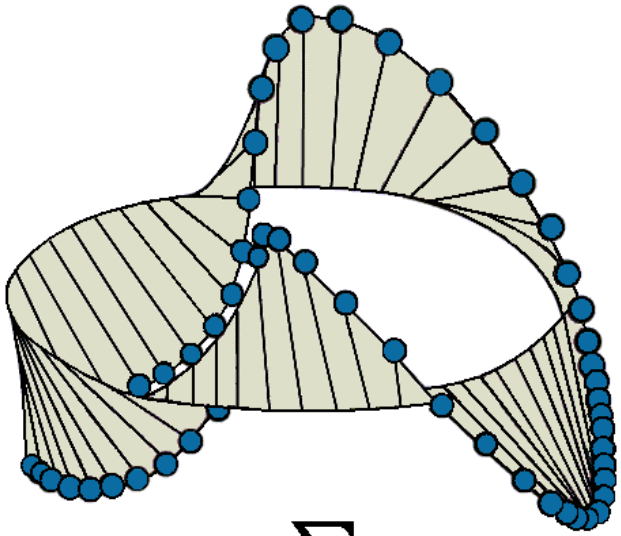
Garden State Undergraduate Math Conference 2004



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Rutgers University
New Brunswick, NJ

Saturday, March 27, 2004

MAA-NJ

Greetings!

Welcome to the first Garden State Undergraduate Math Conference (GSUMC) hosted by the New Jersey Section of the Mathematical Association of America (MAA-NJ). We hope that you will enjoy today's events, which are intended to promote undergraduate students in presenting their mathematical work and to foster interaction among students through activities such as career workshops and the New Jersey Undergraduate Math Competition. Feel free to also participate in events from the MAA-NJ Section Meeting being held in parallel with GSUMC.

Please don't hesitate to ask any of the GSUMC staff members for assistance. Also, don't forget to fill out the **Conference Evaluation Form** (look for a copy in your program folder; additional copies are available at the registration table). Your feedback will help us to better plan future events.

Thank you for coming!

New Jersey Undergraduate Mathematics Competition (NJUMC)

NJUMC is a problem-solving contest in which teams of up to three students participate over a three-hour period in two events: a group session, where team members are allowed to collaborate, as well as an individual session, where students must work by themselves. The nature of the problems is modeled upon the Indiana Friendly Math Competition and much more accessible than the Putnam Exam. Questions on the test will involve material from HS mathematics, calculus, linear algebra, differential equations, and introductory courses that a math major would take. The emphasis of the competition will be on having fun with interesting problems that stress problem solving.

Results of the Competition will be announced at the end of the conference and awards will be presented to winning teams from both four-year and two-year institutions.

Here are some teaser sample questions:

1. What is the probability that a dart, hitting a square board at random, lands nearer the center than the edge?
2. Call a number N fortunate if it can be written with four equal digits in some integral base $b > 1$.
   - Clearly 2222 is fortunate; why is 2000 fortunate?
   - Find the greatest fortunate number less than 2000.
3. Determine whether $\sqrt{1+\sqrt{2+\sqrt{3+\sqrt{4+\ldots}}}}$ converges or diverges.

Keynote Speaker

John H. Conway, Princeton University
The Mysterious Arithmetic of Lexicographic Codes

Integral Lexicographic codes are very simply defined (by a "greedy algorithm"), but have strange arithmetical properties that are hidden in a theorem I call "The Lexicode Theorem." I'll tell you what the theorem says, and together we'll puzzle out what (if anything) it means.

John H. Conway is John von Neumann Distinguished Professor of Mathematics at Princeton University, NJ. Born in Liverpool, England, he received his education at the University of Cambridge and then taught at Cambridge as a mathematical logician upon graduation. He remained at Cambridge for many years before joining the Princeton faculty in 1986.

Conway is the author or co-author of at least ten books, and of many expository articles which have had substantial impact not just on research mathematicians but on mathematical amateurs as well. Conway has a rare gift for naming mathematical objects, and for inventing useful mathematical notations. He is widely known for his discovery of surreal numbers, the Conway group, and for inventing of the Game of Life.

