We are delighted to host the Southwestern Undergraduate Mathematics Research Conference this year. It is our pleasure to extend a warm El Paso welcome to you all! We hope you will enjoy the presentations and be motivated to pursue a career in STEM research.

Time	**Speaker**	
Friday		
4:30 - 5:45 pm	Registration	
5:45 - 6:00	Welcome - Drs. Natalicio, Kirken, Mariani	
6:00 - 7:00	Dinner BUSN 312	
7:00 - 8:00	Prof. M. Zuhair Nashed	
8:00 - 9:30	Student Social / Moderators Meeting / Faculty Meeting	
Saturday		
9:00 - 9:20 am	S. Mundy	N. Addleman
9:25 - 9:45	P. Doi	R. Ford
9:45 - 10:10 am	Break BUSN 312	
10:10 - 10:30	J. Hunt and Z. Parker	J. Tillay
10:35 - 10:55	D. Malcolm	P. Colmenares
11:00 - 12:00 pm	Prof. Niall Ives Gaffney	
12:00 - 1:30	Lunch BUSN 312	
1:30 - 1:50	S. Lubold	J. Barraza
1:55 - 2:15	L. Crider	M. Shearer
2:20 - 3:20	Prof. Benedict H. Gross	
3:20 - 3:45	Break BUSN 312	
3:45 - 4:05	J. Cianci	E. White, L. Heath
4:10 - 4:30	K. Luna	B. Preston, N. Diefenderfer
4:35 - 4:55		M. Hastings, H. Prawzinsky, A. Whittemore
5:00	Closing	
6:00 - 7:00	Dinner BUSN 312	
7:30 - 9:30?	Centennial Museum tour / Game Night	
Sunday		
9:00 - 9:20 am	W. Lough	M. Theobald
9:25 - 9:45	J. Lira	R. Bozkurt
9:45 - 10:10	Break and Math Contest Trophy Presentation BUSN 312	
10:10 - 10:30	J. Viramontes and N. Jimenez	B. Anderies
10:35 - 10:55	K. Patel	M. Walker
11:00 - 12:00 pm	Dr. Bruce T. Myers	
12:00 - 1:00	Lunch BUSN 312	

Friday evening, February 27, 2015
Room: BUSN 309

7:00–8:00 **M. Zuhair Nashed**, University of Central Florida
Inverse Problems Across the Undergraduate Curriculum

The subject of inverse problems and ill-posed problems is an important research area in contemporary applied mathematics, engineering and the applied sciences. The purpose of this talk is to inspire undergraduate students to conduct research in this subject. After providing some perspectives and important examples of inverse problems, we discuss examples of inverse and ill-posed problems across the undergraduate curriculum, including trigonometry, calculus, differential and integral equations, linear algebra, vector analysis, signal processing, calculus of variations and control theory.

Saturday morning, February 28, 2015
Room: BUSN 309

11:00–12:00 **Niall Ives Gaffney**, University of Texas at Austin
Data is the New Black:
The Future of Data Driven Insight

It takes little analysis to detect the current buzz around "Big Data", but what does it all mean? What of the many promises to come out of the current hype will lead to useful results and meaningful outcomes? How will advances in computational hardware, software, and algorithms improve how we work with data? And how will the changes that come from current and future data scientists change the way we ask questions of the world around us? These are the questions that will be answered in the coming years as the impact of advances in data research are fully understood. In this talk, I will talk about the past and current state of Data Science and Data Systems, where the field is and is going, and why, as the current hype surrounding "Big Data" goes away, it will be replaced with real impactful results that will act as the foundation for working and understanding with the large complex systems that make up our world. At the heart of this new method of research will be the data scientists that understand how to combine data, algorithms, statistics, and field-specific knowledge in ways to help people make sense of the massive quantities of data now available in fields ranging including cosmology, finance, healthcare, and history.

Saturday afternoon, February 28, 2015
Room: BUSN 309

2:20–3:20 **Benedict H. Gross**, Harvard University
The function $n \to n!$

One of the early applications of integral calculus was an estimate for the growth of the function $n! = 1 \cdot 2 \cdot 3 \cdot 4 \cdot \ldots \cdot (n-1) \cdot n$, first by de Moivre and then by Stirling. Euler refined their estimates by introducing the Gamma function on the positive real line, which took these values on the positive integers. I will discuss some of this material, and end with the definition of a p-adic Gamma function, which enjoys many similar properties.

Sunday morning, March 1, 2015
Room: BUSN 309

11:00–12:00 **Bruce T. Meyers**, National Security Agency
Mathematics Today at the National Security Agency

An overview of how the role of mathematicians at NSA is continually evolving in response to the ever changing world of communications technology.

