MD/DC/VA Fall 2001 Meeting Contributed Papers - Four Sessions
Graduate Student Papers – Four Sessions

CONTRIBUTED PAPERS C1: 10:00-10:30 AM

Ray Fletcher, Virginia State

A Structure Theory for Central Digraphs with Nontrivial Homomorphic Image

A central digraph is a directed graph with the property that if (a,b) is any pair of vertices, then there exists a unique path of length 2 from a to b. A central digraph can be turned in to an algebra by taking vertices as elements and defining a product ab to be the midpoint of the unique 2-path from a to b. Donald Knuth called such an algebra a central groupoid, and demonstrated a one-one correspondence between central digraphs and finite central groupoids. Due to this correspondence we can use the usual algebraic notion of homomorphism in connection with central digraphs. We will present a structure theory for central digraphs with nontrivial homomorphic image, which parallels somewhat the classical structure theory for quotient groups.

Roland Minton, Roanoke College

Reviews of Calculus Reform

Colleagues' reviews over the six years of the development of a calculus book provide one measure of how successful and widespread the calculus reform movement has become. Excerpts from numerous reviews will be quoted to address the issue of which aspects of calculus reform will become standard, as well as to indicate some of the pressures and impediments to change encountered by current textbook authors and publishers. (Note: the second edition of Calculus by Smith & Minton will be published by McGraw-Hill in 2002.)

Craig Bailey, U.S. Naval Academy

Latitude and Longitude on an Ellipsoidal Earth

Latitude and longitude on a spherical earth is just spherical coordinates (almost). An ellipsoidal earth adds some subtlety and some complexity. This talk will describe which definition of latitude is used, of several available, and how that choice was made. It will also cover distance between 2 points of known latitude and longitude.

CONTRIBUTED PAPERS C2: 10:40-11:10 AM

Judy Kidd and Jeanne Fitzgerald, James Madison University

What happens when teachers create activities to improve geometrical visualization skills of middle school students?

Teachers of grades 4-8 from Augusta, Page, Rockingham, and Shenandoah counties worked together with pre-service teachers and faculty at JMU last summer to create more than 100 problem-solving activities for middle school students. Every activity emphasized geometric visualization of mathematical concepts. In this talk, we will discuss how the teachers' own skills and attitudes changed during their work, and we will share several of the engaging and unique activities that resulted. (The workshop was funded by the federal Dwight D. Eisenhower Professional Development Program through the State Council of Higher Education for Virginia.)

George DeRise, Thomas Nelson Community College

FIBER BUNDLES; the MATH, the PHYSICS

A fiber bundle is a very complicated abstract construct developed in the 1930's to sort out questions posed about the topology and differential geometry of manifolds. The fiber bundle concept was adopted by the physicists and amazingly enough it is the mathematical formulation of Dynamical Theories. The strong, weak and electromagnetic interactions explained physically by gauge theories mathematically are principal fiber bundles. A great example of Eugene Wigner's, "Unreasonable Effectiveness of Mathematics in the Natural Sciences"!

Ilhan M. Izmirli, Strayer University

Invariance Vectors in Music

There are certain operators in music called the ***twelve-tone operators*** (TTO) that can be defined in simple algebraic terms on appropriate spaces. It is musically important and mathematically interesting to study the invariances and complement mappings of such spaces under the TTOs. The ***invariance vectors*** provide us with a systematic method of doing this. In this paper, I will talk about the ***invariance vectors*** and some related concepts such as ***set-classes*** and the ***Prime Form Algorithm*** and discuss their significance in mathematics and music.

Lincoln Bragg

Seven and Seventeen Sided Polygons

The idea was put forth in 600-300 BC that perhaps everything meaningful about life and the universe could be understoon in terms of numerical relationships. As part of gaining an appreciation of the role that this idea has played in the intellectual development of western civilization, one might want to gain some idea of how Carl Friederiche Gauss determined in 1796 that one can construct the seventeen sided regular polygon with straight edge and compass. The underlying algebra (although not the constructibility) is the same, and can be seen more simply, for the case of seven sides.

CONTRIBUTED PAPERS C3: 11:20-11:50 AM

William N. Traves, U.S. Naval Academy

The Elliptic Curve Attack on RSA Encryption

The RSA-algorithm forms the basis for a popular method of public-key encryption. Elliptic curves are special curves whose points form a group. I will explain an attack on RSA that uses elliptic curves to help factor large numbers.

Fat C. Lam, Gallaudet

A Theorem on Slopes and an Application

A theorem relating the slopes of the sides of a triangle in projection equidistant position is proved. An application of this theorem is another proof of the Pythagorean Theorem.

Caren L. Diefenderfer, Hollins University

Quantitative Literacy: National and Local Perspectives

The National Council on Education and the Disciplines (NCED) has recently published "Mathematics and Democracy: The Case for Quantitative Literacy." I wish to summarize the key issues in their case statement and discuss some of the response papers. In addition, I will describe the relatively new Quantitative Reasoning program at Hollins and give a brief overview of our faculty development program (NSF funded) during 2000-2001.

Alexander White, American University

Visual Comprehension Skills of Incoming Calculus and Applied Calculus Students

We have created an assessment tool to measure the basic visual thinking skills of students entering calculus and have applied this instrument to all calculus and applied calculus students at American University. The results show, that despite increased use of graphing calculators in high school and recent emphasis on graphing in mathematics reform efforts, students still have great difficulty understanding graphs and their relationship with the corresponding equations.