Conway is a Fellow of the Royal Society, a Member of the American Association for the Advancement of Science, and recipient of the Berwick Prize of the London Mathematical Society (1971), Pólya Prize of the London Mathematical Society (1987), Frederic Esser Nemmers Prize (1999), Leroy P. Steele Prize of the American Mathematical Society (2000), and Joseph Priestley Award (2001). He received an honorary doctorate from the University of Liverpool on July 4, 2001.

Career Workshops in Mathematics

Mathematics in Industry, *Greg Coxson, Lockheed Martin*

Do you like to apply mathematics to challenging problems? A career in industry might work for you. In this session, I will explain some of the benefits and difficulties you would face in this line of work. I will also talk about some ways to make your work exciting and satisfying, offer some example problems and answer your questions.

Greg Coxson is a radar system analyst at Lockheed Martin Maritime Systems and Sensors (or MS2) in Moorestown, New Jersey. Previous jobs were at Hughes Radar Systems in Los Angeles and the Center for Naval Analysis in Alexandria, VA. He holds a Master's degree in Math and PhD in EE from the University of Wisconsin at Madison.

Teaching careers in middle and high school mathematics, *Marlene Krupp, Lyndhurst school district and Suzanne Reynolds, Kean University*

This session will focus on the critical need for highly qualified mathematics teachers, particularly at the middle and secondary school levels; the pros and cons of teaching in public schools; and the disadvantages/advantages of the alternate route program. The session will include a question and answer period.

Marlene Krupp is District Math Supervisor of Lyndhurst Public Schools, Lyndhurst, NJ. She previously taught secondary mathematics for 31 years at Becton Regional High School. She has held various consulting positions including working for the College Board, Rutgers University and The Algebra Project, San Antonio School District in Texas and the Seattle School District in Washington. **Suzanne L. Reynolds** is Assistant Professor of Instruction and Educational Leadership at Kean Univeristy. Previously she taught mathematics and mathematics education at Felician College and prior to that taught mathematics and physical science in public school.

Continuing your education: Graduate programs in the Mathematical Sciences, panel organized by *Stephen Greenfield, Rutgers University*
Panelists: Samuel Coskey, Inessa Epstein, Devon Morrese, Stephen Greenfield.

Are you planning to further your education by enrolling in a graduate program in mathematics? This session will discuss what is involved in completing a typical Master's or Ph.D. program and the various things you can do in your undergraduate years to help prepare for graduate school. We will also discuss other closely related

graduate programs in the mathematical sciences for which an undergraduate math major is excellent preparation.

Mr. Samuel Coskey is a first-year graduate student in Mathematics at Rutgers University. He was an undergraduate at the University of Washington, where he majored in Mathematics and Computer Science. He participated as a student and assistant at the REU there.
Ms. Inessa Epstein, originally from Belarus, is an undergraduate at Rutgers University, majoring in Mathematics and Computer Science with a minor in Economics. She participated in REU's at Rutgers University and Central Michigan University. She is currently applying for admission and support to mathematics graduate programs.
Mr. Devon Morrese is a graduate student in the Operations Research program at Rutgers, where he is completing his doctoral work on the Boolean satisfiability problem under the supervision of Professor Endre Boros. He majored in Mathematics and Physics at Rutgers.
Dr. Stephen Greenfield is a faculty member in the Department of Mathematics at Rutgers, where he has served several times as Graduate Director. He has read thousands of applications to the graduate program in mathematics at Rutgers. He was awarded the 2003 MAA-NJ sectional award for Distinguished College or University Teaching of Mathematics.

Abstracts of student contributed paper sessions

Student contributed papers organized by Catherine Bénéteau, Seton Hall University
Session 1, SEC 207
Presider: John T. Saccoman, Seton Hall University

1:50-2:05

Cristian Aldea, Seton Hall University
An Investigation into Chromatic Polynomials

Graph colorings are a source of information about structural properties of graphs. Some of this information is contained in the chromatic number and the chromatic polynomial of a graph. The chromatic polynomial of a graph is a polynomial that counts the number of ways to color the graph using exactly u colors. It can be determined using the Factoring Theorem and the concepts of deletion and contraction. The chromatic polynomial may also be expressed using the Tutte Polynomial and polynomials are computed for some specific classes of graphs.