Saturday morning, February 28, 2015
Room: BUSN 321

9:00–9:20 **Sam Mundy**, University of New Mexico
On The Existence of Perfect Morse-Bott Functions

In this talk, I want to pose the following question: Which smooth manifolds M have the property that every perfect Morse-Bott function on M is actually Morse? I will give an introduction to the basic ideas of Morse theory and then present some results on this question. For instance, spheres have this property, while general products of manifolds do not.

9:25–9:45 **Philip Doi**, Northern Arizona University
The Toronto Problem

In point-set topology, a Toronto Space is a topological space that is homeomorphic to every subspace of the same cardinality. The Toronto Problem asks if there is a non-discrete Hausdorff Toronto space of cardinality aleph-one. We will examine some of the literature known about Toronto spaces and will suppose the existence of non-discrete Hausdorff Toronto spaces, reviewing known results about these hypothetical spaces. Additionally, we will discuss the notion of logical independence for mathematical statements within the scope of axiomatic set theory; a notion that pertains to understanding the problem's full nature.

10:10–10:30 **Jordan Hunt and Zachary Parker**, Northern Arizona University
Eisenstein Amicable Pairs

An amicable pair (m, n) is a pair of positive integers with the property that the proper divisors of m sum to n and vice versa. In 2013, R. Clark discovered a complex analog to amicable pairs in $\mathbb{Z}[i]$, the ring of the Gaussian Integers. In this presentation, we will present our progress towards classifying amicable pairs in another unique factorization domain, $\mathbb{Z}[w]$, the ring of Eisenstein Integers.

10:35–10:55 **Daniel Malcolm**, Northern Arizona University
Quotients and Pure Braid Groups and Their Graphical Representations, Preliminary Report We will explain the meaning of group presentation, with examples. We will then define braid groups and their pure braid groups, giving presentations, as well as the geometric meaning in terms of braids. Then we show how a simple graph gives rise to a quotient of the pure braid group. We report on progress toward the classification of these groups, and give examples.

Saturday morning, February 28, 2015
Room: BUSN 313

9:00–9:20 **Nikhil Addleman**, University of New Mexico
A Stochastic Model of Childhood Disease on Metapopulations

Central to the study of disease ecology is the question of when and under what conditions do endemic diseases go locally extinct. The deterministic SEIR model framework, named for its compartmentalization of host populations into susceptible, exposed, infected, and recovered classes, remains a powerful tool in the arsenals of infectious disease researchers. However, when demographic factors such as births and deaths in each population are included in the basic model's differential equations, diseases which undergo epidemics, that is, those diseases whose basic reproductive rate $R_0 > 1$, never experience extinctions. We attempt to overcome this failure of the model to emulate real phenomena by producing a stochastic model utilizing a tau-leap approximation of the Gillespie algorithm which employs Poisson distributed random variables to update each population over a fixed time interval. The model is structured to study the effects on extinction and persistence which varying degrees of inter-population connectivity have on collections of populations.

9:25–9:45 **Raymond Ford**, University of Texas at El Paso
Statistical and Computational Techniques Assisting in the Identification of Potential Enhancer Elements for the Genes Expressed in the Gamma Neurons of Drosophila

Several existing bioinformatics software for identifying DNA motifs are combined with a novel tool to develop a new approach for identifying potential enhancer elements for a set of genes related to learning and memory in Drosophila. Using six different DNA motif discovery software tools, 160 conserved motifs among the DNA sequences driving mushroom body expression were identified. Two different approaches were taken to identify DNA motifs among 28 lines known to display gamma-lobe expression: the first based on the length of individual line sequences, and the second based upon stochastic line selection. The FASTA files for all HHMI Janelia Farm lines were computationally searched to determine if any of the discovered motifs were present in these sequence data. Eight candidate DNA motifs were identified. The frequency of each motif's occurrence was noted among the 28 lines displaying gamma-lobe expression against 28 randomly selected lines known to not display gamma-lobe expression. The Fisher's exact test and Chi-Square test of homogeneity was performed for each motif and the p-values were compared to a level of significance established with the use of a Bonferroni correction. This talk focuses on the computational and statistical techniques that are being used to assist with the identification of potential enhancer elements for the genes expressed in the mushroom body gamma neurons.

10:10–10:30 **Jeremy Tillay**, Louisiana State University - Baton Rouge
Spectrum of Propagating and Evanescent Fields on Half-Cut Tubes Modeled by Quantum Graphs.

