ST. NORBERT COLLEGE

1898

C O L L E G E

DE PERE, WISCONSIN

Twenty-Ninth Annual

Pi Mu Epsilon

Regional Undergraduate Math Conference

November 7 – 8 , 2014

Featured Speaker: Colin Adams
Williams College

FRIDAY EVENING

5:00   **Registration**, conversation, coffee, juice, fruit, and rolls in Cofrin basement lounge

STUDENT TALKS

Time	COF 11	COF 15
5:40	**Lauren Miller** **Carthage College** Searching for a New Knot Invariant	**Marissa Hartzheim** **St. Norbert College** A Particular Polarity, Part I
6:00	**Ben Weber** **Carthage College** Generalizations of Riemann's Rearrangement Theorem to Complex Numbers	**Taylor Miller** **St. Norbert College** A Particular Polarity, Part II
6:20	**Micole Gauvin** **Carthage College** A Problem With Baseball Hats	**Ryan Weber** **Marquette University** Peg Solitaire Variant on Various Graph Classes
6:40	**Tyler Shimek, Lincoln Wurtz, and Erin Frassetto** **Ripon College** Exploring 3-Manifolds with Computers	**Mitchell Krock** **Bradley University** Donuts and Data
7:00	**Jeremiah Fogarty** **Bethany Lutheran College** Penney Ante: An Exploration and Expansion on Random Selection	

7:30 - 8:30   **COLIN ADAMS**   Cofrin 11
                              "Blown Away: What Knot to Do When Sailing"

8:30 – 9:30   **Face Off! The Mathematics Game Show**   Cofrin 11
                    Ken Price, Steve Szydlik, John Koker, UW - Oshkosh

9:30 - ?   Pizza in Cofrin Basement Lounge

SATURDAY MORNING

8:30   **Registration**, conversation, coffee, juice, fruit, and rolls in Cofrin basement lounge

STUDENT TALKS

Time	COF 11	COF 15
9:30	**Kesley Zimmermann** **Benedictine University** Persistence in A Pulse Vaccination SVEIR Model with a Saturation Incidence Rate and Time Delay	**Mfoniso Ekong** **Benedictine University** Bifurcations in the Dyamics of a Continuous Model for Gene Regulatory Networks
9:50	**Nwafor Nwoke** **Benedictine University** A Stage Structured Integrated Pest Management Model with a Holling Type II Functional Response	**Hannah Wangler** **Benedictine University** Is This The End for Facebook?
10:10	**Rachel Majerczyk** **Benedictine University** An Integrated Pest Management Model with a Holling Type II Functional Response	**Samuel Larimer** **Purdue University, Calumet** A Latently Infected Cell Inclusive Model for HIV Dynamics
10:30	**Maryam Moeed** **Benedictine University** Persistence in A Pulse Vaccination SVEIR Model with a Half Saturation Incidence Rate	**Erin Sullivan** **UW Stevens Point** What are the Hyperreals?

11:00 - noon   **COLIN ADAMS**   Cofrin 11
"Zombies & Calculus: A Survival Guide"

DETAILED PROGRAM

Friday, November 1

5:00 p.m.   Registration, socializing, cookies, and soda in Cofrin basement lounge.

5:40 - 7:15   **Student Talks** in Cofrin 11 and Cofrin 15

5:40 – 5:55
COF 11   **Lauren Miller, Carthage College**
              Searching for a New Knot Invariant
              This presentation examines topology and how it differs from Euclidean
              Geometry. It also includes an introduction to the history of knot theory and
              describes some important concepts in this area of mathematics. We then
              discuss ongoing research in using graphs of the curvature and the speed of a
              knot to find a new knot invariant. This invariant could be used to determine
              the behavior of a knot without using a representation of the knot itself.

COF 15   **Marissa Hartzheim, St. Norbert College**
              A Particular Polarity, Part I
              In projective geometry, a polarity is a kind of correlation between points and
              lines that preserves incidence. One such correlation associates points (a, b)
              in the Cartesian plane with non-vertical lines $y = ax - b$. We will discuss this
              polarity and explore some of its properties.

6:00 – 6:15
COF 11   **Ben Weber, Carthage College**
              Generalizations of Riemann's Rearrangement Theorem to Complex
              Numbers
              In this talk, we will discuss Riemann's rearrangement theorem for sequences
              of real numbers. Continuing on, we will discuss previous generalizations of
              the theorem to the n dimensional case. Because of the difficulty of that proof,
              we present a more approachable proof for the case of complex numbers. The
              talk presents the current strategy we are taking to the problem, and the
              progress we have made.

