Jan 1st, 12:00 AM

13. Mathematics

Northeastern State University

Abstracts from the 2015 Oklahoma Research Day

Held at Northeastern State University

05. Mathematics and Science

13. Mathematics

05.13.01 Using Cauchy's Theorem

Karina,Chavez *East Central University*

This project draws on various aspects of abstract algebra dealing with Abelian groups—specifically, cyclic groups. In order to show that a particular Abelian group (of order 33) was cyclic, I focused on showing that it was true by using Cauchy's theorem instead of some other means. This project first identifies necessary definitions and theorems and this is followed by a thorough examination of the proof.

05.13.02 Fascinating Properties of 153

Adrienne,Pinkstaff *Northeastern State University*

The number 153 has many unusual properties. This project explores the properties of 153 with a focus on its narcissistic character. A proof is presented for the number 153 being the eventual sum of the cubes of digits of numbers divisible by three after a given number of cycles.

05.13.03 Roots of polynomials and their applications

Akinola,Akinlawon *Cameron University*

Ioannis,Argyros *Cameron University*

We introduce a special class of real recurrent polynomials of degree n,(n a natural number) with unique positive roots, which are decreasing as n increases. The first root as well as the last root are expressed in closed form and enclose all in between roots. Some applications are also provided in this study.

05.13.04 Determining the Topological Connections Between Diamond and Lonsdaleite

Michael,Fulkerson *University of Central Oklahoma*

Wenwen,Li *University of Central Oklahoma*

Diamond and Lonsdaleite are two different allotropes of carbon that have hexagonal lattices. Their structures have different symmetry characteristics, but the symmetry alone is not able to fully reflect the differences between Diamond and Lonsdaleite. The purpose of this project is to determine the topological differences between the two structures by fundamental group theory and covering spaces. In this project we calculate the deck transformation groups of Diamond and Lonsdaleite.

05.13.05 Antitumor Laser Immunotherapy: A Mathematical Model and Analysis

Bryan,Dawkins *University of Central Oklahoma*

Sean,Laverty *University of Central Oklahoma*

We present a mathematical model describing the immune-mediated dynamics of primary and metastatic tumor cell populations treated with laser immunotherapy. We explicitly model dendritic cell and cytotoxic T cell dynamics in the immune response to treatment. Also included in the model are tumor antigens, which are tumor-specific proteins released during tumor irradiation by laser and tumor cell death via cytotoxic T cells. We present the qualitative cases that our model simulations predict as a function of key parameters directly influenced by regulatory T cells. Using these key parameters, we describe conditions for successful and unsuccessful treatment. The qualitative cases of our model simulation will be compared to experimental tumor burden data.

05.13.06 An ANALYSIS on the BEIGE BOOK'S DALLAS DISTRICT

Ashley,Huhman *East Central University*

The Beige Book is an anecdotal and economically relied report released through the Federal Reserve. My research will explore comparing the anecdotal to the factual data gathered from a variety of sources. Through rigorous statistical methods and testing, we will demonstrate evidence for comparison. Results will either show economic relevance or that testing needs to continue.

05.13.07 Mathematical Observations of Ventral Horn Cells in Xenopus Laevis

Brittany,Myers *University of Central Oklahoma*

Lance,Ford *University of Central Oklahoma*

The number of cells that live in the ventral horn region of the Xenopus Laevis have been recorded in a paper by M.C. Prestige. The cells can be observed as living and degenerating cells. One leg was amputated at different stages and for each amputation the number of cells in the ventral horn were recorded. In our research, we used the data to model the behavior of cells in the ventral horn using age-structured partial differential equations. We use this model to study the behavior of cells in the ventral horn.

05.13.08 Estimates on Minimal Perfect Order Subset Groups

Michael,Fulkerson *University of Central Oklahoma*

Shanta,Ghosh *University of Central Oklahoma*

In this research we explore a certain class of finite groups, called perfect order subset groups. A group is said to have perfect order subsets (POS) if the number of elements of any given order divides the order of the group. The study of these groups involves both number theory and abstract algebra. These groups were first defined and investigated by Carrie Finch and Lenny Jones. We explore here both abelian and nonabelian POS groups, and we find a size estimate on minimal POS groups whose order is not divisible by 5.

05.13.09 Summations and Squares

Vikki,Orso *East Central University*

This presentation looks at some commonly used summation formulas and also look at how the geometrical shape of a square connects to them. We prove these formulas using a couple of different methods, some algebraic and other geometric, and show how the square connects through a proof of induction.

05.13.10 Population Dynamics of Myotis Velifer in Oklahoma

Brenden,Balch *University of Central Oklahoma*

Sean,Laverty *University of Central Oklahoma*

Cave bats or Myotis Velifer have distinct population patterns that change year to year. This project uses mathematics to model population dynamics of Myotis Velifer in Oklahoma caves. More specifically, the bats that stay in Oklahoma during the wintertime are investigated. It is thought that the resident bats that stay and hibernate have the greatest influence on the overall population patterns of Myotis Velifer in Oklahoma. The baseline model will be extended to look at other factors that could affect the population of cave bats, including weather, diseases, and other environmental factors.

05.13.11 Multiple Solutions for a Fourth Order Boundary Value Problem

Britney,Hopkins *University of Central Oklahoma*

Kristi,Karber *University of Central Oklahoma*

Olivia,Bennett *University of Central Oklahoma*

Thomas,Milligan *University of Central Oklahoma*

This poster describes a process for transforming a fourth order differential equation into a system of second order equations satisfying homogeneous boundary conditions. We follow this by providing proofs of two lemmas that give estimates on a defined operator. These lemmas in conjunction with two others allow for the application of the Guo-Krasnosel'skii Fixed Point Theorem, which yields multiple positive solutions.

