ABSTRACTS
Joint Conference
Mathematical Association of America, Southeastern Section
Society for Industrial and Applied Mathematics, Southeastern Atlantic Section
Auburn University
Auburn, Alabama
31 March – 1 April 2006

Key: * = presenting author; ** = undergraduate; *** = * + **

Convergence of p-Series Revisited and Some Applications

***** Elom Abalo, Wofford College and Kokou Abalo, Erskine College**

We construct two adjacent sequences that converge to the sum a given convergent p-series. In case of a divergent p-series, lower and upper bounds of the partial sum are constructed. In either case, we extend the results obtained by Hansheng and Lu (2005) to any integer greater than 1. We give some numerical examples.

Multidecomposition of the Complete Graph into Graph Pairs of Order 5 with Various Leaves

Atif Abueida*, University of Dayton and Christian Hampson, Colorado State University

A graph-pair of order t is two non-isomorphic graphs G and H on t non-isolated vertices for which G [H _= Kt for some integer t _ 4. Given a graph-pair (G,H), we say (G,H) divides some graph K if the edges of K can be partitioned into copies of G and H with at least one copy of G and at least one copy of H. We will refer to this partition as a (G,H)-multidecomposition of K. In this paper, we consider the existence of multidecompositions of Kn−F for the graphpairs of order 5 where F is a Hamiltonian cycle or a 1-factor. Where a multidecomposition is not feasible, we will also look for maximum multipackings and minimum multicoverings of Kn − F.

On Iterative Processes Generating Dense Point Sets

Gergely Ambrus, Auburn University

The central problem of the presentation is the question of denseness of those planar point sets P, a specific triangle center (incenter (IC), circumcenter (CC), orthocenter (OC) resp.) is also in the set P. All of the results are joint with A. Bezdek. We generalize and solve the CC problem in higher dimensions. We prove that if a point set $P \subset E^n$ has the property that for each simplex of P the circumcenter of the simplex also belongs to P, then it is dense in the whole space. We present the solution of the OC problem in the plane, essentially proving that P is either a dense point set of the plane or it is a subset of a rectangular hyperbola. In the latter case, it is either a dense subset or it is a special

discrete subset of a rectangular hyperbola, for which we give both an algebraic and a geometric characterization.

Can You See a Ring?
Professor David Anderson, University of Tennessee--Knoxville

Let R be a commutative ring with identity. The zero-divisor graph of R is the graph $G(R)$ with vertices the nonzero zero-divisors of R and two distinct vertices x and y are adjacent if $xy = 0$. We will discuss the connection between ring-theoretic properties of R and graph-theoretic properties of $G(R)$.

On the Chromatic number of the $AO(2,k,k-1)$ graphs
****Navya Arora and Debra Knisley, East Tennessee State University**

Let a, k and t be positive integers, $0 < t < k$, $0 < k$, and $0 < a$. We define the Alphabet Overlap graph by $G = AO(a,k,t)$ where the vertex set of G is the set of all k-letter sequences over an alphabet of size a. There is an edge between vertices $u \neq v$ if and only if the last t letters in u match the first t letters in v or the first t letters of u match the last t letters of v. The chromatic number of $AO(a,k,t)$ is known for all values of a when $t \leq k/2$ but it is not known in the case $t > k/2$. We consider the chromatic number for the $AO(a,k,t)$ when $k > 2, t = k-1$ and $a = 2$.

Uniqueness of Solutions for Third Order Boundary Value Problems on a Time Scale
Ashley Askew, Clayton State University

A Plethora of Algebra Examples from Rank One Matrices
Catherine C. Aust, Clayton State University

A semigroup with a left identity and right inverse for each element is not necessarily a group. A search for such an example using matrices resulted in, for each integer n greater than or equal to two, infinitely many examples using rank one $n \times n$ matrices. In addition, the search revealed many other interesting abstract and linear examples involving subsets of these matrices. These additional examples include groups of rank one matrices whose identity elements are very different from the identity matrix.

The Braid Index and Number of Seifert Circles for a Link
Jennifer Aust, Clayton State University

This talk/poster will focus on Seifert circles, braids, and their relationship, with a discussion of bunching operations. Discussion will lead to a proof that the braid index for a link equals the minimum number of Seifert circles.

Rational Vertices for Triangles Inscribed in the Unit Circle
Paul Baker, Catawba College

Problem 1736 in the Mathematics Magazine asks, “Is there a triangle all of whose vertices are points with rational coordinates on the unit circle and whose vertex angles are 45, 60 and 75 degrees?” Although the concepts and proofs are fairly elementary, they do give some insight into the connections between geometry and elementary number theory. This will be completely accessible to undergraduates.

Extremal Eigenvalue Problems and Applications
Laurie Battle, Georgia College & State University

Considering eigenvalue problems of the Stieltjes Sturm-Liouville type, we search for extremal values of eigenvalues as the problem parameters vary over some set. We discuss applications such as maximizing the fundamental frequency for vibrating elastic systems. We examine a fourth order problem where the coefficient functions vary over a certain set. To determine the existence of extremal eigenvalues, we apply a theorem which guarantees the continuous dependence of the eigenvalues on the problem parameters under certain hypotheses. We prove the existence of coefficient functions that attain the maximum value of the least eigenvalue, realizing that these functions may not be elements of the original set.

Mathematics History Across the Curriculum: An Integrated Approach for Future Teachers
*** B.D. Beasley, P.E. Campbell, D.S. Daniel, G.D. Goeckel, C.C. Harshaw, Presbyterian College and D.E. Schoolfield, Bell Street Middle School**

Recognizing the significance of learning through a historical context, but lacking "spare" hours in the major, our department developed an integrated approach to teaching mathematics with history. We will share our development and implementation process along with successful teaching and learning activities. This work is supported by the MAA's Preparing Mathematicians to Educate Teachers (PMET) project, funded by the National Science Foundation Grant DUE-0230847.

Brian Becker, Western Carolina University
Mastering Monopoly

Solving Algebra Word Problems Using Simple Diagrams
*** Debbie Bell and Cynthia Sikes, Georgia Southern University**

Presenters will demonstrate a visual method for solving simple work problems. Examples for Math for K-8 Teachers Courses, Learning Support Math Courses, and College Algebra will be illustrated.

Exploring the Outcomes of Placing an Inscribed Triangle
****Carissa Berglund, Elon College**

When one triangle is inscribed in another, the edges can be extended to form more triangles. This talk will explore the relationship between the placement of the vertices of the inscribed triangle and the areas of the resulting triangles.

Some Data from the North Carolina Early Mathematics Placement Testing Program, 1997-2006
Robert L. Bernhardt, East Carolina University

The NC EMPT program is financed by the General Administration of the University of North Carolina System. The goal of the program is to reduce the amount of mathematics remediation required in the universities throughout the UNC System. The method used is to give a facsimile of a mathematics placement test to high school algebra II completers (mostly sophomores and juniors, but some seniors as well), who volunteer to take it, and to report their scores back to those students and their teachers. By identifying at-risk students early, one hopes that they will be motivated to fix the problem before graduating from high school. This talk will present data from the program for the last nine years.

Euclidean Geometry as a Teaching Tool
Andras Bezdek, Auburn University

In the talk I mention a couple of problems (different from well known classical ones) of Euclidean geometry, whose solutions turned out to be extremely useful at teaching mathematical thinking for undergraduate students.

Wazir Circuits, Pick's Theorem, Counting Corners, and Parity
Irl Bivens, Davidson College

A ``wazir" is a now obsolete chess piece that moves exactly one square at a time vertically or horizontally. (It is sometimes referred to as a ``single-step rook".) In this talk we will discuss an interesting parity result for wazir circuits on chess boards of arbitrary size. We allow our chess boards to be ``obstructed" in the sense that movement into certain squares may be forbidden by ``guideposts". Any square of the board without a guidepost will be called "acceptable". A ``wazir circuit" is a sequence of moves in which the wazir begins in an acceptable square, ends in the same square, and visits every other acceptable square on the board exactly once. Our goal is to determine the parity of the number of moves the wazir makes in a specified direction (e.g. to the right) during a circuit.

Isoperimetric Problems in the Euclidean Plane
Michael Bleicher, Kennesaw State University

This talk will survey some of the classical isoperimetric problems and focuses on new variations.

Bridgette Boley, Western Carolina University
The Origin of Pi

The Shift from Faculty to Administration…Moving on up to the East Side or over to the Dark Side? Larry Bouldin, Dean of Math-Science, Roane State Community College, facilitator/moderator

Many times, leadership of a department comes from within the institution; other times not. Whenever a new person comes to the position, however, that person looks in vain for the instruction book of how to do the job. While there may be some contacts or sources of information or help, most are left to navigate the waters on their own. One individual has referred to the whole experience of being a chair or dean as "herding cats". This session will focus on this challenge by considering some insights that the presenters have gained in their years of experience in leading a group of faculty and dealing with other administrative levels at a school.. Tips, pitfalls, war stories, and good times will be related. Audience participation will be appreciated (and expected). Those who may desire to make the transition from teaching to administration, those presently involved in such endeavors, and those who are veteran leaders are encourage to attend and share advice and information.