This project is concerned with quantum graphs that model tubes supporting a field of energy with two dimensions of periodicity. The model we observe is very similar to the often-studied carbon nanotube, though our quantum graph does not exactly mimic graphene. We are concerned with finding what kind of states of motion are possible on a half-cut tube with self-adjoint boundary conditions and what spectra of frequency allow these states of motion. For the model to represent a physically meaningful tube, we impose vertex conditions that model conservation of energy. In doing so, we find useful relations between frequency and the relative energy at each point on the tube. Furthermore, we can examine the vertices at the edge of the tube, where the cut is made and determine exactly what conditions must be met for the system to be conservative or self-adjoint. Not all conditions can be satisfied by all fields and not all fields can satisfy a set of self-adjoint conditions. So we investigate which fields could possibly exist on a tube that conserves energy. Investigating this simpler system could reveal characteristics of the more complicated carbon nanotube made of graphene.

10:35–10:55 **Paola Colmenares**, University of Arizona
Survival Analysis with High Censoring Rates

Only recently has there been significant progress in developing better estimators for stochastically ordered survival functions. We will discuss a new approach that will perform better in terms of mean squared error for large classes of examples and for the case of censored data. The estimators we have created were influenced by Rojo's (2004) estimators, and this project focuses on the case when there is a high censoring rate. We will also emphasize the importance and need of stochastic ordering in fields outside statistics. A comparison between the proposed estimators and Rojo's (2004) and the Point-Wise Constrained (Park et al., 2012) estimators will be demonstrated. In conclusion, we will show simulations that will exhibit that the proposed estimators yield better results in terms of the mean squared error.

Saturday afternoon, February 28, 2015
Room: BUSN 321

1:30–1:50 **Shane Lubold**, Arizona State University
Detecting Edges in Piecewise Smooth Functions from Fourier Data

The detection and characterization of changes or edges in signals is important in a number of signal-processing applications. Many of these applications collect data in the Fourier domain, which makes edge detection difficult because Fourier data are global, while edges are local features. The concentration factor method uses a first order accurate relationship between Fourier coefficients and the edges of the corresponding unknown function to devise a family of band pass filter (the concentration factors) that generates an approximation concentrating at the singular support of the underlying function, thereby detecting its edges.

In recent results, concentration factors were reverse-engineered based on this first order relationship between the Fourier coefficients and its corresponding edges. Specifically, concentration factors were constructed to find the edges of a saw tooth function. It is clear that for applications in which the underlying function has more variation between the edges, the concentration factor method may not be effective. Hence we develop new concentration factors that allow for more variation between the edges. The covariance of the different concentration factors enables us to predict edges in piecewise analytic functions with multiple jumps.

1:55–2:15 **Lauren Crider**, Arizona State University
Value of Information Sharing in Signal Network Detection

Coherence estimation is an established approach in multiple-channel detection and estimation, providing optimal solutions in many cases. Recent work has considered the use of maximum-entropy matrix completion when elements are missing from the gram matrix from which the coherence statistics are formed. This is desirable in sensor network settings, for example, where direct communication is not available between every pair of nodes in the network. This talk demonstrates detection performance in such scenarios where maximum-entropy methods are used to "surrogate" data for sensors that may not be in direct communication, providing a mechanism for quantifying the value of information sharing within the network. The relationship between the topology of the network graph and the conditional distributions of the data obtained via maximum-entropy methods is further discussed.

3:45–4:05 **Juan Pablo Madrigal Cianci**, University of New Mexico
Study Modifications of the Black Scholes Equation

The financial markets are, by nature, full of risk. If we add the potential of mismanagement to this inherent risk, we might face another market crash, like the one during 2008-2009. That is why, over the time, mathematicians, physicists and some of the brightest minds in the financial industry have proposed several models to quantify risk, and, in an effort to make better decisions, to try to predict the future value of an asset. Perhaps the most important and most widely known equation in the field of stock option pricing is the Black-Scholes equation, an equation that, under certain conditions, can give us the theoretical price of a European style option. Another broadly used model is the binomial model (proposed by Cox, Ross and Rubinstein in 1979) which provides a generalizable numerical method for the valuation of options. Essentially, the model uses a "discrete-time" model of the varying price over time of the underlying financial instrument. In general, binomial options pricing models do not have closed-form solutions. As we shall see, the black Scholes model needs some assumptions, like taking the volatility as a constant. In this project,I will study the implications of having a non-constant (i.e, being a function of the underlying) or random volatility (stochastic or pseudo random) volatility for both the Black Scholes and Binomial model. I will also study their relation to each other and the heat equation.

