waves Collide

   My poster covers the collision of waves using the transverse motion formula and the Principle of Superposition. It graphs the resulting waves from two collisions and shows how noise reduction technology uses these theories in various industries.

9. **Tyler Starr** (Frosh/Sophomore) Bakersfield College
   Can We 3D Print Anything?

   Can any three dimensional shape be constructed using additive manufacturing processes? Modern 3D printers use 'slicers' in order to convert 3-dimensional shapes into 2-dimensional slices that can be printed one on top of another. An important question can be gleaned from this understanding of converting 3-dimensional objects into the tool paths necessary for 3D printing. Is it possible to approximate any 3-dimensional shape into 2-dimensional slices? We explore this question using Fubini's Theorem, which states that any n-dimensional object can be converted into n–1-dimensional slices. This means any real world object can be 3D printed; however, material constraints and the balance of objects will still provide challenges for students of additive manufacturing processes for years to come.

10. **Mark Thompson** (Frosh/Sophomore) CSU Channel Islands
    Math in Today's Technological World: Military Applications

    I highlight military applications of mathematics involving the use of explosives to detonate trees in order to clear an area, or creating an abatis. Also, I explain how explosives are used to reduce an explosive hazard such as a piece of unexploded ordnance (UXO) or an Improvised Explosive Device (IED). I describe the surrounding mathematics used to calculate the net explosive weights of the charges, and safe distances at which you can detonate the charge without causing internal damage to the body, or entering the range of fragmentation.

Junior/Senior

11. **Miranda Bakke** (Junior/Senior) CSU Fullerton
    Exploring Cauchy-Schwarz Inequality: Remarks on Problem 11670 from the American Mathematical Monthly

    We explore many applications of the Cauchy-Schwarz Inequality. One the inequalities we obtain was published in the American Mathematical Monthly as Problem 11670. In our poster presentation, we describe our project, our explorations of the so-called Engel's Lemma, our references and classical similar inequalities (e.g. Nesbitt's inequality).

12. **Brenna Biggs** (Junior/Senior) CSU Fullerton
Remarks on the Maximum Values for Classical Curvature Invariants for Smooth Three-Dimensional Hypersurfaces

The mean curvature H, scalar curvature s, and Gauss-Kronecker curvature K are the natural curvature invariants for a three-dimensional smooth hypersurface in the four-dimensional Euclidean ambient space. At every point of the hypersurface H, s, and K can be defined as a function of the principal curvatures. The present project studies the range of these classical curvature invariants, H, s, and K, for a compact three-dimensional smooth hypersurface in the four-dimensional Euclidean ambient space, under certain natural constraints described also in terms of curvature.

13. **John Cajahuaringa** (Junior/Senior) CSU Northridge
The Weighted 2-Page Crossing Number of the Complete Graph

A k-page book is the union of k closed half-planes in the space sharing only their boundary. The common boundary is a line called the spine, and the half-lines are called the pages. The k-page book crossing number of a graph G is the minimum number of crossings over all drawings of G on a k-page book so that the vertices are on the spine of the book and each edge is completely contained on a single page. We consider the problem of determining this crossing number when G is the complete graph, $k = 2$, and the number of edges in each page is given. This in turn gives bounds on the 3-page crossing number of the complete graph for small numbers of vertices. We report on behalf of the CSUN Crossing Numbers Research Group.

14. **Andrew de la Pena** (Junior/Senior) CSU Fresno
A Reduced Presentation of the Virtual Singular Braid Monoid

A braid is a set of n strings passing between two horizontal bars. These strings may interact with one another but must always travel in the downward direction. If the two horizontal bars are brought together and each pair of string ends are glued together in order, the resulting structure will be a knot or a link, called the closure of the braid. We study the set of braids whose closure is a virtual singular knot or link. We define the set of virtual singular braids on n strands as a monoid via generators and relations. The defining set of relations mimic the isotopies of virtual singular links. Further we prove that the virtual singular braid monoid has another presentation using fewer generators and relations.