Fast Solvers for C^0 Interior Penalty Methods
Susanne C. Brenner, University of South Carolina

C^0 interior penalty methods are discontinuous Galerkin methods for fourth order elliptic boundary value problems that have many advantages. In this talk we will first give a brief introduction to C^0 interior penalty methods and then discuss multigrid and domain decomposition methods for solving the resulting systems. We will present convergence results for the V-cycle, W-cycle and F-cycle multigrid algorithms, and also condition number estimates for two-level additive Schwarz preconditioners. Numerical results will also be reported.

Equivalence Classes of Matrices and the Rational Canonical Form
Jayson Burak, Coastal Carolina University

Square matrices form equivalence classes via change of bases. To determine which matrices belong to which equivalence classes, we use the rational canonical form. In this talk, we will show how to construct the rational canonical form and the change of basis matrices.

Parallelogons and Cutting Elliptical Cakes.
Douglas G. Burkholder, Lenoir-Rhyne College

While the definition of an affine regular polygon is straight forward - any polygon which is the affine image of a regular convex or regular stellar polygon - it is not obvious how to determine whether or not a given polygon is affine regular, nor is it obvious how to easily construct an affine regular polygon without an affine map. In this talk, we produce three generalizations of parallelograms and prove that they are equivalent. These provide

a simple technique for constructing and a simple technique for identifying affine regular polygons - both convex and stellar - using a quilter's ruler and a single calculation.

We then use the quilter's ruler, and occasional calculations, to cut elliptical cakes equally, even after someone has made the first cut. If someone has cut, but not removed, one or more pieces from the elliptical cake, we can determine whether or not they are $1/n^{th}$ of the cake. Since a photograph of a round cake will look elliptical, we can also analyze photographs of round cakes to determine whether or not the pieces are $1/n^{th}$ of the cake.

A Tree Decomposable Graph Model for RNA Structure Search
Liming Cai, University of Georgia

Searching genomes for RNA secondary structure with computational methods has become an important approach to the annotation of non-coding RNAs. Fast and effective search requires efficient structure-sequence alignment algorithms established upon accurate RNA structure models. However, due to the computational intractability of RNA pseudoknot prediction, such algorithms are difficult to obtain. In this talk, we introduce a graph-theoretic model for RNA secondary structure, which profiles the topology of the structure with a graph and nucleotide pairings with covariance models. Such a graph demonstrates small tree width for almost all RNA structures including pseudoknots.

Within this framework, the optimal structure-sequence alignment can be accomplished via dynamic programming on a tree decomposition of the graph in time $O(k^t n^2)$, where t is the tree width of the decomposition, k is a small parameter, and n is the length of the profiled RNA sequence. Applications of the alignment algorithm to searches in genomes have yielded the same search accuracy as methods based on the covariance model but with a significant reduction in computation time. In particular, very accurate searches of tmRNAs in bacteria genomes and of telomerase RNAs in yeast genomes can be accomplished in days, as opposed to months required by other methods.

Sequence Motif Recognition using Artificial Neural Networks.
*****Nicholas Cain and Laurie Heyer, Davidson College**

Many techniques in sequence motif recognition, such as MEME, rely on statistical analysis of biological information to identify conserved regions. Such techniques rely solely on primary structure information, and do not consider the more complicated molecular dynamics at work in a biological system. Often molecular secondary structure is essential in the facilitation of the motif's biological function. An algorithm that utilizes artificial neural networks to identify degenerate, conserved regions in mRNA molecules has therefore been developed, which exploits estimation of the molecules secondary structure using MFOLD. A committee machine architecture is used, implemented in parallel with grid computing techniques. This algorithm successfully identifies a seven base-pair motif in mRNA strands known to locomote to the forming bud-tip during mitosis in S. cerevisiae, where the importance of secondary structure in motif function has been established.

Straight Talk about Large Primes
Chris K. Caldwell, University of Tennessee at Martin

A graph of the logarithm of the digits in the largest known primes over the last 50 years is approximately linear. We use a "Moore's Law" along with estimates of the time it takes to find large primes to explain why this is true and why it should continue for some time.

A New Approach to Poisson Approximation of Simple Point Processes Using Compensators
*** Jayalakshmi Casukhela and Kameswarrao S. Casukhela, Ohio State University and Hussain Elalaoui-Talibi, Tuskegee University**

Consider a simple point process N on the line, and let $\hat{N}$ be its compensator. We use a result of Kallenberg (2005) to give a new approach to estimate the total variation distance between the distributions of N and that of a Poisson process when $\hat{N}$ has small jump sizes.

Critical Values for Normal and Half-Normal Probability Plots with Application to Unreplicated Two-Level Factorial and Fractional Factorial Designs
*** Charles W. Champ and Minal Vora, Georgia Southern University**

Normal and half-normal probability plots have often been used to analyze data from a unreplicated two level factorial and fractional factorial designs. Interpreting the data for active effects is subjective on the users part. A method is given for estimating (via simulation) limits (critical values) for the plotted points that can be used to determine objectively if an effect is active. Recommendations are given for selecting plotting positions. A second method, also based on simulation, estimates the maximum probability for various ordered data values that they will provide as much evidence or more against the assumption they are estimating inactive effects. Examples are provided.

Vectors, Computer Art and Toy Story
Timothy P. Chartier, Davidson College

Ray tracing, necessary in animated films, is an eye-catching application of mathematics and modeling that can transform a mathematician into a graphic artist. In more precise terms, ray tracing is the process of mathematically generating visual art from a given description of a scene via geometrical modeling of light rays. This talk introduces ray tracing at basic levels.

In particular, I demonstrate the use of free raytracing software called POV-Ray that can be used in computer classrooms in connection with either liberal arts math classes or Calculus. Students enjoy exploring three dimensions with this software.

I'll Take the Lamborghini

Jack Cheng, Western Carolina University

A Fractional Step θ-Method for Convection Diffusion Problems
****John Chrispell, Clemson University**

The accurate numerical solutions of viscoelastic fluid flow problems poses two difficulties: the large number of unknowns in the approximating algebraic system (corresponding to velocity, pressure, and stress), and the different mathematical types of the modeling equations. Specifically for viscoelastic fluid flow the conservation of momentum equation is parabolic, and the constitutive equation for the fluid is hyperbolic. An appealing approximation approach is to use an operator splitting method which decouples the conservation of momentum equations from the constitutive equation. This split thereby reduces the size of the linear systems that need to be solved, and separates the parabolic and hyperbolic equations into different substeps. Motivated by the viscoelastic fluid flow problem, we consider an operator splitting fractional step θ-scheme for the numerical approximation of time dependent convection-diffusion problems. Here the fractional step θ -method allows for the convection and diffusion operators to be considered in separate solution substeps. In this presentation we describe the approximation scheme, present numerical simulations, and give some preliminary theoretical results.

Teaching Mathematics Majors How to Write Mathematics
Jeff Clark, Elon University

Many of our best mathematics students have trouble putting their work in print. This talk will talk about how Elon has use writing developmentally throughout its mathematics curriculum, along with examples of assignments.

Perusing Pascal's Triangle
Christa Conner, Western Carolina University

Negative-norm Least-squares Methods for Axisymmetric Maxwell Equations
Dylan Copeland, Texas A & M University

We present negative-norm least-squares methods for the axisymmetric static and time-harmonic Maxwell equations in three dimensions. The method approximates the solution in a two-dimensional meridian plane, eliminating unnecessary computation. To achieve this dimension reduction, we must work with weighted spaces in cylindrical coordinates. In this setting, approximation spaces enriched by bubble functions are analyzed. We also report the results of some numerical experiments, which demonstrate quasi-optimal convergence rates and robustness with respect to the domain and coefficients.

A Study of the Type I and Type II Error Rates of Tests for Species Diversity Based on Shannon's Index of Diversity
Kristina R. Corts, Kennesaw State University

You Are What You Breathe: A Study of Air Toxins in Kingsport Tennessee
Kristen Dale*, Adraea Brown, and Kyla Williams, Spelman College

This study seeks to find if the people living in the city of Kingsport, Tennessee are at risk from the levels of chemicals being detected in the air. Kingsport is a moderate size suburban city located in Northeastern Tennessee with a population of approximately 45,000. Within Kingsport are several gas stations, chemical companies, dry cleaners, and other industries that are known to emit hazardous chemicals into the air. The chemicals chosen for this study are propylene, acetylene, formaldehyde, acetone, m/p xylene, and toluene, based on what the industries in the area emit. The findings indicate that the chemical concentration levels are below what EPA designates as the minimum level at which people should be concerned. Although these levels are low, additional monitoring should continue to ensure the safety of the Kingsport residents.

A Knight's Tour for all Rectangular Boards with Minimum Square Removal
Joe DeMaio, Kennesaw State University

A closed knight's tour is a tour that using legal moves of a knight visits every square on a chess board exactly once and returns to its starting position. In 1991, Schwenk classified all rectangular chess boards that admit a knight's tour. For a rectangular chessboard that does not contain a closed knight's tour, this talk determines the minimum number of squares that must be removed in order to admit a closed knight's tour. Also, constructions that generate a closed tour once appropriate squares are removed are provided.

Convergence of Nonstationary Subdivision
Baiqiao Deng, Columbus State University

In studying convergence and regularity of stationary and nonstationary subdivision schemes one usually reduces matters to considering associated trigonometric polynomials via the Fourier transforms of scaling functions. When the mask coefficients used in nonstationary subdivision schemes are dependent of the scale and location at the same scale, trigonometric polynomials may not be adequate in studying convergence and regularity of the nonstationary subdivision schemes. We study convergence of the scaling functions associated with the nonstationary subdivision by bi-infinite matrices, which can be used to construct multiwavelets. We provide several sufficient and necessary conditions for the convergent nonstationary subdivision scheme.

