SDUMC Abstracts 2009

Session on Number Theory

An Arithmetic Metric
Diego Dominici, SUNY New Paltz
Abstract: What is the distance between 11 (a prime number) and 12 (a highly composite number)? If your answer is 1, then ask yourself “is this reasonable?”
In this talk, I will introduce a distance between natural numbers based on their arithmetic properties, instead of their position on the real line.
Level: 1

Pythagorean Triples and the Gaussian Integers
Lynea Snyder, Manhattan College
Faculty Sponsor Name: John McCabe
Abstract: A set (x, y, z) of positive integers is called a Pythagorean Triple provided x, y, and z satisfy the Pythagorean relation x2 + y2 = z2. A Pythagorean Triple is said to be primitive if x, y, and z are pairwise relatively prime. The object of this talk will be to derive Euclid's formulas for primitive Pythagorean Triples by using the ring of Gaussian integers.
Level: 1

p-adic numbers
Glenn Henshaw, Wesleyan University
Faculty Sponsor Name: W. K. Chan
Abstract: p-adic numbers are fundamental to the study of number theory. I will present a few different constructions, give examples of their geometric/topological properties and then I will outline how they can be used to solve some number theory problems.
Level: 2

The Pell Equation
Anna Haensch, Wesleyan University
Abstract: Studied widely by the ancient Greeks, the Pell equation, x2-ny2=1, is one of the oldest Diophantine equations, and arguably the most important. In this talk I will provide a brief introduction to the general Pell equation, its group of solutions, and its relationship to the irrational \sqrt{n}. This will culminate with a walk through Dirichlet's 1840 proof of the existence of a nontrivial solution to the general Pell equation.
Level: 1

They go on and on...
Emily Dennett, University of Massachusetts Amherst
Faculty Sponsor Name: Dr. Farshid Hajir
Abstract: This talk will give a brief history of continued fractions and then highlight some of their interesting and very useful applications. One interesting application will show how continued fractions can be used to approximate irrational numbers.
Level: 1

In Pursuit: the search for odd perfect numbers
Addie Armstrong, Norwich University
Faculty Sponsor Name: Robert Poodiack
Title: In Pursuit: the search for odd perfect numbers.
Abstract: We will discuss the search for odd perfect numbers from the early 1800's to today.
Level: 1

Session on Algebra

Correcting the Record with Knot Coloring
Robert McGrail, Bard College
Abstract: This talk introduces CMK ("Color My Knot"), a logic program for computing quandle colorings of three dimensional knots. We will introduce the notions of knots, quandles, and logic programming. Moreover, we will present several examples of errors in the Mathematica KnotData digital library that were discovered using this tool.
Level: 2

Trace Diagrams and the Gram Determinant
James R. Lee, United States Military Academy
Faculty Sponsor Name: Dr. Elisha Peterson
Abstract: This presentation will explore the use of trace diagrams in simplifying mathematical concepts, more specifically linear algebra concepts. The presentation will provide a background of basic trace diagrams, examples of their implementation, and a proof regarding the diagrammatic representation of the Gram Matrix.
Level: 1

A family of recursively defined polynomials: Their properties and applications
Steven Goliber, Western Connecticut State University
Faculty Sponsor Name: Dr. Xiaodi Wang
Abstract: Through the exploration of an International Mathematical Olympiad problem, an unlikely family of recursively defined polynomials has extremely useful properties that has many applications to a variety of problems and in this paticular case yields an infinite amount of pairs of integers (a,b) such that it satisfies (a2+b2)/(ab+1)=y2 where a, b, and y are integers. The Mathematical Olympiad problem as stated is: given positive integers a and b let (ab+1)|a2+b2, prove that (a2+b2)/(ab+1) is a square of some integer. We may also apply the properties of these polynomials to solve applied numerical analysis problems.
Level: 2