4:10–4:30 **Kevin Luna**, Northern Arizona University
The Gradient Newton Galerkin Algorithm and Its Application

The Gradient Newton Galerkin Algorithm (GNGA) is a computational algorithm for finding numerical solutions to partial differential equations. The GNGA can be readily applied to the family of nonlinear elliptic PDEs of the form $\Delta u + su + f(u) = 0$ with Dirichlet boundary conditions on some piecewise smooth region that is a subset of $\mathbb{R}^n$, where $f(u)$ is the non-linearity of the PDE, and $s$is a parameter. In this talk the GNGA will be discussed, and results from its application on the interval $[0, \pi]$ and the square region $[0, \pi] \times [0, \pi]$ will be examined when the non linearity is set to be $f(u) = u^3$.

Saturday afternoon, February 28, 2015
Room: BUSN 313

1:30–1:50 **Jay Barraza**, Arizona State University
Puzzle Modeling:Lights Out

Lights Out is a puzzle game where the goal is to turn off all the lights on a $n \times n$ board starting from a random configuration. In order to find the solution of a configuration, the game is constructed using a matrix basis. The initial configure or "state" is defined to be a $n \times 1$ vector column s. The "pushes" are defined as a $n \times 1$ column vector p and $\mathbf{A}$ is defined as the "Action Matrix" which is the $n \times n$ matrix composed of all the configurations of pushes on the board. Thus the game can be defined by the system $\mathbf{A}p = s$ which will be the center of the investigation when determining the solution for an $n \times n$ board. The goal is to determine if $\mathbf{A}$ is invertible such that $p = \mathbf{A}^{-1}$s where p are the pushes that would get the player to the desired state which in this case is all the lights off. The topic of this thesis will mainly explores the 5×5 due to the fact that not every configuration has a solution due to the matrix basis being singular. From there, we will discuss the higher dimensions and show how the solution may not work for those cases while investigating for which n the problem is solvable. This leads to some interesting properties for the $n \times n$ system.

1:55–2:15 **Meagan Shearer**, The University of Arizona
Models of Two-Sided Matching

We explore ways to increase the optimality of a one-sided optimal match for the agents who the match is not optimal for. We found three types of stable matches over a set of 100 agents (50 men and 50 women in context to Gale and Shapley's Stable Marriage Problem. The methods of stable matches explored were male-optimal, female-optimal, and two-sided optimal. The male-optimal match is found by the method developed in the Stable Marriage Problem. We found that limiting the amount of agents ranked in the opposite subset creates an internally stable match, which increases the optimality of the match for the women in the male optimal match. Our results lead to a match that is more optimal for both men and women than the two-sided optimal outcome, but with a low amount of agents unmatched.

3:45–4:05 **Emily White and Levi Heath**, Northern Arizona University
New Results on Prime Vertex Labelings: Part I

A prime vertex labeling is an injective assignment of the labels $\{1, 2, ..., n\}$ to the vertices of an n-vertex simple connected graph such that adjacent vertices receive relatively prime labels. We will present new labelings for several infinite families of graphs. This talk is part I of a series of three talks. Neither prior knowledge nor attendance at related talks is necessary.

4:10–4:30 **Nathan Diefenderfer and Brianna Preston**, Northern Arizona University
New Results on Prime Vertex Labelings: Part II

A prime vertex labeling is an injective assignment of the labels $\{1, 2, ..., n\}$ to the vertices of an n-vertex simple connected graph such that adjacent vertices receive relatively prime labels. We will present new labelings for several infinite families of graphs. This talk is part II of a series of three talks. Neither prior knowledge nor attendance at related talks is necessary.

4:35–4:55 **Michael Hastings, Hannah Prawzinsky, and Alyssa Whittemore**, Northern Arizona University
New Results on Prime Vertex Labelings: Part III

A prime vertex labeling is an injective assignment of the labels $\{1, 2, ..., n\}$ to the vertices of an n-vertex simple connected graph such that adjacent vertices receive relatively prime labels. We will present new labelings for several infinite families of graphs. This talk is part III of a series of three talks. Neither prior knowledge nor attendance at related talks is necessary.

Sunday morning, March 1, 2015
Room: BUSN 321

9:00–9:20 **Wilson Lough**, Northern Arizona University
Determinant Spectra of Quartic Root of Unity Matrices

For any natural number n finding all possible determinant values of n-by-n matrices with entries restricted to the set $\{+1, -1\}$ is known as the determinant spectrum problem. For n less than or equal to 7 the spectra consist of sets of consecutive integers in arithmetic progressions, but gaps appear in the spectra for n greater than or equal to 8. In this talk, I will present results involving the spectra of n-by-n matrices with entries restricted to the set $\{+1, -1, +i, -i\}$.