Modeling the air conditioning system at the Macon Volunteer Clinic
Jeff Denny and Carrie Keel, Mercer University

The Macon Volunteer Clinic building is cooled using four independent air conditioner systems. Due to the placement of the air condition system controllers and the floor plan, these systems do not effectively cool many areas in the clinic. We will present a temperature model of the clinic that uses a system of differential equations to divide the clinic into seven zones. Challenges in collecting data and modeling heat sources will be

discussed along with our suggestions for improving the efficiency of the cooling systems in the clinic.

Vacuum Formation in Multi-Dimensional Compressible Flows
****Kristen DeVault, North Carolina State University**

It is well known that vacuum formation can occur for inviscid compressible flows. However, for viscous compressible flows, governed by the Navier-Stokes equations, vacuum formation in the multidimensional case is an open question. The analytic difficulties associated with this problem translate into numerical difficulties requiring the use of a highly accurate method. Using a spectrally accurate collocation method, we show that vacuum formation does occur under certain conditions.

Connectivity in Trees: An Investigation into the Geometric and Combinatorial Properties of Graphs Arising in Pure Mathematics
Wesley Digh, University of North Carolina at Asheville

Occurrence of Discrepancies In Common Continuous Distributions Using a Student-t Test
Christine Doyle and Eric Howington, Coastal Carolina University

The standard way to analyze sample data is to calculate the test statistic using raw data. Sometimes when dealing with large quantities of sample data, grouped data (for example binned data from a histogram) is used in lieu of raw sample data. Depending on how the sample data is distributed with respect to the class marks, the grouped data may give results that differ from those of the raw data. In this study, random pseudo-sample data is generated from common distributions and tested using the Student t-distribution both as raw data and grouped data. Using R, the number of times the pseudo-data disagrees (either the raw or grouped data rejects the null hypothesis and the other fails to reject the null hypothesis) is calculated and a percentage of agreement for each of the distributions is tested. The normal, uniform and exponential distributions all have agreement rates in the mid to high 90th percentile. The Cauchy distribution had an agreement rate of approximately 80 percent. Results of these simulations will be presented.

A Problem Concerning Set Partitions
Bryce Duncan, Auburn University Montgomery

A routine exercise from Herbert Wilf's ``Generatingfunctionology'' suddenly became a great deal more interesting when the wording was changed from ``Let f(n) be the number of subsets of [n] that contain no two consecutive elements'' to ``Let f(n) be the number of set partitions of [n] that contain no two consecutive elements.''

A Markov Chain Model for Osmosis
Steven Edwards, Southern Polytechnic State University

We construct a Markov Chain model for osmosis, using a variation of the Ehrenfest Urn model for diffusion of gasses. We examine elementary properties of this Markov Chain and use it to explain long-term behavior of a system of two types of particles separated by a semi-permeable membrane.

Uniform Convergence of A Nonlinear Energy-based Multilevel Quantization Scheme Via Centroidal Voronoi Tessellations
Maria Emelianenko, Carnegie Mellon University and Qiang Du, Pennsylvania State University

Efficient algorithms for computing the centroidal Voronoi tesselations play crucial role in many large scale scientific and engineering problems, such as data communication, vector quantization and mesh generation. In this talk, we discuss the details of a recently developed multilevel approach to the optimal quantization problem. The new multilevel scheme offers considerable speed up over the traditional methods such as the celebrated Lloyd iteration. Since the problem is nonlinear in nature, it cannot in general be analyzed using standard linear multigrid approach. We propose an alternative optimization formulation that makes it possible to develop a rigorous mathematical theory for the new algorithm and prove its uniform convergence with respect to the problem size for a large class of densities. Both the details of convergence analysis as well as the results of numerical experiments confirming the theory will be provided.

Evaluation and Comparison of Normalization Methods for Genomic Microarray Data
****Alexander Engau and Margaret E. Staton, Clemson University**

The tremendous progress in microarray technology has produced a vast amount of experimental genomic data. A common problem in comparing these results, however, is that many experiments use different instruments or unequal hybridization intensities and thus show effects which arise from variation in technology rather than biological differences. The purpose of normalization is to adjust for those effects by balancing the individual signal intensities and eliminating questionable or low-quality measurements. Based on our preliminary analysis which suggests that different methods of normalization dramatically determine the interpretation of the experiments, we propose a simple yet effective new normalization alternative.

Further Results on Holes in $L(2,1)$ Colorings on Certain Classes of Graphs
****Gilbert Eyabi and Renu Laskar, Clemson University**

An $L(2,1)$) coloring of a graph $G=(V,E)$ is a vertex coloring $f:V(G)\rightarrow\{0,1,2,\ldots,k)$ such that$|f(u)-f(v)|_2$ for all $uv2E(G)$ and $|f(u)-f(v)|_1$ if $d(u,v)=2$. The span $\lambda(G)$ is the smallest k for which G has an $L(2,1)$ coloring. A span coloring is an $L(2,1)$ coloring whose greatest color is $\lambda(G)$. Define the upper span $\Lambda(G)$ as the largest k for which G has an irreducible $L(2,1)$ coloring. An $L(2,1)$ -coloring f is a full-coloring if $f:V(G)\rightarrow\{0,1,2,\ldots,\lambda(G)\}$ is onto. h is a hole in an $L(2,1)$ coloring f, if

$h2[0,k]$ and there is no vertex v in G such that $f(v)=h$. Let $h_i(G)$ be the minimum number of holes over all irreducible $L(2,1)$ colorings of G, let $H_\lambda(G)$ be the maximum number of holes in an upper span coloring of G, let $H_i(G)$ be the maximum number of holes over all irreducible $L(2,1)$ colorings of G and let $H_\lambda(G)$ be the maximum number of holes in an irreducible span coloring of G. Let ρ(G), the index of G, be the minimum number of colors not used in an irreducible span coloring of G. A graph G is said to be a good graph if $H_\Lambda(G) - H_\lambda(G) = \Lambda(G) - \lambda(G)$. In this talk, we investigate holes in $L(2,1)$ colorings f on certain classes of graphs. We give exact values for the maximum number of holes for a path, cycle, star, complete graph, complete bipartite graph and give bounds for an arbitrary graph and other classes of graphs. We conclude the talk with a study on certain classes of graphs that are good graphs.

Numerical Analysis for a Line Arization of a Backward Euler Scheme for a Class of Porous Medium Equations
Koffi B. Fadimba, University of South Carolina Aiken

Numerical approximation of the saturation equation (that models two-phase flow through porous media)

$$(0.1) \quad \phi\frac{\partial S}{\partial t}+\nabla\cdot(f(S)u)-\nabla\cdot k(S)\nabla S=0,$$

using a Discrete Galerkin Finite Element Method, yields a nonlinear Euler Backward scheme. A linearization of the scheme through a first order Taylor expansion of the coefficients is proposed. Error estimates are established under reasonable assumptions on the first and second derivatives (with respect to time) of the solution to a Continuous Galerkin Approximation.

Roof Path Curvature: Santa vs. Rudolph
Robert Ford, Auburn University

A path of least curvature will be compared with the shortest path on a simple roof. This will lead to possible conclusions for other surfaces, including cylindrical.

Victoria Frost, Spelman College
Digital Processing and the Fourier Transform

Functionals and the Quantum Master Equation
Ronald O. Fulp, North Carolina State University

The quantum master equation is usually formulated in terms of functionals of the components of mappings (fields in physpeak) from a space-time manifold M into a finite-dimensional vector space. The master equation is the sum of two terms one of which is the antibracket (odd Poisson bracket) of functionals and the other is the Laplacian of a functional. Both of these terms seem to depend on the fact that the

mappings on which the functionals act are vectorvalued. It turns out that neither the Laplacian nor the anti-bracket is well-defined for sections of an arbitrary vector bundle. We show that if the functionals are permitted to have their values in an appropriate graded tensor algebra whose factors are the dual of the space of smooth functions on M, then both the anti-bracket and the Laplace operator can be invariantly defined. This permits one to develop the Batalin-Vilkovisky approach to BRST cohomology for functionals of sections of an arbitrary vector bundle.

Methods for Constructing Finite, Noncommutative Semigroups
****Sandra Gaskins and Ronald Linton, Columbus State University**

Employing a program that generates semigroups, given the criteria of noncommutative, regular, and of size n, $5 \leq n \leq 10$, with exactly k idempotents, $2 \leq k \leq n$, hundreds of semigroups were generated and dissected for patterns and common methods for constructing these semigroups. The methods of deconstructing these semigroups only to rebuild them are discussed, as well as the significant patterns found and propositions from these patterns and reconstructions. Finally, these propositions are proved.

HIV Epidemic Model for Uganda including Education Information Campaign
Kevin Gipson, University of Tennessee

A system of ordinary differential equations modeling the HIV epidemic in Uganda will be presented. The effect of information and education campaigns on the epidemic will be featured. Some parameters were estimated using data from Uganda. This work is joint with Suzanne Lenhart and Kendra Albright.