The insolubility of the quintic
Dusan Milanovic, St. Francis College
Faculty Sponsor Name: Dr. Fotios Paliogiannis,
Abstract: Using Galois group and starting from the notions such as splitting field and automorphism we can see that there is no general solution for polynomial equations of degree five or higher. This was established in 19th century by Abel after which Galois built an entirely new theory of equations that explained nonexistence of formulas.
Level: 2

Babylonian number system and quadratic equation
Nicholas Stano, College of Mount Saint Vincent
Faculty Sponsor Name: Dr. Bjorn Schellenberg
Abstract: The Babylonians had a number system different from ours and we know from historical texts they were able to solve many problems. They had a procedure for solving quadratic equations even though they did not accept negative numbers. We will present one such problem, the steps, and its solution.
Level: 1

From Prime Factorization to Primary Decomposition
Cameron Bishop, Southern Connecticut State University
Faculty Sponsor Name: Jooyoun Hong
Abstract: It is desirable to be able to factor an element in a ring into a product of irreducible elements. When every element of a ring can be factored, the ring is said to be a Unique Factorization Domain (UFD). Given an ideal of a ring, we examine the analog in "factorizing" the ideal, namely the primary decomposition. We will look at the resulting parallels between a Noetherian ring and a UFD with respect to factorization/decomposition.
Level: 2

Session on Game Theory

Unusual Payout Scheme in a Bingo-like Carnival Game
Matthew Lopes, Marist College
Faculty Sponsor Name: Matthew Glomski
Abstract: In many state and county fairs, carnival games of pure chance are prohibited. Game operators have circumvented this obstacle with games such as "I Got It!" This Bingo-like game is characterized by a significant element of chance, with a complicated underlying model. We investigate the probabilities and payouts in this interesting game.
Level: 1

An Alternate Approach to Sprouts
Lionel Barrow and Cedric Cogell, Bard College
Faculty Sponsor Name: Maria Belk
Abstract: Sprouts is a pen-and-paper game with interesting mathematical properties. It is played by drawing lines that connect vertices on a plane, so that no lines cross and no vertex has more than three lines connected to it; the winner is the player who makes the last move. The authors present an approach to the game that reaches the same results as traditional methods for $n = 1, 2,$ and 3, and provide an argument for the Applegate Conjecture, which states that the first player has the win if and only if $n = 3, 4,$ or 5 mod 6.
Level: 1

The Value of Information in Simple Competitive Games
Peter Kerkhof, United States Military Academy
Faculty Sponsor Name: Dr. Sheila Miller
Abstract: This project uses games which are based roughly on the card game war, with the addition of features that allow players to adjust their forces and affect the outcome of the game

based on information about the disposition of the other player. The value of each type of information was assessed by gradually decreasing the strength of the player with information. Through many trials of different types and combinations of information it was determined which information was most helpful to winning the games. Also, interesting relationships emerged between the informed players strength given up and win percentage.
Level: 1

What does it mean to say a game is fair?
Rita Welsh and Alexandra Konneker, Manhattan College
Faculty Sponsor Name: Dr. Kathryn Weld
Abstract: What does it mean to say a game is fair? I will be talking about the fairness and unfairness of playing Rock, Paper, Scissors in a two-person, or multi-person game. With most people thinking there is no strategy to win at Rock, Paper, Scissors I will use probability to show two different strategies to win against your opponents.
Level: 1

Are the Rules of Poker Wrong?
Silas Meredith, Horace Mann School
Abstract: Since time immemorial, the order of poker hands has been: straight flush, four of a kind, full house, flush, straight, three of a kind, two pair, one pair, no pair. This is based on probabilities from five-card stud. But in Texas hold ’em, you make the best hand of 5 from 7 total cards, changing all the probabilities. Do we need to re-write the rules of poker? We’ll calculate the theoretical probabilities, then run a few thousand computer simulations to check them.
Level: 1

