Friday, April 4, 2003

Concurrent Session of Contributed Papers 1 Wright Hall 7

2:00 **On the Use of Computer Algebra Syntax in the Calculus Classroom**
Russell Goodman, Central College
In this talk, the idea of using computer algebra syntax in a calculus course will be presented. The presenter believes that students, to a certain degree, can become acquainted with CAS conventions and syntax before ever sitting down and wrestling with such software. Moreover, this intentional syntactical use might lead to better student understanding of the composition of functions, and thus better understanding of the concepts of the Chain Rule (for derivatives) and the Substitution Method (for antiderivatives). The presenter will show some sample assignments as well as discuss the pros and cons of such an idea. There will be time for general discussion of this notion both during the presentation time, and hopefully afterwards for any interested parties.

2:30 **Using the Pivot Package in Linear Algebra and Finite Mathematics**
Al Hibbard, Central College
After seeing my students in Finite Mathematics struggle with doing the pivot calculations inherent in the Simplex Method, I wrote a *Mathematica* package that allows one to simply click on the pivot location. This generalizes to a package that can perform any of the elementary row operations. This session will look at how I use this package in a Finite Mathematics class and how it can be used in other situations. Time permitting, we will take a brief look to see how *Mathematica* buttons accomplish these tasks.

3:00 **The Classical Ramsey Number $R(3,3,3,3;2)$ Is No Greater Than 62**
Richard Kramer, Iowa State University
In this paper, we show that $R(3,3,3,3) \leq 62$, that is, any edge coloring of the complete graph on 62 vertices with four colors must contain a monochromatic triangle.

3:30* **An Elementary Integration Arising in Astronomy**
Joseph C. Keller, Iowa State University
The author has found an exact elementary solution to a certain integral. This solution agrees closely with the approximate solution, lacking error limits, that was given by astronomer Fritz Zwicky, in the *Proceedings of the National Academy of Sciences*, 1929. The integral shows that the cosmological redshift might be due not to expansion of the universe, but rather, to a gravitational drag on photons.

4:00 **What it Took Sylvester 3 Days to Do, I Can Do in 2**
A. M. Fink, Iowa State University
To engineers and other undergraduates, sin x is a calculator button. Scratch a mathematics major, and you might get a bit more; maybe something about opposite over hypotenuse. Is there a little man inside your calculator drawing triangles when you push the sin button? I would say that mathematics majors ought to know something more about what sin x is. Maybe a complex variables course can convince them that it has nothing to do with the circular arguments (pun intended) given in undergraduate calculus texts. So I do all of trigonometry in my advanced analysis course in two days. It took

Sylvester three.

Concurrent Session of Contributed Papers 2 Wright Hall 109

2:00 **What's Your Angle? The Role of Definitions in Algebra and Geometry**
Cathy Gorini, Maharishi University of Management
Definitions can serve a variety of purposes. They can describe clearly what we are studying, limit our study to something manageable, or incorporate conditions that are difficult to establish by proof. We will look at definitions of angle and group from a variety of sources to compare the use of definitions in algebra and geometry.

2:30 **Mathematics Without Words: A project to study visual representations of mathematical ideas**
M. E. (Murphy) Waggoner, Simpson College
During the spring of 2002 the students in Mathematics for Elementary School Teachers participated in a project intended to help them make a stronger connection between the analytic, verbal, and visual representations of mathematics. Another goal of this project was to provide the students with a semester-long problem-solving opportunity where the results of each phase of the process must be used as inputs in the next phase. Pairs of students were responsible for independently learning a topic from the standard mathematics curriculum for pre-service elementary teachers and then designed a quilt block that was a visual representation of some aspect of the concept they studied. The students wrote papers to explain the connections between the analytic and visual representations. Finally, the students constructed the quilt blocks they designed from fabric which were then made into a quilt. This paper will describe the goals of the project, the procedures taken, the topics used, an evaluation by the instructor and comments from the students, and future plans for similar projects. The quilt designed and sewn by the students will be displayed.