Incorporating a Critical Pedagogy of Place in the Rural Mathematics Classroom.
Jim Gleason, University of Alabama

We will discuss some of the education theory involved in a critical pedagogy of place. Then we will use this to explore how to use these ideas to incorporate rural issues into the mathematics classroom.

Derivations of a Giant
Gregory Goeckel, Presbyterian College

To me, the study of the history of mathematics is like giving the sense of smell to a student that can only see and touch. Topics become more interesting, which results in better comprehension.

Newton is quoted as writing "If I have seen farther than Descartes, it is because I have stood on the shoulders of giants." I believe that one of the `giants' that he was referring to was a professor of his by the name of Isaac Barrow. I will present Barrow's method of tangents along with several examples.

Gambling It All Away

****Ann Gregson, Elon University**

In the classic Gambler's Ruin, a gambler bets the same fraction of his current capital during each round of play. This talk will look at the probability of being in a losing position after n bets as n tends to infinity if the gambler bets half his current capital each round

****Adapting the Parareal algorithm to Reduced Order Models**
Chris Harden, Florida State University

The Parareal algorithm was introduced by Lions, Maday and Turinici as an innovative parallel approach to solving time dependent differential equations. The computation is divided across multiple processors, which work on separate but connected parts of the problem. As a result, accurate solutions can be computed in much reduced time. The key step in the Parareal algorithm is the decomposition of the temporal domain into a coarse grid shared by all processors, and fine grids unique to each processor. Data on the coarse grid may be regarded as boundary or initial data, which is passed back and forth between processors as it is computed and updated. We are interested in examining the behavior of this algorithm as a function of the number of processors for a variety of complex systems. We will present results based on standard test cases. It is our intention to employ this procedure in a parallel implementation of Reduced Order Modeling.

Gene Clustering Using SGO (Semantic Gene Organizer)
Kevin Heinrich and Michael W. Berry, University of Tennessee, and Ramin Homayouni, University of Tennessee Health Science Center

A major challenge in bioinformatics research concerns the interpretation of high-throughput genomic data and the understanding of functional associations between genes. Several approaches for extracting gene relationships from biological databases based on term-matching methods have been proposed. In this talk, we demonstrate a more flexible and automated approach for the identification of functional relationships (explicit and implicit) between genes from biomedical literature. The Semantic Gene Organizer (SGO) software environment, which employs vector space information retrieval models such as Latent Semantic Indexing, has been designed and implemented for the automatic identification of conceptual gene relationships from the indexing of titles and abstracts in MEDLINE citations.

An Exploratory Analysis of Hazardous Air Pollutants in Mississippi
Luvenia Hellems*, Shayla Ball, and Daana Nelson, Spelman College

This study analyzes trends and irregularities for Mississippi's Harrison, Hinds and Jackson counties in the chemical concentrations of Benzene, toluene, and formaldehyde. The health effects of these chemicals and the possible causes of the levels of their concentrations are also examined. Attempts have been made to correlate air quality with industrial accidents in the area and other meteoro logical factors.

Defining Mathematical and Educational Goals in Mathematics Courses for Elementary Teachers
Cindy Henning, Columbus State University

What mathematics should preservice elementary teachers know? Though mathematics educators and mathematicians may share the same vision of the content knowledge elementary teachers should possess, finding a common language that expresses that vision can be challenging. For example, if a learning outcome reads, "A student should be able to solve equations and inequalities in one variable," is this sufficient to communicate that the equations should be solved in a variety of ways, including graphical, numerical, symbolic and informally? If it is rephrased, what does solving the problem "informally" mean? Difficulties in developing a common language became evident during the revision of courses targeting preservice elementary teachers, which attempted to address the national recommendations produced by NCTM and the Conference Board of Mathematical Sciences while maintaining high mathematical expectations. In this session, we will discuss the challenges encountered during work with a Preparing Mathematicians to Educate Teachers (PMET) mini-grant.

A Class of Practically Nowhere Differentiable Functions on the Complex Plane
Andrew J. Hetzel, Tennessee Tech University

This talk presents a teaching note that could find classroom use in an introductory course on complex analysis. Using some of the most significant theorems from complex analysis, we provide a simple method for transforming many elementary functions (defined on the complex plane) into everywhere continuous functions that are differentiable only on a nowhere dense set. Accordingly, we term such continuous functions ``practically nowhere differentiable." The twofold pedagogical value of this method is that (1) students can readily generate examples of everywhere continuous, practically nowhere differentiable functions that do not require any direct appeal to infinite series, and (2) the often dynamical difference between the behavior of functions of a complex variable and functions of a real variable is showcased.

Bioinformatic Discovery of Co-Evolution
Robert Hochberg , East Carolina University

Co-evolution of organisms has been observed in the visible traits of those organisms (for example flower shapes and hummingbird beaks) as well as at the molecular level. In this paper we describe a computational approach to the discovery of co-evolving proteins and/or genes. The basic idea is that if two molecules, thought of as strings, are co-evolving, then this may be discoverable by correlating their evolutionary histories, obtained by finding optimally parsimonious reconstructions of the ancestral sequences. We'll describe the algorithm and show some examples of its implementaion.

Existence and Uniqueness of Solutions in Mini-Sudoku
Laura Hodge and Collin Witt

In this talk we will explore initial set-ups which produce unique solutions in a variant of the popular logic puzzle Sudoku. To date, a concise formulation describing initial conditions which determine a unique solution has not been discovered for 9×9 Sudoku. We will examine the more manageable 4×4 variation and present conditions which produce unique solutions. Explanations involve concepts including permutations, transpose, matrix row operations and first order logic. Factors affecting the number of givens will be categorized in order to gain some insight into the larger version of the puzzle.

Properties of Self-quasi-regularity in Certain Rings

Allen K. Hoffmeyer, Georgia College & State University

Let R be an associative ring, not necessarily having unity. Recall an element $x \in R$ is called *quasi-regular* if and only if solutions y and z exist for the equations $x + y - x * y = 0$ and $x + z - z * x = 0$, in which case $y = z$. This unique element $\hat{x} = y$ is called the *quasi-inverse* for x. It is well known that $\mathbf{J}(R)$, the Jacobson radical of R, is the unique largest ideal in R consisting entirely of quasi-regular elements. In this paper, we explore the implications of the case $x = \hat{x}$, that is, when a ring element is its own quasi-inverse. We call such elements self-quasi-regular. We explore $sq(R)$, the set of all *self-quasi-regular* elements, for certain rings, including homomorphic images of $\mathbb{Z}$, the integers. We characterize this set in some cases and also compare this set to $\mathbf{J}(R)$.

The Shields-Harary Numbers of the complete bipartite graph Km,n for Continuous Concave Cost Functions Vanishing at One

John E. Holliday*, North Georgia College and State University and Peter D. Johnson, Jr, Auburn University

The Shields-Harary numbers are a class of graph parameters that measure a certain kind of robustness of a graph, thought of as a network of fortified reservoirs, with reference to a given cost function. In this talk, we consider results pertaining to the Shields-Harary numbers of the complete bipartite graph with respect to the cost function $f(x) = 1 - x$ as well as to any cost function h with the property that $h(1) = 0$. We will also consider possible extensions to these results.

Notes on the Villainy of a Graph

Sarah H. Holliday*, University of Tennessee at Martin, Sally A. Clark, Birmingham-Southern College, John E. Holliday, North Georgia College and State University, Robert R. Rubalcaba, University of Alabama in Huntsville, Matt P. Walsh, Indiana University Purdue University, Peter D. Johnson, Jr. and Janet E. Trimm, Auburn University

Given a simple graph G on n vertices, and given a proper colouring of G using $k = (G)$ colours, written as an n-vector v, we consider the set $S(v,G)$ of n-vectors which are

permutations of v. For each element u of $S(v,G)$, we define the villainy of u with respect to G, denoted $b(u,G)$, to be the minimum number of components of u that must be permuted so that the resulting n-vector again represents a proper colouring of G. Then let $S(G)-s(v,G)$, where the union is taken over all proper colourings v, and define the Villainy of G, denoted $B(G)$, as the supremum over $S(G)$ of $b(u,G)$.

Convergence Analysis of Adaptive Edge Element
Methods in 3D Electromagnetic Field Computation
Ronald H.W. Hoppe, Univ. of Houston and Univ. of Augsburg

We consider an Adaptive Edge Finite Element Method (AEFEM) for the 3D eddy currents equations with variable coe±cients using a residual-type a posteriori error estimator. Both the components of the estimator and certain oscillation terms, due to the occurrence of the variable coe±cients, have to be controlled properly within the adaptive loop which is taken care of by appropriate bulk criteria. Convergence of the AEFEM in terms of reductions of the energy norm of the discretization error and of the oscillations is shown. Numerical results are given to illustrate the performance of the AEFEM.

****Parallel Implementation of Finite Element Code Using PETSc**
Jennifer Houchins, Clemson University

The Portable Extensible Toolkit for Scientific Computation (PETSc) is a set of software tools developed at Argonne National Laboratory for use in writing large-scale application codes involving the solution of Partial Differential Equations (PDEs). PETSc provides a means of creating a parallel implementation of an application code by using the Message Passing Interface (MPI). We wish to utilize PETSc to add parallel implementation and built-in solvers to the CAEFF viscoelastic flow model. In order to achieve this goal, steps have been taken to integrate PETSc and its solvers into a serial version of a one-dimensional finite element code which will be parallelized. This process will then be applied to a two-dimensional finite element code for Stokes equations and the CAEFF viscoelastic flow model. This work gives a brief description of features within PETSc and the steps required to incorporate PETSc into existing finite element codes. We also provide results for a one-dimensional test problem.