05.13.12 The Effect of Platelets on the Degradation of Blood Clots

Ara,Han *University of Central Oklahoma*

Brittany,Bannish *University of Central Oklahoma*

Fibrinolysis, the degradation of blood clots, is initiated by tissue-type plasminogen activator (tPA). However, tPA is inhibited by a molecule called PAI-1, which is secreted by platelets. The presence of both PAI-1 and platelets affects how easy the clot is to degrade. Thus, we use mathematics to study how the configuration of platelets and the presence of PAI-1 affects the degradation of clots. We investigate how the distribution and the different amount of platelets and PAI-1 affects the degradation rate by using a stochastic model to count the fibers in a blood clot as time progresses.

05.13.13 M-harmonic Functions on the Unit Ball

Michael,Fulkerson *University of Central Oklahoma*

We investigate properties of a class of real-valued functions on the unit ball in n-dimensional complex space, called M-harmonic functions. These functions are defined by a differential operator, called the invariant Laplacian. An important result is that a function on the unit ball is the real part of a holomorphic function if and only if it is both harmonic and M-harmonic.

05.13.14 An Initial Heuristic to Dynamically Generate a Student's Optimal Course Schedule

Bradley,Paynter *University of Central Oklahoma*

Kristina,Sundy *University of Central Oklahoma*

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. Previous work has developed a heuristic based on the Program Evaluation and Review Technique (PERT) and the critical path method (CPM). This heuristic finds the critical courses and has been implemented in C++. The next stage of development is another heuristic to turn this critical path information into an actual schedule of courses. We present the implementation details of the former heuristic and the initial progress on the latter.

05.13.15 Developing a Station Rotation Schedule for Vacation Bible School

Bradley,Paynter *University of Central Oklahoma*

Janice,Ford *University of Central Oklahoma*

Ryan,Hoffpauir *University of Central Oklahoma*

Many day camps for children (like Vacation Bible School) are run on a station model. That is, children are divided into groups and activities are divided into stations. The groups of children then move between activity stations on a pre-arranged schedule. This system has several advantages including that regular transitions work well with children's short attention spans and volunteers only have to deal with small groups of children at a time. The disadvantages to this system are that it may not be the most efficient use of volunteer labor and scheduling by hand can be a complicated endeavor. We model this problem as an Open Shop Problem with unit processing times and modify standard algorithms to work with constraints specified by a customer organization.

05.13.16 Saving Lives One Ambulance Trip at a Time

Bradley,Paynter *University of Central Oklahoma*

Jake,Burdine *University of Central Oklahoma*

Jordan,Michela *University of Central Oklahoma*

Robert,Smith *University of Central Oklahoma*

In emergency situations, a person may lean towards calling 911 for an ambulance. From the scene of the accident, the victims are rushed to a hospital where their injuries can be taken care of. When you have multiple hospitals in the area, which one would be best to send the patient to? Problems could result from having a shortage in doctors, a delay, no rooms available, or even no one specializing in that specific injury. So how do you come up with the best solution without worsening the condition of the patient? How do you get to see the doctor in the quickest way possible? If one hospital is full of very severe injuries, is it possible that driving to the furthest hospital would be the best for that patient? We model this problem using Queueing Theory.

05.13.17 Vector Matrix Representations of Non-Associative Moufang Loops of Order 2n.

Kyle,Reeves *East Central University*

Moufang loops are quasigroups which contain an identity element and satisfy the Moufang identities. A method published by Orin Chein details the construction of non-associative Moufang loops of order 2n from non-abelian groups of order n. The feasibility and utility of representing certain of these with vector matrices is examined.

05.13.18 Distinguishing the Distinguishing Game Number for Graphs

Connor,Allen *Northeastern State University*

The distinguishing number for a graph is the minimum number of colors required to color the vertices of a graph so that the only color preserving automorphism that exists is the identity. The game distinguishing number is the minimum number of colors needed so that Alice is always able to provide a distinguishing coloring of the graph in play against her adversary, Bob. It is known that the distinguishing number is less than or equal to the game distinguishing number for any given graph. This creates an interesting question: Can we use the game distinguishing number to provide sharper upper bounds for the distinguishing number? To find out more about game distinguishing numbers for graphs we created a program to play the game over a wide array of graphs. In this game Alice and Bob are presented with a generated graph. They try and decide which vertices, of the uncolored, to color and which color to use on that said vertex that still allows for an eventual distinguishing coloring. Each player gets a turn until all vertices are colored. This is automated to make the best choice possible. We will then examine the results and talk about our findings.

05.13.19 Direct Numerical Simulation of the Origin of Flow Chaos at Late Boundary Layer Transition over a Flat Plate.

Manoj,Thapa *University of Central Oklahoma*

The transition process from laminar to turbulent flow in boundary layers is a basic scientific problem in modern fluid mechanics and has been the subject of study for over a century due to its great importance in various engineering applications. Delaying laminar-turbulent transition definitely reduces the skin friction at the wall and hence reduce fuel consumption in many flows of practical interest. However, designing and optimizing devices for skin-friction reduction requires a fundamental understanding of transition mechanisms and phenomena. This paper is devoted to the investigation of the origin and mechanism of chaotic flow (asymmetric flow) in late boundary layer transition over a flat plate without pressure gradient. After carefully analyzing our recently conducted high order direct numerical simulation (DNS) results, we exhibit an entirely new approach about the origination and evolution process of flow chaos in late boundary layer transition. The direct relation between small scale vortices generation and skin-friction production, the mechanism of boundary-layer thickening are also discussed.