Playing Games with Abstract Algebra: The "Lights Out" Puzzle
Jenae Beauchamp, Eastern Connecticut State University
Faculty Sponsor: Professor Pete Johnson
Abstract: The "Lights Out" puzzle is a handheld electronic game by Tiger Toys that consists of 25 lights arranged in a square. By pressing a button, its light and those of the adjacent buttons will switch on if it was off, and vice versa. Given a pattern of lights, the end goal is to switch them all off by pressing the correct buttons. This presentation will analyze the puzzle’s ties to the field of Abstract Algebra, and will explore how mathematical modeling has been utilized to introduce this real-world application into the classroom.
Level: 1

Session on Geometry

Angular Determinations of a Quadrilateral I
Donald Silberger, SUNY New Paltz
Abstract: Any two angles of a triangle ABC is a ``minimal angular determination'' of ABC. That is, the similarity class of ABC is determined by your knowing, for instance, angle A and angle B. However, for a proper convex plane quadrilateral ABCD, the plot thickens: Not even the values of all four of the vertex angles of ABCD determine a unique similarity class of ABCD. If one sketches in the diagonals AC and BD of ABCD then there are twelve angles to be

considered, three of them at each vertex. Which subsets of that twelve-angle set determines the remaining angles (and thus the similarity class) of ABCD?
Level: 1

Angular Determinations of a Quadrilateral II
David Hobby, SUNY New Paltz
Abstract: A set of angles in a convex quadrilateral $ABCD$ is an `` angular determination" of $ABCD$ if it determines all of the other angles in the quadrilateral. An angular determination is ``minimal" if removing any angle from it gives a set that is not an angular determination. We present some nice examples of sets which are and are not minimal angular determinations.
Level: 1

A Resolution of the Geometry Dilemma
David M. Clark, SUNY New Paltz
Abstract: Formulating a successful geometry curriculum demands that we achieve two seemingly incompatible goals. We want our students to build the subject carefully from axioms, thereby developing the ability to reason from premises and to construct and articulate logical arguments. We also want them to learn the traditional content of plane geometry so that they can use and apply it in mathematics and other subjects. Hilbert style curricula achieve the first goal but barely touch the second. Most high school curricula focus on the second and ignore the first. We will present a new geometry curriculum that is successfully achieving both.
Level: 2

No angle axioms
Bjorn Schellenberg, College of Mount Saint Vincent
Abstract: A widely used approach for teaching Axiomatic Geometry was developed by David Hilbert. A different set of axioms uses the real numbers to introduce distance and angle measurement via the so-called Ruler Postulate and Protractor Postulate. We explore a variation on this set that, while using the real numbers to define distance, replaces angle axioms with definitions and propositions.
Level: 2

How To Measure Angles with a Ruler
Marko Dedovic, St Francis College
Faculty Sponsor Name: Erez Shochat
Abstract: We present a technique that enables us to approximate angles using a ruler. Also we will investigate the error that occurs and discuss ways to modify the computation in order to minimize the error. This talk is based on a paper by Travis Kowalski.
Level: 1

What is the most distant point?
Brianna Frabizio, Manhattan College
Faculty Sponsor Name: John McCabe
Abstract: Given a triangle ABC, which point P of the triangle is most distant from the vertices? To be precise, we'd like to find that point P of the triangle that is most distant from the nearest vertex. That is, we'd like to maximize the function: Min{d(A, P), d(B, P), d(C, P)}, where P can

be any point of the triangle.
It will be seen that the answer to this question depends on whether the triangle is acute, or not.
Level: 1

Session on Applied Mathematics

Cooperation in Pursuit and Evasion
Lucas Gebhart, United States Military Academy
Faculty Sponsor Name: Dr. Elisha Peterson
Abstract: Pursuit and evasion games, at their most basic level, are instances of one person chasing another. From games like "cops and robbers," to more serious events like the United States chasing Osama Bin Laden, our lives are filled with examples of pursuit and evasion. Most current research on these games focuses on individual interactions, and tactics that make an individual better at pursuing or evading. The fundamental flaw with this approach is that most real-life pursuit and evasion is done on the team level.
This talk investigates the interactions between members of teams, studying factors that make teams successful. We also use metrics that measure the cooperation of teams to study algorithms that lend themselves to selfish and altruistic cooperation.
Level: 1