3:00 **The Best Fitting Line**
Irvin Roy Hentzel, Iowa State University
We study the point which is closest to the three sides of a triangle. We also study the line which is closest to the three vertices of a triangle. The Lhuilier-Lemoine point is the point which minimizes the distance from the three lines. We use the Euclidean norm for the distances.

3:30 **The Number of E-ban Numbers: It Can Go Either Way**
Charles Ashbacher, *Journal of Recreational Mathematics*, Mount Mercy College
A number is an e-ban number (e-banned) if the English spelling of the number does not contain the letter e. For example, two and six are e-ban numbers, but one, seven, and eight are not. In a paper to be published in the *Journal of Recreational Mathematics*, J. C. Hernandez, C. Mex-Perera and Simon J. Shepherd prove some theorems about e-ban numbers and end the paper with the question: “Are there an infinite number of e-ban numbers?” That question is examined in this paper as well as some related questions, such as the number of n-ban numbers.

4:00 **Orders Of L-Shaped Polyominoes**

Charles Jepsen, Grinnell College

We are interested in the problem of tiling a rectangle with copies of a given polyomino, i.e., a plane figure composed of unit squares placed together along their edges. The *order* (resp. *odd order*) of a polyomino is the smallest number (resp. odd number) of copies that tile a rectangle. We say that a polyomino is *odd* if it has a finite odd order and is *even* if it has finite order but no finite odd order. We show that a certain L-shaped polyomino L_n is even if n is a multiple of 4 and is odd otherwise. When L_n is odd, we find an upper bound on its odd order.

Concurrent Session of Contributed Papers 3 Wright Hall 119

2:00 **The Largest Impossible Bet**

Ronald K. Smith, Graceland University

A bet of size \$*n* is possible with chips of size \$*a* and \$*b* if and only if *n* can be written as a linear combination of *a* and *b* with non-negative coefficients. Otherwise, the bet is impossible. In case *a* and *b* are relatively prime integers, it is well known that if the bet is large enough, it is always possible. This leads us to the question, what is the largest impossible bet? We will show that the largest linear combination of positive integers *a* and *b* that cannot be written with non-negative coefficients is lcm(*a*,*b*) - *a* - *b*. In the case of positive, relatively prime *a* and *b*, this says that the largest impossible bet is *ab* - *a* - *b*.

2:30 **John Graunt, John Arbuthnott, and the Emergence of Statistics**

R. B. Campbell, University of Northern Iowa

This talk will complement the insights in "Observatons upon the Bills of Mortality" and "An Argument for Divine Providence" with the errors, thereby presenting a more realistic picture of how statistics became a science.

3:00 **On the Number of 100 . . . 01 Strings in Certain Bernoulli Trials, and Random Permutations**

Sunder Sethuraman, Iowa State University

It is well known that the asymptotic joint distribution of the number of *k*-cycles in a random permutation of 1,2, . . . , *n* converges, as *n* tends to infinity, to independent Poisson factors with intensities 1/*k*. By making a connection with the numbers of 100 . . . 01 strings in certain independent Bernoulli sequences, we give a new proof of this result which allows for some generalization, and also answers a problem in the literature.

3:30 **Periodic point numbers and group structure - or 'the world's two weirdest primes'**

Christian Roettger, Iowa State University

Consider the space *X* of doubly infinite sequences *g*(*s*,*t*) where *s*,*t* are integers and the entries are from an abelian group *G*. The space *X* carries two natural shift actions (shift left, shift up), so *X* is a module over Z^2. Let *H* be a subgroup of Z^2 of finite index. The elements of *H* are shifts - some number of steps to the left/right, some number of steps up/down. In analogy to the one-dimensional sequences, say that a sequence *g* in *X* is *H*-periodic iff it is invariant under all shifts from *H*. Let F_H be the number of those sequences for given *H* that lie in the subspace *Y* of *X* defined by *g*(*s*,*t*+1) =

$g(s,t)$+g(s+1,t). We ask whether the set of all the numbers F_H determines the group G. T Ward (UEA, Norwich, UK) proved that the answer is yes in most cases, and no counterexample is known. We will explain the easy part of his argument - the case where $|G|$ is odd and not divisible by a Wieferich prime. After presenting these weird primes (only 2 known examples) and time permitting, we will outline an approach to computing some more of the numbers F_H that could settle the whole problem.