15. **Tavish Dunn** (Junior/Senior) California Lutheran University
Influence of Matrix Symmetries on Eigenvalues and Eigenvectors

This paper examines the connections between the bisymmetric matrices R. Reid's “Some Eigenvalues Properties of Persymmetric Matrices” and the symmetric centrosymmetric matrices of A. Cantoni and P. Butler's “Eigenvalues and Eigenvectors of Symmetric Centrosymmetric Matrices.” It demonstrates that bisymmetric matrices and symmetric centrosymmetric matrices are the same type of matrix and describes the group structure of the set of matricies of this type. The proofs given in both papers about the eigenvalue and eigenvector properties of bisymmetric matrices of even order establish a method for determining the eigenvalues and eigenvectors more quickly utilizing the block structure of the matrix. After investigating the methods used in proving the even case, the methods are modified in order to extend the results to prove the statements given in the papers without proof about bisymmeric matrices of odd order, exploring why the different block structure made these changes necessary.

16. **Su Ji Hong** (Junior/Senior) California Lutheran University
Applying Queuing Theory to A Queuing Theory

Queuing theory uses flow balance equations derived from steady states to determine the probability of each state; in queuing theory a state represents the number of customers present at the system. I modeled the queuing system at the Centrum Cafe on California Lutheran University campus assuming that the arrival and service rates follow exponential distribution. The queue system at the register followed M/M/1/FCFS/∞/∞, which means the arrival and service times are independent, there is one server, it has a first come first serve queue discipline, infinitely many people can be in the queue, and there are infinite many people from which customers are drawn. I figured out the arrival rate and service rate. I computed the waiting time and compared it to the data. I simplified the model at the kitchen to M/M/1/FCFS/∞/∞. Then I connected them using the fact that the arrival rate depends on the service rate. After calculating the probability of each steady state, I calculated the queue time at the register and the kitchen.

17. **Matthew Lam** (Junior/Senior) Harvey Mudd College
Elliptic Curves and Generalized Wheel Graphs

Elliptic curves are a type of algebraic curve that naturally arise in number theory and algebraic geometry, and wheel graphs are simple objects of combinatorial origin. Gregg Musiker recently discovered that these two classes of objects share a surprising degree of structural features. For instance, the number of points on an elliptic curve equals the number of spanning trees of the associated generalized wheel graph. We explore deeper results comparing certain group structures and enumerative polynomials in detail.

18. **Jazmin Ortiz** (Junior/Senior) Harvey Mudd College
Chromatic Polynomials, Orbital Chromatic Polynomials and their Roots

The chromatic polynomial, $P_\Gamma(x)$ of a graph Γ, is a polynomial that when evaluated at a positive integer k, is the number of proper k-colorings of the graph Γ. We can then find the orbital chromatic polynomial $OP_{\Gamma,G}(x)$ of a graph Γ and a group G of automorphisms of Γ, as a polynomial whose value at some positive integer k is the number of orbits of k-colorings of a graph Γ when acted upon by the group G. We study the similarities and differences of these polynomials by considering the roots of the orbital chromatic and chromatic polynomials. Specifically we work toward proving a conjecture concerning roots of the chromatic polynomial being bounded above by the roots of the orbital chromatic polynomial.

19. **Marcos Reyes** (Junior/Senior) CSU San Bernardino
Equality of $\mu(D)$ and $\kappa(D)$ with $|D|=3$

Let D be a set of positive integers. The distance graph $G(\mathbb{Z},D)$ with distance set D is the graph with vertex set $\mathbb{Z}$, and two vertices x and y are adjacent if $|x-y| \in D$. The chromatic number, fractional number, and circular chromatic number of distance graphs have been studied greatly over the past two decades. Closely related to these parameters is the density of a distance set D, $\mu(D)$, and the parameter $\kappa(D)$—where the later is involved in the Lonely Runner Conjecture. It is known that $\kappa(D) \leq \mu(D)$ for all distance sets D, and equality of these two parameters have been brought to light when $|D| \leq 2$. Now, a natural question to ask is, "What about when $|D| = 3$? Would equality still hold?" The evidence we have collected strongly favors the equality $\mu(D) = \kappa(D)$. Whether or not this is true for all 3-element distance sets remains an open question. In this poster presentation I will talk about this open problem.

