Jan 1st, 12:00 AM

13. Mathematics

University of Central Oklahoma

Abstracts from the 2014 Oklahoma Research Day

Held at the University of Central Oklahoma

05. Mathematics and Science

13. Mathematics

05.13.01 The Senior's Dream

Stephanie, Duncan

East Central University

This research looks at what real value conditions for matrices make ⟦(A+B)⟧^(-1)=A^(-1)+B^(-1) true. We'll examine the 1x1 matrix, the conditions found in a general result, and the 2x2 matrix.

05.13.02 The Golden Ratio in Geometric Figures

Cady, Murphy

East Central University

This project presents four geometric figures in which the golden ratio can be discovered. With the findings of several mathematicians, we used geometric theorems and statements along with algebra to prove the golden ratio's appearance in specific geometric figures. The work presented here has great applications for future studies of the golden ratio in more abstract geometric figures and three-dimensional figures.

05.13.03 Locating Roots of A Certain Class of Polynomials

Akinola, Akinlawon , Ioannis Argyros

Cameron University

The issue of finding roots of polynomials has been one of great concern and value over the years of progressive research. This issue cuts across several disciplines including medicine and pharmaceutics, engineering, economics and even business finance. In this presentation, a further analysis of the celebrated Newton type method to finding roots of polynomials will be shown.

05.13.04 How Far is a Chicken McNugget From Being Prime?

Staci, Gleen

Langston University

Numerical monoids have long been studied for their interesting (i.e., non-unique) factorization properties. While numerical monoids of embedding dimension 2 are relatively well- understood, the presence of a third minimal generator makes these monoids more difficult and interesting to study. We provide a complete analysis of McN = (6, 9, 20), an embedding dimension 3 numerical monoid whose elements correspond to the amounts of Chicken McNuggets one can purchase using the traditional order sizes of 6, 9, and 20. Our analysis includes a closed formula for $\omega(x)$, the omega-primality of an element, which measures how far that element is from being prime in the monoid. Furthermore, we also develop formulas for the elasticity $\rho(x)$ and delta sets $\Delta(\text{McN})$, quantities which measure non-uniqueness of factorization in McN.

05.13.05 A Mathematical Model of Circadian Rhythms in Drosophila

Alanna, Riederer , Brittany Bannish, Brittany Myers

University of Central Oklahoma

Periodically occurring events can be expressed by a system of differential equations. Circadian rhythms, daily rhythmic activity cycles, are an example of such an event. Experimental observations coupled with previous modeling efforts have explained much of the behavior of Drosophila circadian rhythms, but questions remain. We develop a more comprehensive model which includes two different Drosophila genes (PER and TIM), in an effort to better fit experimental data. We hypothesize that our biologically-motivated model will better capture the observed circadian rhythms. We will present model results and compare them to experimental data.

05.13.06 When is a Ride on Airport Pavement Too Rough For Humans?

David, Stapleton

University of Central Oklahoma

Models such as the Boeing Bump Model are in current use to determine when airport pavement is too rough on aircraft. In contrast, this paper considers when vibration is considered too uncomfortable by humans. Presentation of 37 real world taxiway and 37 real world runway rides on a B737-800 flight simulator using vertical vibrations provided a subjective 0-10 rating and an acceptable/not acceptable rating from 33 pilots for each ride in a data collection effort. The vertical profiles of each taxiway and runway were known and a numerical score for each was calculated in terms of four ISO standard estimators of ride roughness: weighted RMS, weighted MTVV, weighted VDV and DKup obtained by running the profiles through the flight simulator with certain modifications and enhancements. The results were • High correlations were found between the subjective pilot ratings and the four objective ISO measures of total acceleration experienced, with different trends for taxiways and runways, • Objective indicators of subjective human ratings of discomfort were deduced as functions of the ISO indices with confidence intervals for the fits, • Limits for cockpit vibration were obtained by identifying index values at which 5% of pilots would rate a taxiway or runway as unacceptable.

05.13.07 A Within-Host Mathematical Model of HIV Infection during Combination Therapies

Candace, Baker , Sean Laverty

University of Central Oklahoma

Mathematical models provide us with a quantitative description of the immune system and its interactions with viruses and other pathogens. We model HIV infection dynamics within a host to study the effects of drug treatments, specifically those that alter the ability of the virus to infect susceptible cells and to produce infectious viruses. The two drugs considered in the model are Reverse Transcriptase inhibitors and Protease inhibitors which block the ability of HIV to successfully infect a cell, and cause the production of non-infectious viral particles, respectively. Our current model is a 6 equation differential equations model that describes Helper T cell, Cytotoxic T cell, infectious and non-infectious HIV viral particle interaction within the host whilst the host is undergoing antiretroviral drug treatment. Changes in the efficacies of these drugs can cause large fluctuations in host cell and virus dynamics. We will expand the model to examine the effects of novel drug combinations and more detailed T-cell population structure on host and virus dynamics.