4:00* ***Mathematica*-Aided Propagation Phenomena in Operator Theory**
Jasang Yoon, University of Iowa
In joint work with R. Curto, we use symbolic manipulation techniques to prove that a commuting quadratically hyponormal pair of 2-variable weighted shifts with consecutive equal weights must be flat. I will first discuss the proof in the single variable case, based on the Nested Determinants Test. I will then use a 6-point weight diagram to discuss the 2-variable case.

Round Table Discussion Wright Hall 7

4:45 **Teacher Certification in Iowa**
Joyce Becker, Luther College
Rob Keller, Loras College
Catherine Miller, University of Northern Iowa
The organizers will lead a discussion of issues concerning teacher certification in mathematics in the state of Iowa.

Dinner on your own

Plenary Session 1 and Reception Sabin Hall 102

7:30 **I Know it's True, I Just Can't Prove it!**
E. Todd Eisworth, University of Northern Iowa
We will give an introduction to the ideas lying behind proving independence results. We will begin with the concept of non-Euclidean geometry, and then talk about what it means for a statement to be independent of the axioms of arithmetic or of set theory. After a few concrete examples, we will end by discussing Gödel's Incompleteness Theorem and its ramifications.

Saturday, April 5, 2003

Plenary Session 2 Sabin Hall 102

8:45 **Finding Your Way in a Graph**
Ronald Graham,University of California, San Diego and President of the MAA
There are many situations in which one would like to find the shortest path between various points in a network, for example between two Websites on the Internet. In this

talk, we describe one approach to this problem in which optimal routes can be found based just on local information about the network.

Plenary Session 3 Sabin Hall 102

10:00 **Undergraduate Programs and Courses in the Mathematical Sciences: A CUPM Curriculum Guide**
Herbert E. Kasube, Bradley University and Chair of the MAA CUPM
MAA's Committee on the Undergraduate Program in Mathematics (CUPM) has produced a set of recommendations for mathematics departments approximately once every ten years since its inception in 1953. The latest draft of the Curriculum Guide is in its final stages. This presentation will outline the recommendations and ask for comments.

Undergraduate Student Competition Wright Hall and Sabin Hall
10:00-1:00 **Ruth Berger**, Luther College

Concurrent Round Table Discussion 1 Sabin Hall 102

11:00 **MAA Student Chapters**
Cathy Gorini, Maharishi University of Management
This meeting will provide an opportunity for MAA student chapter advisors to share ideas.

Concurrent Round Table Discussion 2 Wright Hall 7

11:00 **Cooperation Among Mathematics Departments in the State**
Jim Freeman, Cornell College
This discussion will explore ways that mathematics departments can cooperate for their mutual benefit and the benefit of the discipline.

Business Meeting, Iowa Section of the MAA Sabin Hall 102

12:00 **Steve Nimmo**, Morningside College, Chair of the Iowa Section of the MAA

Lunch on your own.

Concurrent Session of Contributed Papers 4 Wright Hall 7

2:00** **Searching for (96, 20,4) Difference Sets**

Logan Axon, Grinnell Colllege

A description of Summer Research performed by Logan Axon and Nathan Gotman at Grinnell College under the direction of Professor Emily Moore as a follow up to a Mt. Holyoke College Research Experience for Undergraduates. Ken Smith's "bootstrap" method of constructing a difference list, the image of a difference set under a homomorphism, is used as the basis for the search for new (96, 20, 4) difference sets. Difference lists are first constructed from (16, 6, 2) difference sets and then used as the basis for a computerized search for (96, 20, 4) difference sets. Intersection numbers and representation theory are applied to constrain the search. Results are a verification of the Mt. Holyoke REU's results in the group $Z_2^4 \times Z_6$ and the discovery of a set of equivalent difference sets in the group $D_4 \times Z_2 \times Z_6$. Both difference sets are possibly equivalent to known difference sets in their respective groups.