COF 15   **Taylor Miller, St. Norbert College**
              A Particular Polarity, Part II
              A special polarity in the Cartesian plane associates points (a, b) with non-
              vertical lines described by the equations $y = ax - b$. In this talk, we will look
              into the possibility of extending this correlation to a three-dimensional
              version.

6:20 – 6:35
COF 11 **Micole Gauvin, Carthage College**
A Problem With Baseball Hats
A young baseball player piles n hats by each door of his house. When he leaves, he takes a hat, and when he returns, he tosses his hat on the pile by that door. In our problem we consider how many times, on average, a young baseball player will go out to practice and back into his house before his stack of baseball hats by the door he exits runs out. We will begin with an examination of a house with two doors to determine a formula that calculates how many cycles the boy will run through before he goes to grab a hat as he leaves the house, but instead finds an empty stack. We will then broaden our focus, as we start to consider the implications other such nuances and alterations might bring to the problem, looking at what happens when we add an additional door, evaluate the variance surrounding our average (that is the greatest and least number of times before he loses the hat), introduce the very likely probability that the boy could lose a hat and so forth. Thus we will see the problem with baseball hats as we seek to find the solution to this mathematical problem—though perhaps not quite the solution an actual baseball player (or his mom) might be looking for.

COF 15 **Ryan Weber, Marquette University**
Peg Solitaire Variant on Various Graph Classes
Peg solitaire is a board game that involves pegs occupying all but one of the spaces on some game board, with the goal of the game to use geometric moves, or jumps, to reduce the number of pegs to one. In the traditional game, the only allowable move is a checker-like jump, requiring two adjacent pegs and a hole for one peg to jump over and in, removing the jumped peg. Recently peg solitaire has been played on graphs, where pegs occupy all but one of the vertices, with the goal of the game to use checker-like jumps across edges to reduce the number of pegs to one. Others have investigated how the original game can be played on various graph classes. We introduce a variant of the peg solitaire move in which two pegs adjacent to the same hole merge to create a single peg in that hole, and we see what graphs can be reduced to a single peg using this new operation.

6:40 – 6:55
COF 11 **Tyler Shimek, Lincoln Wurtz, and Erin Frassetto, Ripon College**
Exploring 3-Manifolds with Computers
Three-manifolds are always difficult to visualize and hence are better described numerically. In this talk, we will describe piecewise flat triangulated 3-manifolds in terms of their geometric properties. Specifically, we will define the notions of edge and vertex curvatures
as well as a total curvature functional. Moreover, we will present a Python program that will ultimately use a hill climbing algorithm to find extrema. This research is funded by a Center for Undergraduate Research Mathematics grant.

6:40 – 7:10
COF 15   **Mitchell Krock, Bradley University**
            Donuts and Data
            Recently, topological ideas and techniques have been applied to the study of
            data through a tool called persistence homology. We compare and contrast
            information gleaned from persistent homology with that obtained from the
            established techniques of clustering and principal component analysis. We
            investigate partnerships between these techniques that will lead to new
            insight and more effective modeling of data.

7:00 – 7:15
COF 11   **Jeremiah Fogarty, Bethany Lutheran College**
            Penney Ante: An Exploration and Expansion on Random Selection
            What sequence will occur first when flipping a coin; HHHHH or HTHHT? This
            competition between different sequences of heads and tails is the basis of the
            game Penney Ante. In this talk, we show that although it may be unintuitive,
            one sequence is more likely to occur before the other. We also discuss ways
            we have expanded this game to longer sequences, three sided die, and the
            selection of playing cards.

7:30 – 8:30
COF 11   Invited Address: **COLIN ADAMS, Williams College**

            Blown Away: What Knot to Do When Sailing
            (by Sir Randolph Bacon III, cousin-in-law to Colin Adams, Williams College)
            Being a tale of adventure on the high seas involving great risk to the tale
            teller, and how an understanding of the mathematical theory of knots saved
            his bacon. No nautical or mathematical background assumed.

8:30 – 9:30   **Face Off! The Mathematics Game Show** in Cofrin 11

9:30 – ???   **Pizza Social** in Cofrin Basement Lounge; everyone at the conference is
              welcome!

Saturday, November 2

8:30 a.m.   **Registration**, conversation, coffee, juice, fruit, and rolls in Cofrin basement lounge

8:50 – 10:45 **Student Talks** in Cofrin 11 and Cofrin 15

9:30 – 9:45
COF 11   **Kesley Zimmermann, Benedictine University**
             Persistence in A Pulse Vaccination SVEIR Model with a Saturation Incidence Rate and Time Delay
             Pulse vaccination is an effective strategy for controlling or eradicating an infectious disease within a population. We consider an SVEIR epidemic model with pulse vaccination, a nonlinear saturation incidence rate, and a time delay for individuals moving from the exposed class to the infectious class. We determine the conditions for which the disease persists.