Coupled Cell Networks and Sea Turtle Population Modeling
Cadet Dominic Senteno, United States Military Academy
Faculty Sponsor Name: Dr. Sheila Miller
Abstract: In this project we explore the area of Coupled Cell Networks and apply it to the modeling of the Leatherback Sea Turtle Population. There are many species that have become endangered and nearly extinct in the past century, and although wildlife conservation support has increase its practice has been slow. We use Coupled Cell Networks to create a realistic model to assist us in understanding the causes and effects of humans and other factors on wildlife populations.
In developing the model we used the language of Adobe Flex Builder to create and simulate the model. After developing the model, we can use it to predict changes in the Leatherback Sea Turtle population caused by human activities and policies. This simulation can also be used for other wildlife species that are negatively affected by today's environmental and human effects. We present our work on the problem so far, and the results of the simulation.
Level: 1

Simple mathematical model of optical-fiber manufacturing: Numerical simulation with CAS Maple
John Lee and Xing Zhu, Western Connecticut State University
Faculty Sponsor Name: Lydia Novozhilova
Abstract: An optical fiber is a glass or plastic fiber that carries light along its length. Fiber optics is concerned with analysis, design, and manufacturing of optical fibers that are widely used in numerous applications. In particular, fibers are the enablers of the rates of information flow that make the Internet possible. The design and manufacturing of optical fibers is rich in challenging mathematical problems and provide opportunities to solving real world problems. We present a simple "toy" model of a process of optical fiber manufacturing in the form of a system of ODEs.

The system involves a control parameter that is to be found. We describe an algorithm for finding the parameter and our simulation results obtained with CAS Maple.
Level: 1

Nonlinear Dynamic Systems in Simple Electronics
Joseph Rappa, SUNY New Paltz
Faculty Sponsor Name: Dr. David Hobby
Abstract: Due to the advancement of digital computing, nonlinear dynamic systems have snapped back into the focus of mathematicians. Electronic circuits provide a simple opportunity to explore chaos and strange attractors as an exercise in calculus and algebra.
Level: 2

Mathematical modeling for analysis of infectious diseases
Samia Nazzal, Franco Porto, Rachel Lemmey, Christina Tawfik and Rushabh Jhaveri Mercy College
Faculty Sponsor Name: Dr. Sanjeevani Vaidya
Abstract: The main objective of this project is to research and analyze infectious diseases such as, AIDS, Influenza and Bird Flu using mathematical modeling techniques. AIDS is a global epidemic which affects the immune system and puts infected individuals at risk for contracting various infections. Another example of infectious diseases is Influenza which people can get many times throughout their lives. Moreover, Bird Flu is another case of infectious diseases which alarmed experts. Throughout our research we will use mathematical modeling to study disease transmission and examine how various vaccination or containment programs can help prevent the spread of infectious diseases.
Level: 1

11:20
Ordering of Search Engine Results: google it!
Leigh Noble
Abstract: How does Google order the results of your search? Have you ever encountered a Google bomb? If you and your friend link to each other's site, will your position in a Google search improve? Importance scores are one factor used by Google to measure the popularity of web sites and order them in search results. This measurement is the heart of the algorithm that launched Google and improved the utility of the Internet for everyone in the world. We'll use matrices and eigenvectors from linear algebra to calculate importance scores for pages in an example mini-web.
Level: 1

Session on Numerical Analysis

Gaussian Quadrature Rule
Carlos Suero, SUNY New Paltz
Faculty Sponsor Name: Lawrence Fialkow
Abstract: we will use numerical methods to estimate integrals. Gaussian Quadrature is one such method. The purpose of the research was to find a way of estimating complicated definite integrals using the Gaussian Quadrature rule. In some of the experiments, we will compare the

efficiency of Gaussian Quadrature to the efficiencies of Simpson's Rule and the Trapezoid Rule.
Level: 1