Linear Transport Models Exhibiting Hypercyclic Behavior
Keith Howard, Mercer College

In this talk we illustrate several transport models that exhibit the hypercyclic behavior associated with chaos. We will discuss and illustrate the source of this behavior in several systems and discuss connections between models.

An Update and Extension of the Prisoner's Guard Puzzle
*** Tim Howard and Eugen Ionascu, Columbus State University**

The Prisoners and Guards Puzzle was originally posed by David Woolbright (Computer Science Department, Columbus State University). In P&G, each square of an $n\times n$

checkerboard is occupied by a prisoner or a guard. A board configuration is called "valid" if the squares lying adjacent to each prisoner contain at least as many guards as prisoners. Our goal in studying the puzzle is to characterize the maximum number of guards that can be found on a valid $n \times n$ board. We discuss and prove the optimal cases up to $n = 6$ and obtain bounds for larger board sizes. We also discuss an extension of the puzzle to the torus.

Iterative Defect-Correction Strategies for Viscoelastic Fluid Flow
Jason Howell, Clemson University

The numerical simulation of viscoelastic fluid flow becomes more difficult as a physical parameter, the Weissenberg number, increases. Specifically, at a Weissenberg number larger than a critical value, the iterative nonlinear solver fails to converge. In this work we study defect correction methods for the Johnson-Segalman model of steady viscoelastic fluid flow.

As an extension of the work by Lee (Comp. Math. Appl. 2004) and Ervin and Lee (Numer. Meth. PDE 2006), we develop and analyze a twin parameter defect correction method for the full nonlinear Johnson-Segalman case. In the defect step, we artificially reduce the Weissenberg number to solve a stable nonlinear problem. We then determine the residual correction by solving a linearized version of the problem using a Picard-like iterative corrector. Numerical experiments verify the theoretical results of the method and extend the range of Weissenberg number for which flows can be computed. We also discuss and implement the incorporation of multigrid methods into the defect correction algorithm.

Small Sample Behavior of Robust Estimators of Multivariate Location and Scatter
Eric B. Howington, Coastal Carolina University

Many results in the theory of statistics are based on ``large sample" asymptotics. The theoretical properties of many robust estimators of location and scatter have been derived using asymptotic results. It has been recently discovered (Howington and Gray 2006, in progress) that these theoretical results do not accurately describe the behavior of robust estimators in ``small sample" situations. In ``real-life" applications, all statistical results are based on finite samples, many of them small in size. This talk discusses the small sample properties of robust estimators that are of interest to active practitioners of robust methods.

A Bounded Artificial Viscosity Large Eddy Simulation Model
Traian Iliescu, Virginia Tech

In this talk, we present a rigorous numerical analysis for a bounded artificial viscosity model for the numerical simulation of turbulent flows. In practice, the commonly used Smagorinsky model is overly dissipative, and yields unphysical results. To date, several methods for "clipping" the Smagorinsy viscosity have proved useful in improving the physical characteristics of the simulated flow. However, such heuristic strategies rely

strongly upon a priori knowledge of the flow regime. The bounded artificial viscosity model relies on a highly nonlinear, but monotone and smooth, semilinear elliptic form for the artificial viscosity. For such a bounded model, we have introduced a variational computational strategy, provided finite element error convergence estimates, and included several computational examples indicating its improvement over the overly diffusive Smagorinsky model.

The Effects of a Web-based program on Teaching and Learning in Calculus I
Andrew Incognito, Coastal Carolina University

The purpose of this study is to investigate the implementation of an interactive web-based application on student learning in freshman calculus. Specifically, this study looks at how technology may affect student performance, perception of learning, course satisfaction, and the relationship between performance and satisfaction. In addition, it will examine the impact of technology on mathematics teaching in a calculus course. In this experiment the students will use an interactive internet application developed at Temple University called Calculus on the Web (COW). COW provides instant feedback, visual representation, and step-by-step guidance on a full range of topics in a Calculus I course. Performance assessment will be based on students' exam results and satisfaction assessment and general student reaction will be based on student responses to pre and post questionnaires.

Parameterizations of Equilateral Triangles in Z^3
Eugen J. Ionascu, Columbus State University

It is known that equilateral triangles in Z^2 do not exist. However, in Z^3 there are so many that sub-classes of them can be parameterized up to translations over two free integer valued variables. Such parameterizations are given and related to the solutions of the Diophantine equation $a^2 + b^2 + c^2 = 3d^2$. A characterization of the side lengths of such triangles is provided. Connections with the existence of regular tetrahedral having integer coordinates are discussed and open related questions are proposed.

Estimating the parameter of the Skewed Double Exponential Distribution
Keshav Jagannathan, Coastal Carolina University

The Skewed Double Exponential (SDE) family of distributions is a part of the family of skewed distributions that has received a lot of attention in recent years. In this talk, I will present two methods to estimate the parameter of the SDE distribution and discuss certain problems that arise during the estimation process. Numerical simulation studies will be presented as evidence of desirable properties that these estimators possess.

Handling Graphics in LaTeX
Keshav Jagannathan, Coastal Carolina University

LaTeX is a popular mathematical typesetting software package. This talk will discuss the various methods of producing graphs using LaTeX. It will demonstrate both drawing

curves using simple commands and provide an idea of how to incorporate picture files into a LaTeX file. The material covered in this talk will provide an alternative to using Microsoft Word to type up quizzes and tests.

The Importance of Being Able to Add: What is the Role of Technology in the Classroom?
Robert Jamison, Clemson University, Clemson, South Carolina

In a recent 12 month period, I had the privilege of visiting 15 countries. Most were in Europe, including large countries like Germany, Italy, and England as well as the tiny Vatican City. But Canada, Turkey and Israel were also included. In only two of these countries was there a noticeable segment of the population who were visibly able to perform basic arithmetic tasks -- such as making change and figuring out the price of several items added together. Those countries were India and Guatemala.

How should we take this? Is this just a sign that modern technology has made knowledge and skill at arithmetic unnecessary? Or is this a cause for alarm? Maria Montessori devised a remarkable set of manipulatives for teaching the concepts of arithmetic. Do these now belong in a museum? Or are they still a valuable teaching tool?

How about algebra and trig? Or even Calculus itself? Are they also archaic skills, soon to be replaced by the calculator?

I want to continue and revitalize the discussion about technology in the classroom. It isn't a question of WHETHER we use technology; it is a question of whether we use it INTELLIGENTLY. I will share some of my experiences and Guidelines and hope to learn some of yours.

Coloring the vertices of a graph with open subsets of the unit interval
Peter Johnson* and Christopher Rodger, Auburn University

The chromatic number of a graph is an index of optimality for partitions of the vertices of the graph into independent sets of vertices. More generally, for each positive integer k the k-fold chromatic number is an index of optimality for "k-deep" coverings of the vertex set by (possibly repeated) independent sets, "k-deep" meaning that each vertex is in at least k of the covering sets. Finally, the fractional chromatic number is an index of optimality for such k-deep coverings, over all k. Here we redefine these parameters with reference to proper vertex colorings of graphs with certain kinds of open subsets of the unit interval. So far this redefinition has not been of much use mathematically, but it does seem much more natural in pointing out the connection between vertex coloring and committee scheduling.

Adaptive Finite Element Methods for Elliptic PDE's Based on Conforming Centroidal Voronoi/Delaunay Triangulations
Lili Ju, University of South Carolina

In this talk, we will discuss a new mesh adaptivity algorithm for elliptic PDE's that combines a posteriori error estimation with centroidal Voronoi/Delaunay tessellations of domains in two dimensions. The ability of the first ingredient to detect local regions of large error and the ability of the second ingredient to generate superior unstructured grids result in a mesh adaptivity algorithm that has several very desirable features. In particular: errors are equidistributed over the triangles; the triangles remain very well-shaped, (even if the grid size varies by several orders of magnitude); and the convergence rates are the best obtainable when using piecewise linear finite elements.

Schrödinger's Mathematics
Anna Kamphaus, Western Carolina University

On Packing the Complete Bipartite Graph with 6-cycles
Janie Kennedy*, Samford University, LaKeisha Brown and Robert Gardner, East Tennessee State University, and Gary Coker, Francis Marion University

D. Sotteau provided necessary and sufficient conditions for the decomposition of Km,n into 6-cycles. When such a decomposition does not exist, we consider how close we can get to a decomposition. A packing of Km,n with 6-cycles with leave L is a decomposition of $Km,n-E(L)$ into 6-cycles. The packing is maximal if $|E(L)|$ is as small as possible. We discuss maximal packings of Km,n with 6-cycles.

Applications of Mathematics using applets via Maple
Lyndell Kerley and Jeff Knisley, East Tennessee State University

A presentation will be given representing 5 areas of mathematics implement Maple software where applets (called Maplets in Maple) are utilized. Such applets allow students to interact with the screen producing output such as vectors, 2 and 3 dimensional plots thereby learning key math concepts. Comments about how this can be effective in the classroom will be given. The presentation will illustrate the following applications.