2:30** **(96,20,4) Difference Sets and Designs**

Nathan Gotman, Grinnell College

In this talk, we examine equivalence of (96,20,4) difference sets and isomorphism of (96,20,4) designs. First, we show that the 120 difference sets in $Z_2^4 \times Z_6$ constructed in the talk "Searching for (96,20,4)
Difference Sets" are all equivalent. Then, we build designs from all known (96,20,4) difference sets to synthesize information about all (96,20,4) difference sets as well as all (96,20,4) designs. Finally, we use the *p*-rank to help classify all known (96,20,4) designs.

3:00 **Reliable functions to build phylogenetic trees using minimum evolution**

Stephen J. Willson, Iowa State University

Given a set of taxa, the goal is to build a phylogenetic tree which describes the evolutionary relationship among the taxa. Suppose that distances $d(i,j)$ between each pair (i,j) of taxa are given. The method of minimum evolution in principle looks at every possible tree T with those taxa as leaves and estimates the total amount of evolution $L(T)$ along the tree, assuming the distances d. It then selects the tree T for which $L(T)$ is smallest. At issue is the method for estimating $L(T)$. The talk will suggest criteria for formulas to estimate $L(T)$ so as to increase the reliability of the method.

3:30 **Thematization Of The Calculus Graphing Schema**

Laurel Cooley, York College-CUNY
Bernadette Baker (presenter), Drake University
María Trigueros, ITAM

This article is the result of an investigation of students' conceptualizations of calculus graphing techniques after they had completed at least two semesters of calculus. The work and responses of 27 students to a series of questions that solicit information about the graphical implications of the first derivative, second derivative, continuity, the value of limits, and the inter-relationships among these concepts was analyzed from their interviews. A double triad was developed to describe students' schema as a framework

for the analysis. The study centered on the way students coordinated the various elements of each question, their strategies and difficulties. It was found that coordinating concepts to solve complex problems in a graphical setting is a difficult process. Only two students were considered to have thematized the schema.

4:00** **Optimal Voting Strategies for *The Weakest Link***
Amy Winter, Cornell College
The television program, *The Weakest Link*, is a game show with a winner-take-all format in which players vote to remove potential rivals following each round. The obvious question is whether or not the title of the show indicates the optimal strategy for a player to follow. To make a mathematical model tractable, I consider a game with only three players and replace the time limit with a question limit. I have also chosen a simpler "banking" strategy than the one used on the program. Expected payoffs are calculated as a function of each player's probability of answering correctly, as well as the order in which players are eliminated. Not surprisingly, the strategy implied by the title of the show is, in many cases, not the optimal one. A qualitative description of the optimal strategy will be given. In addition, suggestions on how to extend the analysis to more than three players will be given.

Concurrent Session of Contributed Papers 5 Wright Hall 9

2:00 **Experience of the DevMap Approach to Elementary Algebra**
Anne Dow, Maharishi University of Management
This spring we are using the COMAP textbooks *Developing Mathematics through Applications: Elementary* and *Developing Mathematics through Applications: Intermediate,* published by Key College Publishing, to teach our elementary and intermediate algebra courses. I am just completing the elementary course. In this talk I will share my experiences and give a brief taste of the activities. This integrated approach, in which mathematics is always presented as emerging from and inherent in its applications, makes algebra a natural, relevant part of a student's life. The wealth of diverse classroom and homework activities—listening, reading, interactive discovery exercises, hands-on geometry and data-collecting activities, small group investigations, team projects, and individual exercises—build a solid, integrated knowledge of algebraic and modeling skills. Also, the diversity of activities keeps the students interested and focused, which is crucial in MUM's block system, and allows the teacher to cater to a wide range of abilities.