20. **Leslie Rodriguez** (Junior/Senior) CSU Long Beach
Alternating Volume, a Hyperbolic Invariant of Knots

A knot is a loop in three-dimensional space. Alternating knots are a class of knots with useful geometric properties. Using methods originally due to Blair, we define the Alternating Volume of a knot to be the volume of an alternating link representation of the knot. We then extend results due to Lackenby to relate the Alternating Volume to twist number.

21. **Morgan Rupard** (Junior/Senior) Cal Poly Pomona
Analyzing and Classifying "k-cycles" of Trigonometric Functions using Newton's Method

For this research, we analyze trigonometric functions, specifically $f(x) = \sin(x)$, in order to find initial values that when iterated upon using Newton's Method, give us a new value, which when iterated upon will give us the initial value again, This process then repeats. So far we have found reliable characterizing equations that give us the exact roots that correspond to these special initial values.

22. **Gustavo Subuyuj** (Junior/Senior) California State University, Los Angeles
The Isoperimetric Constant of Generalized Paley Graphs

We investigate the isoperimetric constant of generalized Paley graphs. The goal is to find new and more accurate bounds. There are known bounds for the isoperimetric constant when working with squares. Here we generalize those results to higher powers and seek new bounds, or the actual isoperimetric constant if possible. We find the conditions guaranteeing we get a Paley graph and describe their behavior in general.

Graduate Student

23. **Kathryn Becker** (Graduate Student) CSU Channel Islands
The Limao Surface: A Citric Sextic

In projective space, the limao surface is defined as the set of zeros of the homogeneous polynomial, $x^2w^4 - y^3z^3$. Because it is of degree six, we refer to it as a sextic surface. Although classification of sextics remains an unsolved problem, I have used algebraic geometry and technological visualization tools to examine the properties of the limao.

24. **Dana Cochran** (Graduate Student) CSU Channel Islands
The Sextic Seahorse

The geometric classification of sextic surfaces remains a mystery today. Here we explore the seahorse sextic surface, a degree-six polynomial that we visualize in a three-dimensional projective space given the zero set of our homogenous polynomial. We look at the singular points, the tangent planes, and the curvature of our sextic surface. We also recognize the instability of our seahorse surface by deforming our homogenous polynomial. These algebraic geometry methods and definitions help us unravel the mystery of the seahorse.

25. **Nicholas Desautels** (Graduate Student) CSU Channel Islands
A Survey on Aspects of Solutions to the Viscous and Inviscid Burgers' Equation

We discuss the analytic solution for the viscous Burgers' equation using the Cole-Hopf transformation as well as the limitations of this solution. We then dive into the numerical solution to the uncontrolled viscous Burgers' equation. We present our code with the results and include the numerical challenges that arose. Following this, we introduce how MATLAB was implemented in solving the controlled viscous Burgers' equation with certain initial conditions. Finally, we describe the future goals from our results.

26. **Laurel Drane** (Graduate Student) CSU Channel Islands
Dancing Daisy - The Deformations of a Sextic Surface

The Daisy surface has a singular locus that is made up of two separate curves that meet in a common singular point. The three-dimensional equation for the Daisy is $(x^2 - y^3) = (z^2 - y^2)^3$. Since geometric classification of these types of surfaces is an ongoing question, our goal is to learn to visualize the set of zeroes of this three-dimensional degree-six surface in real projective space. By using methods from algebraic geometry and colorful graphics software, we can study properties of the Daisy. We will discuss the symmetries of the Daisy, its lines, curves and singular points, tangent planes and curvature. We will also study the deformations of the Daisy in regards to what effects their stability.