05.13.08 Dynamics of Laser-Initiated Immunotherapy of Cancer

Bryan, Dawkins , Sean Laverty, Wei Chen

University of Central Oklahoma

We will present a mathematical model composed of a system of ordinary differential equations describing the immune-mediated dynamics of cancer cell populations with exponential growth. The model will include laser-initiated cancer destruction by means of several classes of immune cells. The primary cells in the immune response for this treatment are Dendritic cells, Cytotoxic and Helper T cells, and B cells. Also included in the model are antibodies and tumor antigen, which play a central role in the success of the treatment. We will show successful treatment and the conditions under which this may occur. In addition, we will describe conditions under which failed treatment may occur. Whenever possible, the results of the model will be compared to experimental results of our collaborator to show the relative accuracy of the model. To expand the model, treatment of cancer cell populations with non-exponential growth will be discussed as well. We will show that the ultimate success of laser immunotherapy of cancer is highly related to immunoadjuvants represented by parameters of our model.

05.13.09 Modeling of Blood Clot Degradation Associated with TAFIa and tPA

Hyunjong, Kim , Brittany Bannish

University of Central Oklahoma

The objective of this research is to understand how TAFIa and tPA (molecules present in blood) affect the rate of blood clot degradation. We hypothesize that TAFIa and tPA have an effect on each other, and that greater tPA reduces TAFIa's activity. We use a mathematical model to run computational experiments (using the Fortran and MATLAB programs) to obtain results. We create graphs which depend on the TAFIa and tPA concentrations. The result is that for a fixed tPA concentration, a higher concentration of TAFIa slows the rate of blood clot degradation. On the other hand, tPA makes TAFIa's activity slower, so for a fixed TAFIa concentration, a higher concentration of tPA increases the rate of blood clot degradation.

05.13.10 Jacobi vs. Gauss-Seidel

Kendra, Parker

East Central University

This paper talks about two different numerical methods used to solve systems of linear equations, the Jacobi Method and the Gauss-Seidel Method. The methods are compared by looking at the solutions, how many iterations are needed to obtain the solutions, and the relative and the absolute error.

05.13.11 Modeling The Relationship Between uPA and PAI-1, and Tumor Cell Growth

Ara, Han , Brittany Bannish

University of Central Oklahoma

The plasminogen activators, tissue-type plasminogen activator (tPA) and urokinase (uPA), are expressed in tumor cells. uPA is most common with its receptor (uPAR) and is mostly involved in cellular functions. Also, PAI-1 which is one of the plasminogen activator inhibitors of fibrinolysis, the degradation of blood clots, plays a major role in tumor cell growth as well as in cancer. In other words, increased uPA and PAI-1 were associated with a worse prognosis. We build a mathematical model of the relationship between uPA and PAI-1, and tumor cell growth. The model equations are solved in Matlab, and clinically relevant results are discussed.

05.13.12 Application of Least Square Problem to 3D Intensity Modulated Radiation Therapy Planning Problems - Part I

Andrew, Bucki , Abebaw Tadesse, Laurence Smith, Staci GleenTayla Vaughn, Taylor Pleasant

Langston University

Brief overview of the application of Least Squares problem (LSP) as applied to 3D-Intensity Modulated Radiation Therapy Planning (IMRT) will be presented in this part.

05.13.13 Application of Least Square Problem to 3D Intensity Modulated Radiation Therapy Planning Problems - Part II

Abebaw, Tadesse , Andrew Bucki, Franklin Fondjo, Laurence SmithStaci Gleen, Tayla Vaughn, Taylor Pleasant

Langston University

In this part, MATLAB Implementation of the (LSP)-IMRT on the computational environment for Radiation Therapy Research (CERR) platform will be presented. Sample patient image data from CERR Archives will be used for demonstration purposes.

05.13.14 Counting Nonhomeomorphic Paintings of Noncut Points of Caterpillar Continua

Michael, McClendon , Jonathan Yarbrough, Mikasa Barnes

University of Central Oklahoma

A graph is a continuum that can be written as the union of finitely many arcs, any two of which are either disjoint or intersect in one or both of their endpoints. A tree is a graph containing no simple closed curves. A caterpillar continuum C is a non-degenerate connected tree containing an arc A(C) such that V(C) = {x | x belongs to C, order(x,C) > 2} is a subset of A(C) and the two endpoints of A(C) are elements of V(C). A painting of a caterpillar continuum is a partitioning of the noncut points into two sets, which we call black and white (or 0 and 1). Two noncut points are said to be adjacent noncut points if they are adjacent to the same point of order greater than 2. Two paintings are homeomorphic if there is a one-to-one correspondence between the noncut points in the black sets and the white sets that maps adjacent noncut points to adjacent noncut points. In the research performed, we count the number of nonhomeomorphic paintings of all of the caterpillars with n points of order greater than 2, for n = 0, 1, 2, 3 and 4, in an effort to determine the number of paintings for a general n.