COF 15   **Mfoniso Ekong, Benedictine University**
             Bifurcations in the Dyamics of a Continuous Model for Gene Regulatory Networks
             To compare the dynamic behavior of continuous and Boolean models for gene regulatory networks, it is necessary to understand the behavior of the dynamics of the continuous model , We consider small gene regulatory networks and demonstrate the existence of Hopf bifurcations in the parameter space. These Hopf bifurcations separate the parameter space into regions of oscillatory behavior and regions of stable behavior.

9:50 – 10:05
COF 11   **Nwafor Nwoke, Benedictine University**
             A Stage Structured Integrated Pest Management Model with a Holling Type II Functional Response
             We present an impulsive integrated pest management model utilizing a combination of pesticide, a predator species, and a disease in the prey species. The model incorporates stage structure for both the predator and prey species and assumes that the prey species reproduces according to birth a pulse. We use a full saturation incidence rate for the spread of the disease within the prey population and a Holling Type II functional response for the predation. We determine the condition for which the pest (prey) free solution is globally asymptotically stable. We also consider implications of varying of the timing of the impulsive events, which include the birth pulse, the spraying of pesticide, and the introduction of the predator and diseased prey.

COF 15   **Hannah Wangler, Benedictine University**
                Is This The End for Facebook?
                In this presentation I will show how we (my mentor and I) used epidemic
                models to study online social networks, mainly Facebook, but a few others as
                well. I will briefly talk about epidemic models and then go into how we
                created a few new models of our own to study different aspects of social
                networks. Jacobians, equilibria, and stability are mentioned and briefly
                explained, and then I will go into our results. The purpose of the research we
                did over this past summer was to see if and when Facebook and similar social
                networks would „die" and under what conditions that would occur. This
                presentation will highlight the major results we have procured over these
                past few months, and, of course, address the question: is this the end for
                Facebook?

10:10-10:25
COF 11   **Rachel Majerczyk, Benedictine University**
                An Integrated Pest Management Model with a Holling Type II Functional
                Response
                We consider a stage structured model for integrated pest management (IPM)
                with the impulsive effects of a birth pulse, the application of pesticide, and the
                periodic augmentation of a predator species. In particular, the model using a
                Holling Type II functional response for predation and Beverton-Holt type of
                birth pulse. We find the conditions for which the pest eradication solution is
                globally asymptotically stable.

COF 15   **Samuel Larimer, Purdue University, Calumet**
                A Latently Infected Cell Inclusive Model for HIV Dynamics
                Human immunodeficiency virus type 1 (HIV-1) infection persists despite
                years of antiretroviral therapy (HAART). Proviral latency is established early
                in infection, even in patients who are treated with HAART within the first
                weeks of infection. Latently infected memory CD4+ T cells constitute the
                major reservoir of viral persistence in patients on ART and can replenish
                systemic infection following interruption of therapy.
                We present a mathematical model to investigate theoretically and
                numerically the effect of latently infected cells in the presence of immune
                effectors in modeling HIV pathogenesis. Additionally, by introducing drug
                therapy, we assess the effect of treatments consisting of a combination of
                several antiretroviral drugs

10:30-10:45

COF 11   **Maryam Moeed, Benedictine University**
Persistence in A Pulse Vaccination SVEIR Model with a Half Saturation Incidence Rate
Pulse vaccination, which is a repeated, periodic application of vaccine, is a means by which infectious diseases can be eliminated. We consider an SVEIR epidemic model with pulse vaccination and a nonlinear half saturation incidence rate. In particular, we determine the conditions for global attractivity of the disease free periodic solution. That is, we determine conditions for which the disease will be eliminated.

COF 15   **Erin Sullivan, UW Stevens Point**
What are the Hyperreals?
We explore the hyperreals, a number system that extends the real numbers. The construction of the hyperreals uses sequences and ultrafilters, which will be defined, unlike the construction of the reals using Cauchy sequences. The hyperreal number line is discussed, along with finding limits and derivatives in the hyperreal number system.