How many points?
Lawrence Fialkow, SUNY New Paltz
Abstract:

Let $\overline{\mathbb{D}}$ denote the closed unit disk in the plane, and let

$$\beta_{ij} = \int\int_{\overline{\mathbb{D}}} x^i y^j dxdy \ (i, j \geq 0, i + j \leq 6).$$

The *cubature problem* corresponding to the β_{ij} asks for points $(x_1, y_1), \ldots, (x_m, y_m)$ in $\overline{\mathbb{D}}$ and positive numbers $\rho_1, \ldots, \rho_m$, such that

$$\beta_{ij} = \sum_{k=1}^{m} \rho_k x_k^i y_k^j \qquad (i, j \geq 0, \ i + j \leq 6).$$

It is known that this cubature problem cannot be solved with 10 or fewer points, and that it can be solved with 12 points. Can it be solved with 11 points? This problem is about 40 years old. (Joint work with C. Easwaran (SUNY New Paltz) and S. Petrovic (Western Michigan University))
Level: 2

An Overview of the Picard Method for Solving ODEs
Olga Stulov and Jason Caggiano, SUNY New Paltz
Faculty Sponsor Name: Natalie Cartwright
Abstract: In this talk, we present Picard's Method for solving Initial Value Problem (IVP) Ordinary Differential Equations (ODEs). After discussing introductory theory we will work out some examples to illustrate the functionality of the method.
Level: 2

Complex Polynomial Modeling: Developments and Applications
Addison Bohannon, United States Military Academy
Faculty Sponsor Name: Dr. Bob Ronkese
Abstract: The Complex Polynomial Method approach affords many advantages over typical domain methods of finite differences and finite elements because it exactly solves the governing partial differential equation and does not involve the discretization of the problem domain. We present a new development of the CPM variant of the Complex Variable Boundary Element Method. Instead of fitting the boundary conditions using collocation points, we minimize the error of fit in the l2 norm to minimize the least squares error. This approach greatly enhances the utility and efficiency of the method, allowing us to apply the method to relevant engineering problems of torsion and ground water flow.
Level: 2

Entropy from High Resolution Software Counters
Lucas Enloe, United States Military Academy
Faculty Sponsor Name: Dr. Robert Ronkese
Abstract: I will give a presentation on some research into the "randomness" of random numbers

generated from computer software.
Level: 1

Discrete and Continuous Dynamical Systems via Numerical Methods for Differential Equations
Timothy Andrews, University of Hartford
Faculty Sponsor Name: Robert Decker
Abstract: When continuous dynamical systems (differential equations) are approximated using numerical methods such as Euler's method or Runge-Kutta, attracting fixed points and periodic points can be observed. Bifurcation diagrams and Lyapunov exponent graphs can be used to relate the dynamics of different numerical methods. The presenter will use interactive java applets created by himself (as part of a group project) to relate the dynamics of Euler's method and a second-order Runge-Kutta method. Some interesting relationships are observed, and then proven algebraically.
Level: 2

Session on Differential Equations

The Heat Equation – Derivation and Methods of Solutions
Sandip Hodkhasa, Vaughn College of Aeronautics and Technology
Faculty Sponsor: Professor Paul LaVergne
Abstract: Understanding the Heat equation (also known as the diffusion equation) is of relevance to many fields of science. In this talk we discuss the following:
a. The derivation of the one-dimensional heat equation from physical principals,
b. Solution methods based on the method of separation of variables and Fourier series.
Level: 1

The Heat Equation – Approximation Methods
Paul LaVergne, Vaughn College of Aeronautics and Technology
Abstract: The development and use of approximation methods utilizing finite difference methods is of great importance to applications that involve partial differential equations. In this talk, we compare the results of finite difference methods obtained using Matlab with exact solutions to the one dimensional heat equation and discuss issues concerned with these methods such as accuracy, stability and computational expense. If time permits we will discuss the extension of the finite difference methods from one-dimensional problems to two-dimensional problems.
Level: 1