2:10-2:25

Jessica Alfano and Laurette Kitchen, Fairleigh Dickinson University
Teaching Graph Theory and its Application: An Approach for the Middle School

We will present graph theory topics using technology and innovative techniques in a manner that younger students can be exposed to more difficult ideas. The focus will be on the use of bipartite graphs to solve real-world problems. We will use Inspiration software to effectively present concepts and applications with the use of puzzles, games, and real-life problems. The goal of our presentation is to demonstrate how mathematics can be taught in fun and interesting ways and enhance students' learning at the same time.

2:30-2:45

Zachary Vogel, Fairleigh Dickinson University
Sums of Hypergeometric Terms Using Gosper's Algorithm

The main focus of the presentation is on Gosper's algorithm for determining sums of hypergeometric terms. It would begin with a few binomial coefficient identities. This would be followed by an introduction to hypergeometrics, including a translation of binomial coefficients into hypergeometric form. Then we will examine Gosper's algorithm. An example will be solved using the algorithm.

2:50-3:05

Vidya Venkateswaran, Rutgers University
Path-Center of Closed Curves

In this talk, we introduce the notion of a path center (P-center) for closed figures in the plane. A P-center is the common intersection of lines connecting pairs of antipodal points. We give necessary and sufficient conditions for a figure to have a P-center. We also use this P-center notion to develop an index of asymmetry. We also show how the isoperimetric inequality can be strengthened for figures with a P-center.

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Garden State Undergraduate Math Conference
Spring 2004 Program

8:30 – 10:00	Registration andBreakfast, Lobby
8:30 – 9:00	Check-in for NJ Undergraduate Math Competition, SEC 210
9:00 – 12:00	**NJ Undergraduate Math Competition**
(9:00 – 10:00)	Individual Session
(10:00 – 12:00)	Team Session
	Headquarters: SEC 210
12:00 – 1:00	**Lunch**, Busch Campus Center Multipurpose Room
1:00 – 1:45	**Career Workshops** (concurrent):
	Graduate School: SEC 207: Stephen Greenfield, Rutgers University
	Industry/Government: SEC 208: Greg Coxson, Lockheed Martin
	Education: SEC 209: Marlene Krupp, Lyndhurst school district and Suzanne Reynolds, Kean University
1:50 – 3:30	**Presentations by Students: Talks and Poster Session**
	Student Session 1: SEC 207
	Student Session 2: SEC 208
	Student Poster Session: SEC 210
3:30 – 4:20	**Keynote Address: *The Mysterious Arithmetic of Lexicographic Codes*, John H. Conway**, Princeton University, SEC 111
	Presider: Christopher Simons, Rowan University
4:20 – 4:30	Contest Results, Awards, and Prizes, SEC 111
4:30	End of Conference

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Mathematical Association of America
New Jersey Section
Spring 2004 Meeting Program

All sessions except the concurrent sessions at 1:30 p.m. will take place in SEC111