11:00 – 12:00

COF 11   Invited Address: **COLIN ADAMS, Williams College**

Zombies & Calculus: A Survival Guide
If you are reading this, then you have managed to survive the zombie apocalypse so far. Congratulations! But as the world sinks further into ruin, what additional strategies can you apply to endure the onslaught? Learn how calculus can help you to defeat the zombie hordes. The lecture room will be will be certified a safe haven for the duration of the talk

Colin Adams is the Thomas T. Read Professor of Mathematics at Williams College. He received his Ph.D. from the University of Wisconsin-Madison in 1983. He is particularly interested in the mathematical theory of knots, their applications and their connections with hyperbolic geometry. He is the author of "The Knot Book", an elementary introduction to the mathematical theory of knots, "Why Knot?", a mathematical comic book with attached toy and "Riot at the Calc Exam and Other Mathematically Bent Stories", a compendium of humorous math stories. He is the co-author of the humorous supplements "How to Ace Calculus: The Streetwise Guide" and "How to Ace the Rest of Calculus: the Streetwise Guide" as well as the textbook "Introduction to Topology: Pure and Applied". He also appears with Thomas Garrity in "The Great Pi/e Debate", "The United States of Mathematics Presidential Debate" and "The Derivative vs. the Integral: The Final Smackdown", DVD's of humorous debates on mathematical topics. He has written a variety of research articles on knot theory and hyperbolic 3-manifolds. He is a recipient of the Haimo National Distinguished Teaching Award from the Mathematical Association of America(MAA) in 1998, an MAA Polya Lecturer for 1998-2000, a Sigma Xi Distinguished Lecturer for 2000-2002, and the recipient of the Robert Foster Cherry Teaching Award in 2003. He is also the humor columnist for the Mathematical Intelligencer, and his newest book "Zombies & Calculus" has just appeared.

INVITED SPEAKERS FOR THE
ST. NORBERT COLLEGE PI MU EPSILON
REGIONAL UNDERGRADUATE MATHEMATICS CONFERENCES

1986   Paul Campbell, Beloit College

1987   Joseph Gallian, University of Minnesota - Duluth

1988   Philip Straffin, Beloit College

1989   J. Sutherland Frame, Michigan State University

1990   Jeanne LaDuke, De Paul University

1991   J. Douglas Faires, Youngstown State University

1992   James Kasum, Cardinal Stritch College

1993   Mark Krusemeyer, Carleton College

1994   Robert S. Smith, Miami University

1995   Norbert J. Kuenzi, UW - Oshkosh

1996   Donald Saari, Northwestern University

1997   Paul J. Humke, St. Olaf College

1998   I. Martin Isaacs, UW - Madison

1999   Lisa Townsley Kulich, Benedictine University

2000   S. Brent Morris, National Security Agency

2001   Aparna Higgins, University of Dayton

2002   Frank Morgan, Williams College

2003   Richard A. Brualdi, UW – Madison

2004   Erica Flapan, Pomona College

2005   Alexander Hahn, The University of Notre Dame

2006   Underwood Dudley, Tallahassee, Florida

2007   Keith Devlin, Stanford University

2008   Eve Torrence, Randolph-Macon College

2009   Dan Kalman, American University

2010   Judy Holdener, Kenyon College

2011   John Koker, University of Wisconsin-Oshkosh

2012   David Bressoud, Macalester College

2013   Annalisa Crannell, Franklin & Marshall College

2014   Colin Adams, Williams College

WINNERS OF THE REV. NICHOLAS E. NIRSCHL SCHOLARSHIPS

1996   Dawn Gibson, Jacqueline Gosz, Sarah Nohr, Nicki Schleis, Dennis Schmidt

1997   Debbie Giesler, Tina Huss, Mark Meeker

1998   Laura Lemke, Jenny Schmidt, Libby Wiebel

1999   Renee Jonet, Erica Pagel, Kate Rendall

2000   Michelle Budzban, Danielle Delimata, Heather Olm, Rosemary Tomase, Jeremy Vosters

2001   Cinnamon Danube, Abby Mroczenski, Laura Weiland

2002   Erin M. Bergman

2003   Tammy Bastian, Rachel Meulemans, Jill Schmidt

2004   Adam Christman, Brian Hahn, John Karls, Monica Spang, Damian Wegner

2005   Josh Domina, Christy Ernst, Mike Konicki, Martina Weber, Angie Wille, and AJ Wood

2006   Trina Bower, John Moss, Nicole O'Connell, Jackie Van Ryzin

2007   Elizabeth Colletti, Mark Krines, Sarah Schultz

2008   Francis Beaumier, Kyle Diederich, Jenni Jacobsen, Ryan Pavlik

2009   Brice Hilgemann, Michelle Keehan, Kathleen Miller, Stephanie Schauer, Adam Ziegler

2010   Jamie Biesinger, Bill Lancelle, Benjamin Newman, Renee Wenig

2011   Nicole Harp, Brian Milinski, Katie Steinfeldt

2012   Jana Christel, Nora Delach, Kirsten Englebert

2013   Melissa Diederich, Alex Leitheiser, Elizabeth Wissing