Linear algebra: Supply a vector v and a matrix A determing by an angle theta. Then Av is shown. Extend this to $3d$ by rotating a torus (dough nut) about either the x, y, or z axis.

Differential Equations: Supply a system of 2 linear differential equations $dx/dt = a11x + a12y$, $dx/dt = a21x + a22y$, with $x(0) = x0$ and $y(0) = y0$. Find the resulting solutions. Apply this to a mixture problem with 2 tanks.

Numerical Analysis: Supply 3 non-linear equations. Use Newton's system to obtain an iterative scheme for approximating a solution. Show in $3d$ the approximations.

Differential Geometry: Supply a space curve such as the helix $r =< \cos(t), \sin(t), t >, t = 0...5$ and animate a triple of the tangent vector, normal vector, and binormal vectors as it traverses the curve

Fourier Analysis: Supply a data set consisting of 2 columns of numbers $\{xi, yi\}$. Join the points to see a figure in the plane. Apply the Fourier transform to the sequence of complex numbers $\{xi, yiI\}$ to obtain the Fourier coefficients. Allow the user to modify the Fourier coefficents. Once modified, apply the inverse Fourier transform, to obtain a sequence of complex numbers. By plotting this last sequence, a modified figure is obtained. This illustrates filtering.

Thoughts on the Klein Model of Hyperbolic Geometry
Richie King, Davidson College

One construction in the Klein model serves to produce the three cycles (circle, horocycle, equidistant curve) of plane hyperbolic geometry. They are united in a projective theorem suggested by the construction.

Reflections of Regular Algebras
Ellen Kirkman, Wake Forest University

Let A be an $n \times n$ matrix, and let A act on a polynomial $f(x_1, \ldots, x_n)$ in $\mathbb{C}[x_1, \ldots, x_n]$ as $A \cdot f = f(AX)$ where AX is the usual matrix product of A and the column vector $X = (x_1, \ldots, x_n)$. The Shephard-Todd-Chevalley Theorem states for a finite group G of $n \times n$ complex matrices, the ring of invariant polynomials $\mathbb{C}[x_1, \ldots, x_n]^G$ is a polynomial ring if and only if G is generated by reflections. To generalize the theorem to a non-commutative setting we consider 2×2 matrices acting on the skewed polynomial ring $\mathbb{C}_q[x_1, x_2]$, where $x_2 x_1 = q x_1 x_2$ for a fixed scalar q in $\mathbb{C}$. To obtain an analogous theorem we need a new notion of "reflection". In this short talk we present some examples that illustrate the Shephard-Todd-Chevalley Theorem and its non-commutative generalizations.

Neural Networks, Data Mining, and Real World Neurons
Jeff Knisley, East Tennessee State University

Artificial Neural Networks are models of interacting neurons that were introduced by McCulloch and Pitts in 1943. Since then, they have proven to be powerful tools for pattern recognition, bayesian analysis, and data mining. However, artificial neural networks can be limited by slow convergence, spurious states leading to ambiguous results, and mislabeled data sets. Because networks of real neurons do not seem to be bound by such limitations and because of the many recent developments in mathematical models of real neurons, artificial neural networks derived from our current understanding of the neuron may be better suited to overcome these limitations. Several such neural network models will be derived specifically for the purpose of feature extraction and

dimensionality reduction of large data sets. These neural network models are generalizations of existing models that are amenable to back propagation and that can be shown to overcome one or more of the limitations of existing neural network models.

Rogers-Ramanujan Subpartitions and Their Connections to Other Partitions
Louis Kolitsch, The University of Tennessee at Martin

In this paper the idea of a Rogers-Ramanujan subpartition of an ordinary partition is introduced and how these subpartitions are related to other types of partitions is explored.

A Novel Countergraph Approach to Computing Ramsey Numbers
Aneesh Kulkarni, Davidson College

The Ramsey number $R(m,n)$ gives the solution to the party problem, which asks the minimum number of guests $R(m,n)$ that must be invited so that at least m will know each other or at least n will not know each other. Formally, the Ramsey number, $R(m,n)$, is the minimum number of vertices required in a graph so that there exists a K_m in the graph, or a K_n in the complement. Current methods to compute $R(m,n)$ are computationally inefficient. In this paper, we introduce the concept of a countergraph to find a more efficient approach. We define a countergraph for $R(m,n)$ as a graph on $R(m,n)-1$ vertices with no K_m, and no K_n in the complement. We present two main results. First, we show that every countergraph for $R(m,n)+1$ contains a countergraph for $R(m,n)$. Second, we use this result to propose an algorithm to compute $R(m,n)+1$ from an $R(m,n)$ countergraph. Using this technique, we can recursively compute larger Ramsey numbers, laying the foundation for a solution to the party problem. We also present other results on $R(m,n)$, and conjecture that $R(m,n)$ is related to a corresponding Fibonacci number. Ramsey theory has numerous real-life applications in computer science and related fields.

Two-Target Approximate Control for a Linear Diffusion Equation
*** Sung-Sik Kwon, North Carolina Central University and Jon Tolle, University of North Carolina at Chapel Hill**

We consider the approximate distributed control of a linear parabolic system with two targets. We assume that the targets are prioritized and require a certain level of target satisfaction be achieved for the primary target as a priority over reducing the error for the secondary target. The control variable is divided into two parts, one being thought of as “the leader” and the other one as “the follower”. This problem can be formulated in several different ways as nonlinear, PDE constrained, infinite dimensional optimization. Three different formulations are currently being investigated. In the first approach, we use a bilevel optimization structure in which the inner problem minimizes the norm of the follower control plus the weighted deviation from the secondary target, and the outer problem minimizes the norm of the leader control with the constraint that the primary target is satisfied. The inner minimization assumes the leader control is fixed. In the

second approach, we minimize the weighted sum of the deviations from the targets with weights corresponding to the preferences. This is a straightforward, equality-constrained optimization using the penalty method. However, there is little theoretical guidance for the optimal choice for a set of weights. In the third approach, we modify the first formulation so that the inequality constraint mandating the primary target must be satisfied is removed. We compensate this removal by adding a penalty term in the outer objective function. Our goal is to delineate, as completely as possible, the connections among these formulations and to develop numerical algorithms for solving these problems.

Graph-theoretic Models of Glucosyltransferases
Daniel Lamb*, Debra Knisley and Celia McIntosh, East Tennessee State University

In this work we use graph theory to model thirteen enzymes known as UDP binding glucosyltransferases. These enzymes transfer a sugar molecule in the biosynthesis of flavonoids. Flavonoids are currently of interest due to their anti-oxidant and anti-cancerous properties. Given these enzymes, it is known that they form two distinct functional classes. At this time, there is no known method for determining the functional classification of the enzyme other than time consuming laboratory methods. Using graphs, we quantify each enzyme with a unique numerical signature with the goal of classifying each enzyme.

Collaborative Learning in Introductory Statistics
Aprillya Lanz, Clayton State University

This talk will present an implementation of collaborative learning methods in an Introductory Statistics course. Structure of the groups, types of assignments, and results will be discussed.

Preparing Prospective Elementary School Teachers in Mathematics
Cecelia Laurie, University of Alabama

At University of Alabama we have been developing a three-course sequence of mathematics content courses for pre-service elementary teachers. This has been a collaborative effort between the Mathematics department and the Elementary Education Program. We will discuss the philosophy behind the development, the process of development, the structure and themes of the courses, and encourgament of faculty engagement with such courses.

Curves of Constant Inertia in Mechanical Systems with Symmetry
Jeff Lawson, Western Carolina University

Saari's Conjecture states that an N-body system (N point particles mutually attracted by Newtonian potentials) has a constant moment of inertia along a solution curve in phase space if and only if the system is in relative equilibrium. J. Marsden suggested that Saari's Conjecture may be extended to more general mechanical systems with symmetry,

but there exist non-Newtonian N-body arrangements that would contradict a more general Saari's Conjecture.

We investigate paths of constant moment of inertia in mechanical systems with symmetry, using a decomposition of the phase space into the symmetry component (the orbit) and a transversal component (the slice). The form that the equations of motion take in this decomposition allows us to contribute more examples that satisfy a generalized Saari's Conjecture, including the free rigid body problem and the 3- and 4-body problems in 3 dimensions.

Preparing Students for Success in Algebra

Steven R. Lay, Lee University

Why do so many students struggle with algebra? We believe the primary reason is that they are not thinking correctly about what they are seeing. Most of their errors are usually related to very basic concepts: manipulating signed numbers, fractions, exponents, and canceling. To improve the students' success in algebra, we developed a pre-algebra program to teach them the correct way to think about these basic operations. We have found that improving the way we explain basic arithmetic greatly increases their success in algebra. Our approach involves developing a dynamic model for arithmetic where the emphasis is on an operator changing one number into another number. This presentation will give an overview of the operator approach to pre-algebra and document its successful use with under-prepared college students.

Feedback control of the Burgers equation by CVT-based reduced-order modeling
Hyung-Chun Lee, Ajou University, Korea / Florida State University (visitor)
****Burkhardt Mini****

In this talk, we present a reduced-order model for feedback control of the Burgers equation. We present the background for a CVT(centroidal Voronoi tessellation) approach to reduced-order bases. CVT-reduced order modeling begins with a snapshot set of raw data. We then extract a basis using CVT methods, and determine a very low-dimensional approximation to the solution of the Burgers equation. This technique is demonstrated for some feedback control problems. Numerical experiments are presented which compare the results of the CVT-based algorithm with those using the full finite element model.