2:30 **Infinite Series for Logarithms using Cyclotomic Polynomials and Aurifeuillian Identities**
Marc Chamberland, Grinnell College
The 1997, Bailey, Borwein and Plouffe heralded a new era for the computation of various transcendental constants. For formulae such as the alluring

$$\pi = \sum_{k=0}^{\infty} \frac{1}{16^k}\left(\frac{4}{8k+1} - \frac{2}{8k+4} - \frac{1}{8k+5} - \frac{1}{8k+6}\right)$$

and more generally

$$C = \sum_{k=0}^{\infty} \frac{p(k)}{q(k)b^k}$$

where p and q are integer polynomials, deg $p <$ deg q, and $p(k)/q(k)$ is non-singular for non-negative k and $b > 2$, they showed that the n^{th} digit (base b) of C may be calculated in (essentially) linear time without computing its preceding digits. Moreover, constants of this form are conjectured to be either rational or normal to base b. Perhaps the simplest such formula is the classical

$$\log 2 = \sum_{k=1}^{\infty} \frac{1}{k2^k}.$$

This talk demonstrates such binary formulae for constants of the form $\log p$ for many primes p. Incorporated in the discusssion are cyclotomic polynomials and Aurifeuillian identities such as

$$2^{4n-2} + 1 = (2^{2n-1} + 2^n + 1)(2^{2n-1} - 2^n + 1).$$

3:00 **Association Schemes Are Everywhere**

Sung-Yell Song, Iowa State University

Association schemes are essentially partitions of a complete graph into regular subgraphs which are interrelated in a specific way. They are fundamental combinatorial objects in algebraic combinatorics, which deserve to be studied in their own right. As an important application they provide a uniform framework for coding theory and design theory. They also have a rich algebraic flavor related to both "modern algebra" (groups, rings, and modules) and "post-modern algebra" (ordered sets, monoids, loops, and quasigroups). We will discuss some of the following topics in conjunction with Association Schemes: Codes, Designs, Geometry, Graphs, Groups, and Universal Algebra.

3:30 **Programming Buttons in Mathematica** (Note: this session is a workshop; it may run until 4:30 and will meet in Wright Hall 339.)

Al Hibbard, Central College

This will be a hands-on session to introduce you to the rudiments of programming buttons in Mathematica. While no prior Mathematica experience is essential, some basic knowledge will be useful. This session will start with simple buttons and address how to assign tasks to them. An example may be to design a button that types in a common formula or function. We will then learn to have buttons accomplish more complicated tasks. We will consider an example of building a calculator to do calculations in a group. Finally, we will learn how to do notebook manipulations with buttons. An example here is to have a button find a particular cell in a notebook, read it in, and then create a new notebook based on the input.

Concurrent Session of Contributed Papers 5 Wright Hall 10

2:00 **Trisecting an Angle**
Phil Wood, Baxter, Iowa
You already know that this cannot be done and I do not. You should come see what I have to say on this subject and other related subjects.

2:30 **An information-theoretic approach to demography.**
Jonathan D. H. Smith, Iowa State University
Human demography provides an analysis of census information for a country, aiming to predict the future growth and development of the population. Traditionally, it has relied on a mass of detailed data involving survival and birth rates for various age groups, entered into a matrix known as the *projection* or *Leslie matrix*. A new, information-theory based approach reduces a description of the intensive state of a typical population to five key macroscopic parameters, much as the ideal gas model in physics replaces detailed knowledge of individual molecules with global variables such as temperature. Tracking the kinematics of the five-dimensional parameter vector leads to effective predictions about the future state of the population.

3:00** **Octagon Loops**
Emily Wergin, Grinnell College
An octagon loop is formed by placing regular octagons adjacent to one another so that each octagon borders two others and a single space is enclosed. Such a loop can only be formed with an even number of octagons. The purpose of this research is to explore how many loops can be formed for n octagons. I found a method for counting a special class of convex octagon loops.

3:30** **Comparing the SAT and ACT**
Ben Jones, Grinnell College
It is difficult to compare student performance on the SATs and ACTs. Simple linear regression makes little sense since there is no natural independent and dependent variable. This talk reports on a summer project where an equipercentile and a linear scaling model were developed to analyze pairs of test scores of students in the Grinnell applicant pool. The result was a table, unique to Grinnell, used to compare scores on the two tests.