A successful hunt for periodic solutions
Lydia Novozhilova, Western Connecticut State University
Abstract: We consider a classic model in population dynamics, logistic equation with periodic harvesting. The ODE is a particular example of the Riccati equation. It is well known that any Riccati equation reduces to a linear second order ODE by a change of dependent variable. Using this reduction, we explicitly construct periodic solutions to the original model. We also present stability analysis of these solutions.
The work is done in collaboration with WCSU graduate student Dan Mackey.
Level: 2

Solving ODE by Factoring the Differential Operator
Stela Mihneva, St. Francis College
Faculty Sponsor Name: Dr. Fotios Paliogiannis
Abstract: We present a method of solving second and higher order homogeneous and non-homogeneous ODE with constant coefficients by factoring the corresponding differential operator and treating the resulting expression as a composition of first order differential operators. This approach has an advantage over other methods due to its simplicity.
Level: 1

Session on Analysis

Business Card Cubes and the Menger Sponge
Elizabeth Scherer and Andrea Orlando, Manhattan College
Faculty Sponsor Name: Dr. Kathryn Weld
Abstract: The Menger Sponge is named after mathematician Karl Menger. He discovered this fractal curve in 1926 while exploring topological dimension. During the presentation, I will show a Menger Sponge made out of business cards. Along with this, I will show the equations found to solve for the number of business cards needed to make an "un-paneled" sponge, which is simply attaching together the boxes made of business cards. After this, I will present the equation used to make a "paneled" sponge. The difference is that this model will have a smooth surface and extra business cards.
Level: 1

The composition of functions
Hussain Gardezi, College of Mount St. Vincent
Faculty Sponsor Name: Professor B. Schellenberg
Abstract: The composition of functions is a binary operation on the set of all real-values functions defined on the reals. In general, this operation is non-commutative. We investigate conditions under which two functions f(x) and g(x) commute. In particular, we ask which pair of continuous function commutes.
Level: 2

Minimizing Integrals of Constrained Polynomials
Jean Cesarius, CUNY Queens College
Faculty Sponsor Name: Dr. Ken Kramer
Abstract: In this research, we considered polynomials P(x) of fixed degree *n* constrained by the conditions that P (0) = 0, P (1) = 1 and P(x) ³ 0 on the interval [0, 1] on the x-axis. One might guess naively that the minimum occurs by using the polynomial P(x) = xn, but the case of *n* = 3 indicated that this conjuncture is false. By using extreme value techniques of calculus, investigation involving least squares approximation and the theory of orthogonal polynomials, we obtained the following results that are given by the table below where Jd is the dth orthogonal polynomial with weight *W* on the interval [0, 1], depending on the parity of *n*:

Degree: *n*	Weight: *W*	Optimal Polynomial	Minimum Area
2*d*+2	X(1- x)	X2 [**J***d*(x)]2	1/[(*d*+1)(*d*+3)]

$2d+1$ X2(1-x) X [$\mathbf{J}d$(x)]2 $1/[(d+1)(d+2)]$

Level: 1

What's The Largest Area One Can Bound With A Fixed Length of String
Joel Specter, Wesleyan University
Faculty Sponsor Name: Anna Haensch
Abstract: Consider the set C of all simple, closed curves with a fixed perimeter L and the function F, which assigns to each curve the area of the region of which the curve bounds. The isoperimetric problem asks for which, if any, curves is this function maximized. Intuition tells us the answer must be a circle, and as such the answer has been known since antiquity. However, the proof of this fact is nontrivial and remained undiscovered until the nineteenth century. In this talk, we present E. Schmidt's constructive proof of the isoperimetric inequality for planar curves. The only requirements are a working knowledge multivariable calculus and linear algebra.
Level: 2