27. **Troy Jasso** (Graduate Student) CSU Channel Islands
Smart Look at the Dumbbell: A Variety of Exercises in Algebraic Geometry

Algebraic geometry concerns itself with varieties—that is, zero sets of algebraic equations. Here, we playfully demonstrate the interplay of the analytic and visual as we create and scrutinize a surface that looks like a dumbbell, which is the set of zeros of the polynomial $f(w, x, y, z) = w^2x^4 - w^4y^2 - x^6 + x^4z^2$. Symmetries, projections, and curves of the variety are explored.

28. **Blaine Kutin** (Graduate Student) CSU Channel Islands
Analyzing the Distel Surface

The distel surface is a totally regular six-sided star described by a sextic equation. The surface exhibits many symmetries. In our research, we used computer software to visualize the surface and performed calculations by hand in three-dimensional real projective space to verify properties about the surface.

29. **Ian McGuire** (Graduate Student) CSU Channel Islands
Circles of Love: Sextic Surfaces and their Infinities

A variation on the heart-shaped sextic surface is the focus of my research. The surface presents interesting singularities that meet at points of tangency. We investigate this variation of the heart surface which presents nice symmetries and curves on the surface.

30. **Miryam Moctezuma** (Graduate Student) CSU Channel Islands
The Flight of an Atriphtaloid Fairy

The focus of this poster will be to analyze properties of the sixth degree Atriphtaloid surface. The poster will discuss properties such as, symmetries, singular points, tangent planes and curvature of the surface. It is of interest to study the deformations of the Atriphtaloid and its affect on these properties.

31. **Marina Morales** (Graduate Student) CSU Channel Islands
The Corny Cornoid Surface

An algebraic surface that can be expressed by a polynomial in x, y, and z with degree six is a sextic surface. In this presentation, we study properties about a specific surface, the cornoid. By using algebraic geometry and graphing tools, we describe this alien looking surface. We find singular points, lines, symmetries of the surfaces, the curvature, and other fascinating properties.

32. **Marshall Morita** (Graduate Student) CSU Channel Islands
Ceva's Sextic Surface

Ceva's sextic Surface in is a surface defined as the set of zeros for the homogeneous polynomial $(x^2 + y^2 + z^2)^3 - (3x^2w - y^2w)^2$. We explore some of the properties of this surface in three-dimensional real projective space, including the singular points and tangent planes. We show interesting curves and lines on this surface. The symmetries of the sextic are explained and visualized in the various affine spaces.

33. **Mayra Sahagun** (Graduate Student) CSU Channel Islands
The Lucky Quadrifolium Surface

Have you ever been lucky enough to find a four-leaf clover? A sextic surface is defined as the set of zeroes of a homogeneous polynomial of degree six in three-dimensional real projective space. The Quadrifolium also known as a four-leaf clover is a surface of degree six. Using technology, we visualize the quadrifoliums and describe their properties. We analyze features such as symmetries, singularities, lines on the surface, cuvature, etc.

34. **Emery Stafford** (Graduate Student) CSU Channel Islands
On the Hunt with the Barth Sextic's 'Wolf' Pack of Singularities

In 1996, Wolf Barth presented a counterexample to the thought that a sixth degree surface could have only 52 singular points. Barth's Sextic boasts 65 singularities, a number that was shown in 1997 to be the maximum number of singularities a surface of degree 6 may have. The poster includes a discussion of properties of this surface from an algebraic geometry perspective, such as projections from P^3, its icosahedra symmetry, curves on the surface, and an exploration of the singularities. The symmetries of the sextic are related to the unit circle multiplied by the golden ratio.

35. **Ricardo Suarez** (Graduate Student) CSU Channel Islands
Evaluating the Scarabaeus Sextic Surface in P^3

The objective of the poster is to analyze the Scarabaues Sextic Surface as an algebraic variety $V(f) = V((x^2 + y^2 + z^2)(x^2 + y^2 + z^2 + x)^2 - (x^2 - y^2)^2)$. We analyze the variety by finding the singularities, curvature, as well as lines and curves on this surface in P^3. Then we look at the ideal generated by the variety, as well as the ring of polynomials. Lastly we conduct a group theory analysis on the surface, by explaining the symmetries on $V(f)$.