CONTRIBUTED PAPERS C4: 2:50-3:20 PM

William P. Wardlaw, Naval Academy

Factoring Polynomials with Matrices

Two elementary methods of using matrices to factor polynomials over finite fields are given. The first factors a cyclotomic polynomial over a finite field by finding matrix representations of roots of the polynomial in a splitting field of the polynomial. The second starts with a companion matrix of the polynomial and examines the action of powers of the matrix on randomly chosen vectors. When successive powers of the matrix acting on a single vector produce a dependent set of vectors of size smaller than degree of the polynomial, a factor of the polynomial is obtained.

John H. Drew, College of William & Mary

The Completely Positive and Doubly Nonnegative Completion Problems

A symmetric matrix A is called completely positive if it can be written as the product of B and B transpose, for some entrywise nonnegative matrix B. Every partially specified symmetric matrix, the graph of whose specified entries is G, and each of whose fully specified submatrices is completely positive, may be completed to a completely positive matrix if and only if G is a chordal graph in which distinct maximal cliques overlap in at most one vertex. The same result holds for matrices that are doubly nonnegative (entrywise nonnegative and positive semidefinite).

Kevin Peterson, Lynchburg College

Teaching Calculus Using Geometer's Sketchpad

In this talk we will show some of the many capabilities of Geometer's SketchPad that make it tool that can be used in many mathematics classrooms. Furthermore, we will exhibit several interactive examples that demonstrate some interesting Calculus concepts.

David Stanford, College of William and Mary

Matrix Patterns and Line Sums

Given an m-dimensional vector r and an n-dimensional vector c with equal entry sums, we characterize the zero-nonzero patterns of m-by-n matrices with row sums r and column sums c. In the case m=n and r=c, we characterize the patterns of symmetric, and of skew-symmetric, matrices with row and column sums r.

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MD/DC/VA Fall 2001 Meeting Graduate Student Papers - Four Sessions

GRADUATE STUDENT PAPERS G1: 10:00-10:30 AM

Anna Duzs-Moore, Morgan State University
The Fractal Geometry of Nature
This talk will focus on how the study of fractal geometry will change the way we view nature around us: it will show how fractal geometry can generate precise models of physical structures from ferns to minerals, and much more. No prior knowledge of the subject is assumed. This presentation includes a collection of common natural objects to illustrate Mandelbrot's Manifesto that "There is a Fractal Face to the Geometry of Nature."

Wayne M. Eby, Maryland
Laguerre Calculus on the Heisenberg Group as
Applied to the Pompeiu and Morera Problems with Moments
Much is known regarding the Pompeiu problem in Euclidean space, and some recent research on the problem has been directed toward the Heisenberg group. One may like to see whether certain of the known results in Euclidean space extend to the setting of the Heisenberg group. Herein we consider in particular the moment version of the Pompeiu problem and utilize Laguerre calculus to obtain some results.

GRADUATE STUDENT PAPERS G2: 10:30-11:00 AM

William Ott, Maryland
The Dimension of the Human Genome
Genomic sequencing research can be interpreted in the context of dynamical systems in general and symbolic dynamics in particular. In this talk we shall explore the calculation and scientific significance of dynamical invariants such as metric entropy and dimension spectra. We will discuss the connection between dimension theory and genomics and comment on the ways in which dimensional analysis may shed new light on the global aspects of the sequencing problem.

Bernard Fulgham, Virginia
The Center For Nondegenerate Quadratic Jordan Algebras
It has been conjectured that the center (elements that behave like scalar multiples of 1) of a quadratic Jordan algebra J should be defined in terms of its centroid (linear transformations on J that behave like scalar multiplication). When the algebra is nondegenerate, this characterization is sufficient, but it falls short when considering degenerate algebras. The talk will be self contained; no prior knowledge of quadratic Jordan algebras will be assumed, and all necessary definitions will be presented.

GRADUATE STUDENT PAPERS G3: 11:00-11:30 AM

Christopher Hammond, Virginia

Compactness of the Inclusion Map between Bergman Spaces

For p >= 1, the Bergman space A^p is the Banach space consisting of all analytic, p-integrable functions on the complex unit disk. It is well known that the Bergman spaces are nested: A^p iscontained in A^r for r < p. This talk provides a clean, straightforward proof that the inclusion map i: A^p -> A^r is a compact operator.

Chris Massey, Virginia Tech

Using Flexible Galerkin Methods to Investigate Error Behavior in Discontinuous Galerkin Methods

The first half of the talk will focus on the development of the Flexible Galerkin Method (FGM) on a linear hyperbolic pde. The second half will focus on Discontinuous Galerkin Method (DGM) results obtained using the FGM including an a posteriori error estimate hypothesis.

GRADUATE STUDENT PAPERS G4: 11:30-12:00 AM

David Ferguson, Virginia Tech Mathematics

Group Product Cellular Automata

Cellular Automata or Finite Discrete Dynamical Systems have been a subject of much interest, both since relatively simple models can give complex results and because of the ease with which they can be implemented on a computer. In the talk I will give results from the particular system that I have been studying which is strings of group elements with the transformation rule being adjacent element group product with cyclic boundary conditions.

Jim Bowling, Virginia

The Ring of Fractions of a Quadratic Jordan Algebra

Outlining thesis in which the concept of a ring of fractions for a quadratic Jordan algebra is defined and necessary and sufficient conditions are exhibited for the existence of such a ring of fractions.