8:30 – 9:15	Registration and Coffee, Lobby
8:30 – 1:30	Book Exhibits, Lobby
9:15 – 9:30	**Welcome by Michael Beals**, Dean for Educational Initiatives, Faculty of Arts and Sciences, Rutgers University
9:30 – 10:20	***Designing the Pre-service Teacher Curriculum to Better Meet the Needs of Our Future Teachers*, Mercedes McGowen**, William Rainey Harper College
	Presider: Donna Cedio-Fengya, William Patterson University
10:20 – 10:30	Chair's and Governor's Reports, and recognition of 25- and 50-year members
10:30 – 10:40	Presentation of **Distinguished Teaching** and **Meritorious Service** Awards
10:40 – 11:10	Intermission
11:10 – 12:00	***Role Assignments in Social Networks*, Fred S. Roberts,** Rutgers University and DIMACS
	Presider: Michael Jones, Montclair State University
12:00 – 1:30	**Lunch**, Busch Campus Center Multipurpose Room (Book Exhibits end at 1:30)
1:30 – 3:05	**MAA-NJ Contributed paper sessions** (concurrent):
	History of Mathematics: SEC 202
	Popular and Recreational Mathematics: SEC 203
	SIGMAA on Statistics Education: SEC 205
	Technology in the Mathematics Classroom: SEC 204
	General Contributed Papers: SEC 206
3:05 – 3:30	Intermission, Lobby (Silent Auction bidding ends at 3:30)
3:30 – 4:20	***The Mysterious Arithmetic of Lexicographic Codes*, John H. Conway**, Princeton University
	Presider: Christopher Simons, Rowan University
4:20 – 4:30	Contest Results, Awards, and Drawing of door prizes and announcement of Silent Auction Winners (must be present to win)
5:00	Dinner honoring Award Winners, Invited Speakers and Workshop Leaders

Abstracts of student contributed paper sessions

(continued from page 6)

3:10-3:25

Eric Sundberg, Rutgers University

Maker-Breaker Tic-Tac-Toe on the Integer Lattice

Maker-Breaker Tic-Tac-Toe is a version of Tic-Tac-Toe played by two players, Maker and Breaker, where Maker's only goal is to occupy a winning-line and Breaker's only goal is to prevent Maker from occupying a winning-line. Thus Maker wins at the end of the game if (s)he occupies a winning-line, otherwise Breaker wins. We will examine Maker-Breaker Tic-Tac-Toe on the integer lattice where winning-lines of various slopes are allowed. Based on the number of slopes used for determining the winning-lines we will give a pairing-strategy which allows Breaker to win.

Session 2, SEC 208

Presider: Catherine Bénéteau, Seton Hall University

1:50-2:05

Kevin Hughes, Rowan University

The Unknown Binomial Distribution

A generalization of a question on the 2002 putnam exam. I find a one-dimensional discrete probability distribution based on certain assumptions, and present the general form, with three additional variables. Proof requires only basic laws of probability, and mathematical induction.

2:10-2:25

Wendy Wang, Duke University

Minimum Rank of Positive Semi-Definite Matrices with a Prescribed Graph

A complex nxn matrix $A = [a_{ij}]$ is said to be *combinatorially symmetric* if for i ? j, a_{ij} ? 0 implies a_{ji} ? 0. We associate a simple graph G to a combinatorially symmetric matrix A such that $V(G) = \{1, 2, \ldots, n\}$ and join vertices i and j if and only if a_{ij} ? 0. The graph is independent of the diagonal entries of A. Define $P(G)$ to be the class of all positive semi-definite matrices associated with a given graph G. Denote $\#(G) = \min \{\text{rank } A \mid A \in P(G)\}$ the minimum rank of G. In this talk we will present results about the minimum rank of certain classes of graphs.

2:30-2:45

Josh Isralowitz, NJIT

Classical Lebesgue Integration Theorems For the Riemann Integral

In this paper, we use the concept of gauges to provide easy proofs (proofs that are not difficult and do not use any measure or Lebesgue integration theory except for the notion of measure zero) of integration theorems for the Riemann integral that are closely related to classical Lebesgue integration theorems.

2:50-3:05

Steven Lettieri and Luba Lidman, Montclair State University

Linear Cellular Automata Rules and Finite Fields

This talk examines the class maps $W_{n,k}(x) = (x_1+x_{k+1}, \ldots, x_n+x_k)$ where $x = (x_1,x_2,\ldots,x_n) \in \mathbb{Z} / \mathbb{Z}_{2^n}$. In the case where $k = 1$, $W_{n,k}$ reduces to the well studied Ducci map. The $k = 2$ case results in a shift of Wolframs Rule 90 which has been of significant interest for the past several decades. We analyze the relationship of cycle lengths of $W_{n,k}$ as a function of both n and k. Connections are made between dynamical behavior of all the maps relating the results back to the original Ducci problem.