9:25–9:45 **Jasiel Lira**, Clint Early College Academy
Perfection: Golden Ratio

The quantity of the golden ratio is approximately equivalent to 1.61803398875, but what is it exactly and how do we perceive it? As the golden ratio has been thought to determine beauty and perfection, I share my results by experiment and using the multi-platform mathematics software - GeoGebra .

10:10–10:30 **Jesus Viramontes and Noel Jimenez**, El Paso Community College
Learn How S-STEM Students Receive Great Expertise in the STEM Fields

Learn and share with your students the details of the EPCC S-STEM program.The aim of this program is to increase the retention of full-time Science, Technology, Engineering and Math (STEM) students through learning experiences geared towards interdisciplinary collaboration between all STEM fields. We will share the experiences received by the current cohort.

10:35–10:55 **Karlan Patel**, The University of Arizona
MathCats: The Undergraduate Math Club at the University of Arizona

The MathCats Club at the University of Arizona is open to any undergraduate who wants to be involved in Mathematics outside his or her courses. The club is involved in a variety of activities that serve other UA students and the surrounding community of Tucson, AZ. The officers of the club will describe how the club has effectively tutored UA students and has extended to helping others in the community.

Sunday morning, March 1, 2015
Room: BUSN 313

9:00–9:20 **Melissa Theobald**, Northern Arizona University
Cycles in various nonlinear, age-structured population models

We consider N-dimensional, age-structured models of the normally 1-dimensional Beverton-Holt, Ricker, and Pennycuick population models. Our particular interest is in the impossibility of certain p-cycles in models of corresponding dimension.

9:25–9:45 **Rumeysa Nalan Bozkurt**, North American University
Derivation of Stochastic Prey-Predator Equations for Mnemiopsis leidyi and Beroe ovata in Black Sea

Since 1988, Black Sea ecosystem has experienced a huge invasion because of the accidentally introduced comb jellies Mnemiopsis leidyi & Beore ovata from Atlantic Ocean. In the present investigation, we observed and studied prey-predator relationship of these comb jellies in Black sea ecosystem. Deterministic and stochastic logistic prey growth and Lotka-Volterra models are derived for these species. To derive these models, the changes with their respective probabilities are carefully studied. A discrete stochastic model is first derived. As the time interval decreases, the discrete prey-predator model leads to a certain It$\bar{o}$ stochastic differential equation model. Comparisons between the stochastic models' numerical solutions and real data showed that the models are correct.

10:10–10:30 **Barrett Anderies**, Arizona State University
Computational Modeling of Murine GL261 Brain Tumors

We Consider stochastic parameterizations of a diffusion logistic growth model:

$$\frac{\partial u}{\partial t} = \nabla \hat{A}\dot{(}D\nabla u) + \alpha u(p-u)$$

Initial conditions and boundary conditions are generated from T2 weighted MRI data from a Murine in vivo brain tumor experiment. An Ornstein-Uhlenbeck process is used to generate stochastic values for D and α. Ensemble simulations are run with varying stochastic parameters and initial conditions. The results of each ensemble are used to generate an average simulated tumor for the given set of parameters and initial conditions. These simulations are then compared to the experimental data. Data were collected from immunocompetent mice with artificially implanted GL261 brain tumors. Tumors were allowed to grow for a twenty-five day period and each mouse underwent an MRI scan on days 11, 15, 18, 22, and 25 after implantation. Our simulation tumor volumes were within 0.5 mm^3 of observed tumor volumes, and tumor cell distribution matched closely with observed T2 weighted MRI data.

10:35–10:55 **Melody Walker**, University of New Mexico
With-in Host Models of Dengue

Dengue is a mosquito-borne disease that the World Health Organization estimates infects 50 to 100 million people every year. The dengue virus consists of four different serotypes, which the human immune system recognizes as four distinct but related viruses. It is thought that once infected with one serotype (primary dengue virus infection), an individual develops long-lasting immunity to that specific type. If the same individual is then infected with a different serotype (secondary dengue virus infection), there is an increased likelihood of more severe symptoms such as dengue hemorrhagic fever.
In this talk, I will discuss and compare three different with-in host mathematical models of dengue virus-immune interactions from the literature. My goal is to develop a model that incorporates different elements from these studies to test whether the increased likelihood of dengue hemorrhagic fever during secondary infection can be explained by the timing of primary compared to secondary infections.