Optimal Control applied to a CPR Model
Suzanne Lenhart, University of Tennessee and Oak Ridge National Laboratory

A discrete time model of a circulatory system will be presented. Optimal control theory will be used to improve the standard technique of cardiopulmonary resuscitation, in which the profile of the external chest pressure is taken as the control.

A Sufficient Condition for Hamiltonicity of Graphs

Rao Li, University of South Carolina—Aiken

Rahman and Kaykobad (IPL 94(2005), 37-41) proved the following theorem on Hamiltonian paths in graphs. Let G be a connected graph with n vertices. If $d(u)+d(v)+D(u,v)\geq n+1$ for each pair of distinct non-adjacent vertices u and v in G, where $D(u,v)$ is the length of a shortest path between u and v in G, then G has a Hamiltonian path. It is shown that except for two families of graphs a graph is Hamiltonian if it satisfies the condition in Rahman and Kaykobad's theorem. The result obtained in this note is also an answer for a question posed by Rahman and Kaykobad.

4-cycle Packings of $\lambda K_{2m}-F$
Sasha L. Logan and Thomas R. Whitt III*, Coastal Carolina University

In this discussion we will examine some results of an extension of the following theorem: Let F be a spanning odd forest of K_{2m}. Then $K_{2m}-F$ has a maximum four cycle packing with a leave L_i if and only if $|E(K_{2m})|-|E(F)|\equiv i(\bmod 4)$. Here $L_0=\varnothing$, $L_1=C_5$, $L_2=B$, $L_3=C_3$. Specifically we will discuss results which cover the four cycle decomposition of an arbitrary multiplicity of a complete graph with an even vertex count less a single spanning odd forest. This graph will be denoted $\lambda K_{2m}-F$, where λ is the multiplicity of the complete graph K_{2m} less a spanning odd forest F.

Syntax-Free Maple: An Overview of the Ease-of-Use Features in Maple 10
Robert J. Lopez, Professor Emeritus, Rose-Hulman Institute of Technology, Maple Fellow, Maplesoft

In addition to the "old" command-based worksheet in Maple 10, there is also a new paradigm of "point-and-click" computing based on the use of palettes, a new (2D) math editor, pop-up menus, Assistants, Task Templates, and Tutors. In this presentation, we will give an overview of these features, which coalesce to a "syntax-free" mode of use for Maple.

The Chinese Remainder Theorem and the RSA Decryption Process
Nicole Mack, Spelman College

Genomic Integrity, Environmental Cues, and Network Reduction
Hugh R. MacMillan, Clemson University

A balance between cellular proliferation, differentiation, and death emerges in collective genetic response to naturally varied intrinsic and extrinsic factors. Cancerous adaptation, unfortunately, also emerges. I will present work on top-down modeling of qualitative networks of gene products that is pillared by genomic integrity, microenvironment, and cellular identity. The goal is cell-centric reduction in both network and spatial complexity toward modeling that can approach heterogeneous cell populations.

A Truly Meshfree First-order System Least-Squares Method
***Hugh MacMillan, Clemson University, Max D. Gunzburger and John Burkardt, Florida State University**

Toward a truly meshfree discretiation of PDEs, we statistically approximate Centroidal Voronoi (CV) generators to determine an initial, coarse arrangement of nodes from which radial basis functions can be designed. In this talk, we
explore the use of First-Order System Least Squares (FOSLS) to adaptively direct such discretization according to a coarse-to-fine strategy. The goal is to maintain sharp control over degree's of freedom by equi-distributing error in the sense defined by a FOSLS functional, and we will report on the promise of this approach.

A Direct Proof of Euler's Theorem on 1(mod 3) Primes
Shan Manickam, Western Carolina University

A direct proof of Euler's theorem that every prime congruent to 1 modulo 3 is of the form $x^2 + 3y^2$, where x, y are integers, is given using appropriate involutions. It then follows that such primes are of the form $m^2 + mn + n^2$, where m, n are integers (a conjecture of Gilman (1997)). An elementary procedure to compute these integral quadratic forms is outlined.

A Middle School Mathematics Major Track
****John C. Mayer, University of Alabama at Birmingham**

We will present a planned Middle School Mathematics Track in the Mathematics Major at UAB. This track acknowledges that the mathematics suitable for middle school teachers neither coincides with that required for high school teaching, nor that required for elementary school teaching. The track exceeds CBMS recommendations, and meets Alabama NCLB requirements.

Applications of Error-Correcting Codes in Cryptography
Kina McCanns, Spelman College

Finite Element Method on the Sphere
A.J. Meir and Nec˙ibe Tuncer

The numerical approximation of partial differential equations on the sphere has been an attractive subject of late. We study the model problem $-\Delta u = f(x, y)$ where $u(x, y) = g(x, y)$ on the boundary of the domain. Here the domain is the unit disc. In our research, we generate the FEM on the unit disc, by mapping the unit square to the domain with the radial projection. We introduce these mapped finite elements on the unit disc as "radially projected finite elements" We discuss the approximation properties of radially projected finite elements on the unit disc and the sphere.

Experiencing the Awesome Beauty and Wonder of Mathematics as a Projection with the Musical Octave

Henry and Erika Monteith

We enhance Mathematics to reveal its awesome beauty by introducing the Absolute Law of Oneness (0C4 = 1, a conjecture of Ramanujan), characterizing it with Gender ((+) Feminine Extensive, (-) Masculine Intensive), defining three aspects of 'zero', and uncovering its Musical Octave structure which is based upon numbers and proportions (a brief rendition will be given on the piano). This potentially resolves many mathematical paradoxes and endows mathematics with the ability to not only describe Mechanical, Electrical and Quantum Action but the Causes of these as well! Finally it makes the teaching and learning of mathematics an awe inspiring experience which stimulates the pursuit of a life-long quest to physically and spiritually understand the 'Essence' of our Eternal Cosmos. The quest for Understanding of the Cosmic Essence is unique to each individual's destiny and leads them toward fulfilling their evolutionary responsibilities.
"An equation for me has no meaning unless it expresses a thought of God." (Ramanujan)
"*Science without religion is lame, religion without science is blind*." (Einstein)
"*The most beautiful experience we can have is the mysterious."* (Einstein)
"If you love it enough, anything will talk to you." (George Washington Carver)

Public Key Cryptography
Brittany L. Mosby, Spelman College

Poker Faced
Colm Mulcahy and Jeffrey Ehme, Spelman College

You are handed five cards chosen at random from a deck. You arrange these in a neat row, and invite somebody to exchange one card for a new one. The new card is correctly identified by a mathematical accomplice of yours who only sees the end result.

Three Proofs and Three Variations of the Low Down Triple Dealing Principle
Colm Mulcahy, Spelman College

In October 2004, Martin Gardner turned 90. To celebrate the occasion, the current author published "Low Down Triple Dealing" at MAA Focus Online. This talk will explore this card mixing principle further.

****An Investigation of the Knotting Properties of Polypeptides**
Daniel T. Murphree, Ken Martin, and Ron Taylor, Berry College

Of interest to chemists is the idea that molecules can exist as mathematical knots. Using SPARTAN (a chemical modeling program) we are investigating how many amino acid subunits are required to create chemically-stable, knotted poly-glycine molecules. In particular, we are interested in the minimum number of poly-glycine molecules necessary to form some of the low crossing number, algebraic knots. We plan to investigate the trefoil (or 31 knot), the figure 8 (or 41 knot), and the 51, 52, and 61 knots as time permits.

(This research is being done as part of my enrollment in CHM 498: Topological Chemistry and in conjunction with a chemistry professor and a mathematics professor.)

Time Relaxation for Turbulent Flow Problems
Monika Neda, University of Pittsburgh

A fluid's velocity at higher Reynolds numbers contains many spatial scales not economically resolvable. The question that arises is: How can we truncate the small scales without altering appreciably the solution's large scales. We address this important question by applying the phenomenology of homogeneous, isotropic turbulence to a time relaxation regularization flow problem. A time-discretization relaxation model will be presented, followed by the error analysis and numerical experiments of flows in transition from equilibrium to the time dependent regime via eddy shedding behind the forward-backward step.

The Light Elements and Preliminary Photometric Solution for the Binary DFLyr
Jared Newton, King College

Estimating Probability Densities from Numeric Samples
Hoa Nguyen, Florida State University

A fundamental problem of statistics is to estimate an unknown probability density function (PDF) that has generated a given set of sample points. There are several possible levels of knowledge of the PDF imaginable: we might be allowed to sample it a certain number of times; we might be given a pointset of equally spaced percentiles of the PDF; or our only information might be a set of random deviates generated by the PDF. It is this last case that concerns us. We propose a simple method to construct an approximate model of the unknown PDF, based only on the set of random samples, and to resample the model to produce pointsets that are well distributed under the PDF.

On Fixed and Random Designs for Estimation with Applications and Comparisons
Broderick Oluyede, Georgia Southern

In this note, results on the lower bound for the Bayes risk due to estimation of the mean difference of two populations belonging to the exponential family and expected cost are presented and shown to be of first order efficiency. Comparisons of the random and best fixed designs for the estimation of the mean difference of two Poisson distributions as well as the exponential distributions using gamma priors are presented. Numerical results are also given.