Abstracts for student poster session, SEC 210

Student poster session organized by Catherine Bénéteau, Seton Hall University

Shannon Boyle, Millersville University of Pennsylvania

Teaching Styles and the van Hiele Levels: An Analysis of the Effects of Two Teaching Styles on Student Learning in Geometry

The importance for students to have a solid understanding of geometry is increasing in high schools throughout the United States. For this reason, educators must be aware of how students learn geometry and what styles of teaching are the most effective in geometry courses. Pierre van Hiele and Dina van Hiele-Geldof developed a theory that describes a set of levels that students follow when they learn geometry. Their theory has been the focal point of a great deal of research which details the learning processes of students taking geometry. However, the amount of research completed on which teaching styles will create the most beneficial environment for student learning is limited. In this study, the researcher analyzed the effects of two different teaching styles, constructivist and traditional, on student learning by observing two teachers and testing their students using a pre and post assessment developed by Zalman Usiskin.

Aziza Jefferson, Rutgers University
Mathematical merger models

My poster presents a mathematical model to describe merging traffic patterns. We expand upon several of Richard Haberman.s models, which use differential equations to model traffic density and flow. In our model we vary initial conditions to manipulate the point of merger. The poster discusses under which conditions the model is valid and the physical manifestations of the conditions.

Mendy Malko, William Patterson University
Geometric Constructions and Famous Problems of Geometry

There are many mathematical problems that can be solved using geometric constructions. In our work we start with the 5 basic constructions that will be used to develop more complex constructions. We show using only compass and straightedge a given geometric construction is possible if and only if the number which defines the desired element can be derived from the given elements by a finite number of rational operations and the extractions of square roots. We present several classical construction problems whose solutions had eluded mathematicians for years including the trisection of an angle, the Delian problem, and the problem of squaring a circle and show why such constructions are impossible.

Susana Oblitas, William Patterson University
Mathematical models of cell replication

It is well known that a vast range of mathematics has found biological applications. In this poster presentation we present several models of blood circulation and more precisely of periodic diseases of the blood, known as periodic hematological diseases. We start with a very simple model of random cell loss and we built on a more complicated system where the aging of the cells is also accounted as an independent variable. We construct solutions of these models and at the end of the presentation we present another model of periodic autoimmune hemolytic anemia, as it has been derived by Michael C. Mackey. A detailed derivation as well as solutions will be presented.

Michael Orchard, Rowan University
Theon's Ladder for any Root

Theon's ladder is an ancient algorithm for calculating rational approximations for $\sqrt{2}$. It features two columns of integers, (called a ladder), in which the ratio of the two numbers in each row is an approximation to $\sqrt{2}$. It is remarkable for its simplicity. This algorithm can easily be generalized to find rational approximations to any square root. In this paper we show how Theon's original method is naturally generalized for the calculation of any root, $\sqrt[n]{c}$, where $1 < c$. In the generalization given here we require *n* columns of numbers as we generate rational approximations to an *n* th root. Several different recursion relations for the numbers that appear in the ladder are given, and a generating function for calculating the *n* th row of the ladder is found. Methods of increasing the rate of convergence are given, and a method of reducing the *n*-column ladder to a 2-column ladder is shown.

Jennifer Saria, William Patterson University
Mathematical Analysis of the Design & Control of Robots

Many processes are now carried out by computer-controlled robots. Robotics is a new field of study that deals with the design and control of robots. In this poster, we present how one can control the motion of a two-dimensional, two arm robot making use of simple mathematical concepts from trigonometry and calculus. The concepts developed in such simple settings are crucial to solve problems in more realistic robots.

Acknowledgements

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- Exam writers and graders for the NJ Undergraduate Math Competition: Tom Hagedorn (NJUMC Director), The College of New Jersey, David Richter, William Paterson University, and Christopher Simons, Rowan University.
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Participating Schools

College of Saint Elizabeth, NJ
Duke University, NC
Fairleigh Dickinson University, NJ
Kean University, NJ
Loyola College, MD
Millersville University, PA
New Jersey City University
New Jersey Institute of Technology (NJIT), NJ
Ramapo College of New Jersey, NJ
Rowan University, NJ
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