Session on Combinatorics

An Introduction to Ramsey Theory
David White, Wesleyan University
Abstract: This talk will introduce the notion of Ramsey theory as an extension of the Pigeonhole Principle. I will formulate a few bounds on the sizes of Ramsey numbers, discuss Ramsey's Theorem, and demonstrate how probability theory can be used in graph theory. I will also talk about the history of this field and present some of the big open problems. If there is time I will discuss extensions of Ramsey numbers and deeper uses of probability theory in combinatorics.
Level: 2

Rotation distance and binary trees
Rodion Kosovsky, John Passaro and Yasser Toruno, The City College of New York
Faculty Sponsor Name: Sean Cleary
Abstract: Binary trees are widely used for efficient searching of many types of data. Rotations can be used to balance trees for quicker searching. There are no known polynomial-time algorithms for computing rotation distance between binary trees.
We describe a software package for visualizing tree rotation operations. The package includes methods to create trees randomly, enumerate trees, and to perform simplifications on pairs of trees.
Level: 2

The shortest network problem
Sarah Janssen, Manhattan College
Faculty Sponsor Name: Dr. Kathryn Weld
Abstract: I will briefly go over the problem that Fermat proposed concerning the best way to connect three cities covering the least amount of distance. I will explain the proof of this problem in detail and describe how to arrive at "Fermat's Point." I will finish the talk by clarifying why this point is the best solution you can arrive at.
Level:2

A brief introduction to the Stable Marriage Problem
Steven Dennett, Wesleyan University
Abstract: In a community consisting of n men and n women, each of whom has a preference list of all of the members of the opposite sex, is it possible to match each man to a woman in such a way so that nobody cheats on their partner? We will discuss this problem, give an algorithm that solves it, and take a brief look at a few of its variations.
Level: 1

Session on Complex Analysis

Mobius Transformation
Kristi Burns, Brian Callen and Christine Turner, St. Joseph's College
Faculty Sponsor Name: Vasil Skenderi
Abstract: We will study the three types of classifications of Mobius Transformations; parabolic, elliptic, and loxodromic. We will also demonstrate visual Mobius maps using maple.
Level: 2

Complex Integration and Causality
Natalie Cartwright, SUNY New Paltz
Abstract: Causality is the requirement that the effect cannot precede the cause. In electromagnetics, a direct consequence of causality is that the real and imaginary parts of the function that describes the material response (the dielectric permittivity) must be Hilbert transforms of each other. The derivation is a nice application of complex Fourier transforms and residues.
Level: 2

Conformally Yours, Rectangles
Joe Fera, Wesleyan University
Abstract: Consider the following geometric problem: given two rectangles in the plane, R and R’, does a conformal map exist between them that maps the corners of R to the corners of R’? In this talk, we present a full solution to this problem by uncovering the necessary tools from both Complex Analysis and Geometric Function Theory. Such tools include the definition of a conformal mapping, the Riemann Mapping theorem, and the Schwarz Reflection principle. Time permitting; we also explain how the solution to this problem led to the birth of quasi-conformal mappings.
Level: 1

Practical Applications of Conformal Mapping in the Complex Plane
Tim Ivancic and Ryan Vinson, SUNY New Paltz
Faculty Sponsor Name: Natalie Cartwright
Abstract: Fluid flows around rigid objects can be modeled in the complex plane. Joukowski transforms are conformal mappings that allow one to analyze a family of airfoil shapes in a fluid flow. We will discuss the correlation between fluid flows and conformal mapping and then demonstrate these ideas through a simulation of a sail.
Level: 2

Session on Geometry/Number Theory

Voronoi Diagrams Flag Vectors
Liz Jimenez, Bard College
Faculty Sponsor Name: Lauren Rose
Abstract: A Voronoi diagram consists in the partitioning of a plane with n-points into regions such that each region contains exactly one generating point and every point in a given region is closer to its generating point than to any other.
And, the number of i- dimensional faces of a polytope P is written fi, and f (P)=(f0,…,fd-1) is called the f- vector of P. The flag f-vector of a polytope Q counts all chains of faces according to their corresponding sets of dimensions.
This talk will introduce some basic properties of Voronoi Diagram's flag f- vectors.
Level: 2