05.13.15 Convincing Students That Old Dogs Can Learn New Tricks

Bradley, Paynter

University of Central Oklahoma

Non-math majors are often apprehensive about taking a math course. They bring with them significant baggage from earlier classes that has convinced them that they are no good at math and cannot learn. Following the work of C. S. Dweck, I have developed an idea to try and change this mindset in my Business Calculus students using my own poor basketball skills as an analogy. This poster will present some of the materials developed (including evidence of the aforementioned terrible basketball) and student reactions.

05.13.16 A Heuristic to Dynamically Determine the Minimum Graduation Time for Students

Bradley, Paynter , Kristina Sundy, Spencer Harris

University of Central Oklahoma

Minimizing the number of semesters a student must take in college before graduation can help students find a paying job faster, minimize per-semester fees associated with the college, and reduce transportation, housing, and food costs for the student. This type of problem is an optimization problem requiring the creation of a schedule to minimize a given resource (in this case, semesters taken). The problem is complicated by several constraints; for example, the dependencies courses have on each other. In this project, a complex degree program including many dependencies and several concurrent dependencies was examined. To find solutions to the problem, a heuristic has been developed based on the Program Evaluation and Review Technique (PERT) and the critical path method (CPM).

05.13.17 Determining the Optimal Placement of the Quarantine Specialist in the Board Game "Pandemic"

Bradley, Paynter , Dominic Romano, Kristina Sundy, Nicholas Hardwick-HallSpencer Harris, Victoria Ford

University of Central Oklahoma

In the board game "Pandemic", players work cooperatively to treat and cure the global outbreak of four diseases. Each player has a unique role in the team and the optimal utilization of these roles is essential to success in the game. One possible role is that of the Quarantine Specialist. This player has the ability to prevent the spread of disease in the area of the board in which their player token is located. This research uses the technique of Integer Programming to find the optimal position on the board for the Quarantine Specialist for a given turn of the game. Constraints that need to be taken into account include the distance that the player can move in a single turn. As an objective, we minimize the expected number of new disease cases over the current round of the game. Extensive testing has verified the positive impact this technique has on the outcome of the game.

05.13.18 Proof Involving Biconditional Statements

Beautiful-Joy, Fields

Langston University

Biconditional statements are composed of two conditional statements. Statements can be verified, or proven, mathematically by different means. We were given a biconditional statement to prove; Let n belong to Z. Prove that 2|n4-3 iff 4|n2+3.This statement was successfully verified by proof by cases and a proof by contrapositive.

05.13.19 A Biconditional Proof

Kichelle, Henderson

Langston University

Biconditional statements are composed of two conditional statements. Statements can be verified, or proven, mathematically by different means. We were given a biconditional statement to prove; Let x,y belong to all integers. Prove that (x+1)y^2 is even if and only if x is odd or y is even. This statement was successfully verified by proof by cases and a proof by contrapaositive.

05.13.20 Explicit Formula Derivation of (a,b,c)–sequences using an Endomorphism Approach

Richard, Hwang , Andrew Bucki

Oklahoma School of Science and Mathematics

The purpose of this presentation is to derive a generic explicit formula for (a,b,c)–sequences. Calculating extremely large values of (a,b,c)–sequences is extremely difficult and cumbersome for computational purposes. Using special matrices we are able to increment three consecutive values of an (a,b,c) – sequence. We use linear algebra methods to reduce the total amount of steps required to calculate the nth term of the sequence. We also derive an explicit formula for the nth term of any (a,b,c,)–sequence. Additionally we explore manipulation of the behavior of (a,b,c)–sequences into special cases such as the Fibonacci Sequence.

05.13.21 Computational Thinking and Programming Approach in Teaching and Learning Processes

John, Kreidler , Andrew Bucki

Oklahoma School of Science and Mathematics

In this presentation, some ideas of the new educational program in Mathematics supporting STEM-C are presented. Elements of basic logic serve as illustrations of these ideas.

05.13.22 Richard Courant: "Gottingen is Here".

Charlotte, Simmons

University of Central Oklahoma

As many as 144 German-speaking mathematicians have been listed who were forced to leave their positions at German institutions following the 1933 Law for the Restoration of the Professional Civil Service. The "great migration of the 1930's" is said to have shifted the center of the mathematical world from Germany to the United States. Numbered among these emigrants is Richard Courant, who was "absolutely inexhaustible" and relentlessly pursued his dream of building an institute for advanced training in mathematics at New York University for nearly two decades. By 1958, the Courant Institute, which began as a suite of rooms in a girls' dormitory, was described as the "national capital of applied mathematical analysis." In this talk, we will discuss Courant's efforts to bring his experience in Gottingen to bear upon the state of science in America, as well as how he and other immigrants impacted mathematics in America during this important chapter in our history.

05.13.23 Effective Use of Online Video in Mathematics Education

Michael, Fulkerson , Kristina Stevenson

University of Central Oklahoma

Online learning of mathematics has exploded in popularity in recent years. While many math teachers would like to start making their own content available to their students online, it can be overwhelming to know where to start. In this poster, we discuss various methods for how to create online math videos as well as tips for making effective videos.