Out in left field...way out!
Andrew Lazowski, Wesleyan University
Abstract: Have enough friends to make a baseball team? Maybe you have too many friends and it would be hard choose a team. If you want to make everyone happy, try playing baseball in hyperbolic space. We will introduce hyperbolic geometry and demonstrate how baseball would be different in this setting.
Level: 1

Finite Sums of Fibonacci-Based Sequences
Katharina Carella, Ithaca College
Faculty Sponsor Name: Osman Yurekli
Abstract: Based on known methods of summing the Fibonacci numbers (defined as F_i), we began to consider similar sums involving products of powers of i and the Fibonacci numbers. Applying and modifying techniques found in previous research, we were able to find closed forms of sums for specific powers of i. We also looked for a connection between Fibonacci Polynomials, Triangular numbers, and the sums of products of Fibonacci numbers. We have not found closed forms for all the sums described here, but we have made some interesting connections.
Level: 2

3:00
Toward an Encyclopedia of Finite and Infinite Sums and Products of Fibonacci and Lucas Numbers
Harvey J. Hindin, Emerging Technologies Group, Inc.
Abstract: Multiple techniques are presented that allow the derivation of finite and infinite sums and products of Fibonacci and Lucas numbers in closed form. Several dozen results are obtained, many of which are believed to be new. Some of these results are curious. Derivations are shown from Fibonacci and Lucas number theory, exponential, trigonometric, and hyperbolic functions, and Chebyshev and other polynomials. Brief mention is made of Theta functions and other functions related to, or defined by, the obtained sums and products. The treatment presented is self-contained and accessible to advanced students, teachers and researchers.

Complete references are provided
Level: 2

Session on Mathematics Education/ Operations Research

Qualitative Graphing Techniques
Fred Rickey, United States Military Academy
Abstract: Graphing calculators are wonderful. Computer algebra systems are even better. They easily produce nice graphs. But do these graphs display the salient features of the function? Not always. Without an initial idea of what the graph looks like, one might miss essential features. We present here a way to easily sketch qualitatively correct graphs of most of the rational functions which occur in a calculus course. Calculus then can be used to refine these graphs.
Level: 1

Collaborative projects in an undergraduate mathematical modeling course
Doug Fletcher and Aaron Elliott, United States Military Academy
Abstract: This talk will discuss a project conducted in a Mathematical Modeling and Introduction to Calculus course where students used systems of recursive equations and an understanding of long term behavior to determine the optimal allocation of an advertising budget. In Phase 1 of the project, students worked in groups and were encouraged to collaborate on the mathematics to find a solution. In Phase 2, each student incorporated the group results into their own technical report. We will discuss our goals for students' application of mathematics, our expectations, the student results, and the benefits and challenges we faced with this project.
Level: 1

Dynamic Java Applets for Mathematical Visualization the Easy Way
Victor Sklutovsky, University of Hartford
Faculty Sponsor Name: Robert Decker
Abstract: A team of students at the University of Hartford has been working on a way to make it easier for mathematicians and mathematics educators to create interactive/dynamic java applets which can be used for demonstrations and investigations. The applets can have any number of graph windows, and any combination of functions, parametric functions, and discrete or continuous dynamical systems. The presenter will show how to create such applets with just a few lines of code, using components created by the team, and how to use those applets to present some mathematically interesting ideas.
Level: 1

Methods in Operations Research
Desislava Slavova, Norwich University
Faculty Sponsor Name: Darlene Olsen
Abstract: Operations research is a series of mathematical models and algorithms used for optimization of a variety of real-life problems. The types of mathematical models considered in this presentation are both linear and non-linear, constrained and unconstrained. The methods presented are Newton's Method, the Gradient Search Method, Linear Programming, Separable Convex, the Frank Wolfe Method, and the Lagrange Multipliers Algorithm.
Level: 2