Finding the Nth Term of Recursive Sequences Using Linear Algebra
Nicholas Ostberg, Coastal Carolina University

The Fibonacci sequence is known to many, even those that have only passing interest in the discipline of mathematics. The formula used to find any term in it, without the computational bother of finding the rest, is known to fewer, and the method(s) used to

derive said formula is known to fewer still. In this, we will derive the formula for the Fibonacci sequence and encounter the golden ratio. Using the same techniques, we will come up with a general formula for the nth term of sequences similar to the Fibonacci. A "similar" sequence is such that the nth term is equal to some combination of the two preceding terms, or that satisfy Sn+1=XSn-1+YSn where S0 and S1 are known values. We will use the Jordan Canonical form of a matrix to derive this formula, as well as other facts from linear algebra.

Visualization of point symmetry groups in R^3
Jack Pace, Southern Polytechnic State University

A point symmetry group is a group of isometries of R^n leaving one point (say the origin) fixed. For $n = 3$, it will consist of rotations and possibly the inversion through the origin and its composition with rotations. Adding the crystallographic restriction, so that only 2, 3, 4, and 6 fold rotations are allowed, we get 10 different point groups in R^2 and 32 different point groups in R^3 .

For a point group G in R^2, the set of images of a moving object under all the elements of G forms a 2-D kaleidoscope of moving shapes in the plane. In R^3, a similar computer-generated animation produces a 3-D kaleidoscope in space. Seeing this kaleidoscope helps to understand G and also to appreciate its beauty; however in 3-D it is much harder to visualize.

One way to do this is to generate a stereo pair on the screen, so that (with practice) the set of moving images can be seen in 3-D. Careful choice of the shape of the object, its path of motion, the eyepoint, and other factors can give a strong kaleidoscope effect. Software the author has written to do this will be described and presented.

Measurement Errors in Generalized Poisson Regression Model
Mavis Pararai, Georgia Southern University

The generalized Poisson regression model has been used to model equi-, over- and under-dispersed count data. In many of these situations the assumption is that the response, the count, is reported without error. It is possible that the count maybe underreported or overreported. The Poisson regression model and the negative binomial regression model have been modified and used in modeling count data that is underreported. In this paper, the generalized Poisson regression model for underreported counts is developed. The parameters of the proposed model are estimated by the maximum likelihood method. We propose a score test to determine whether there is significant underreporting in the data in order to use of the generalized Poisson regression model for underreported counts as opposed to the ordinary generalized Poisson regression model.

Mathematics for Freshman Math Majors
Wanda M. Patterson, Winston-Salem State University

What happens to college students who declare themselves a mathematics major but place into the college precalculus sequence? These students finish Calculus II at the end of their sophomore year in a best-case scenario. Thus they begin their major courses beyond calculus as a junior and often have a rude awakening that mathematics is not what they thought it was and that they do not really want to be math majors. They continue in the major because they have already invested half of their proposed undergraduate matriculation there. I am proposing an entry level seminar course exclusively for (freshman) mathematics majors to expose them to the work of mathematicians via reading, reasoning with a mathematician, posing questions, and logic exercises with mathematical content.

Discrete Variational Principle and Symplectic Numerical Methods: A Comparative Study
Kevin Pedde, Western Carolina University

The Euler-Lagrange equations are derived by applying a variational principle, to the Principle of Least Action for a function known as a Lagrangian. The solution to the Euler-Lagrange equations is a differential equation which optimizes the variational principle. The Euler-Lagrange equations are widely used to solve constrained and unconstrained optimization problems.

In contrast to numerical differential equation solvers which seek to minimize error at each step, geometric numerical integration methods seek to preserve the symmetry or qualitative behavior of a dynamical system. Symplectic methods, more specifically Symplectic Euler, are an example of geometric methods which attempt to preserve the area with in the solution.

Here in this work in progress, a discrete version of the variational principle will be presented which leads to a discrete version of the Euler-Lagrange equations. The solution of the discrete Euler-Lagrange equations in phase space exhibit symplectic behavior and will be compared to the Symplectic Euler method using various dynamical systems.

Bisections and Reflections: A Geometric Investigation
Jessie Penley and Carrie Carden, Berry College

Math Models for Crisis Action Planning
E. L. Perry, Faulkner University

This paper describes research into simulation and mathematical methods to support the Course of Action (COA) comparison step in either deliberate or crisis action planning. For the military, Joint Publication 3-30 describes the steps to be used in crisis action planning. The author describes research to: (1) identify and quantify criteria for COA comparison under JP 3-30; and (2) use simulation along with linear programming techniques to build decision aids to assist a commander in the COA comparison step.

While the current research is for educational tools, our ultimate goal is to use results from the study to build a real-world tool set to aid military decision makers in the field.

Modeling Self-Organization in Social Wasps
***Michael Phillips, Istvan Karsai, and Jeff Knisley, East Tennessee State University**

Social insect colonies generally develop into parallel processing systems in which the colony conducts most of its operations concurrently instead of sequentially. The emergence of complex patterns in insect societies was first explained by assuming intelligent individuals with access to global information. Recently, theories of self-organization have explained this behavior by using local information to provide a better understanding of the complexity and dynamics present in these systems. We will look at two different approaches to modeling nest construction behavior in social wasp colonies.

An ODE mathematical model of the division of labor in wasp colonies was developed by Karsai and Balazsi (2002). We have built on this earlier work by creating an agent-based model that prohibits individual access to global information and ensures that all interactions take place on a local level.

The agent-based model attempts to model the situation by incorporating the ideas of individuality and locality, which are not captured in top-down models. Nest construction in social wasps provides an excellent model for studying division of labor. By starting the system from a homogeneous state, we show that a heterogeneous division of labor is an emergent property of the system.

Using only a few simple mechanisms, this model that accurately predicts the division of labor in social wasp colonies. With only a few simple behavioral rules and no central control present, the model is able to predict a great amount of complexity and capture the self-organizing dynamics of the natural system.

The Mean Value Theorem and Analytic Functions of a Complex Variable
Mohammed A. Qazi., Tuskegee University

The mean value theorem for real-valued differentiable functions defined on an interval is one of the most fundamental results in Analysis. When it comes to complex-valued functions the theorem fails even if the function is differentiable throughout the complex plane. We illustrate this by means of examples and also mention some results of a positive nature.

Diffraction by Double Slits
Wen-Hui Ren, Methodist College

accessiblemath@mathdemos: An Accessible Online Resource for Mathematics Instructors and Students
Lila Roberts, Georgia College & State University

An increasing number of students with learning difficulties are being identified and advances in technology have had a direct impact on the individual student's educational process. There is a significant need to make access to mathematics easier for students who have visual and hearing impairments because there is no reason to believe that this segment of the student population does not (potentially) have the same range of mathematical skills as those who do not have impairments. Instructors in post-secondary settings often do not have specialized training in dealing with students who have specific disabilities such as hearing impairments or print disabilities. There is a growing population of students at many two-and four-year colleges who have visual learning disabilities and while we provide accommodations such as additional time for tests, test readers, and a distraction-free testing environment, this only acknowledges that the disability affects a student's ability to take tests. The reality is that the disability can have a profound effect on how a student learns. Development of instructional resources is necessary to address the learning needs of these students. This project will address the issues raised in the following ways. The project will 1) develop a collection of accessible learning materials, focusing on calculus content, that are readily available to instructors and students, 2) provide guidance on how to incorporate these materials into instruction, 3) disseminate the project to a broad audience that has an interest in and need to provide accessible tools for learning mathematics. This presentation will provide illustrative examples of the materials that are being developed through this National Science Foundation supported project (EMD-0511426).

iPod@mathdemos: Mathematics in My iPod
Lila F. Roberts, Georgia College & State University

This project is integrates iPod technology as a learning enhancement tool for mathematics. An initial phase of the project, slated for implementation in Fall 2006 as a component in the Apple Digital Campus at Georgia College & State University, will utilize video iPod in inquiry-based instruction in a Calculus I class for mathematics majors and pre-engineering students. Specifically, mathematical concepts for calculus will be illustrated using dynamic graphical representations as opposed to the static graphics in textbooks. A collection of visualizations will be generated using Mathematica, Excel, and other mathematical graphical tools. Visualizations will be augmented with audio and captions/subtitles to guide student inquiry. While the use of visualization is not novel, the use of hand-held technology to deliver the visualizations in a portable and novel way makes this project particularly innovative. Another plus is that the iPod technology can be used to address some accessibility issues by providing captioning of the videos.

The potential for educational use of iPod technology in areas such as history, political science, music, and art is much more obvious than in mathematics. This presentation will provide illustrative examples of iPod videos for mathematics instruction.

TEAM-Math: An Overview of a National Science Foundation Funded Partnership to Improve Mathematics Education in East-Alabama
Chris Rodger, Auburn University and Mohammed A. Qazi, Tuskegee University

TEAM-Math is a National Science Foundation-funded Math and Science Partnership involving Auburn University, Tuskegee University and 15 school districts in east-Alabama whose common goal is to systemically improve mathematics education in these districts and the two Universities. This session will outline the components of the project along with accomplishments thus far and challenges that we still face.

The Effect of Alcohol on Neuron Firing
Charles R. Rogers, North Carolina State University

Quadratic Inverse Eigenvalue Problems
Charles R. Rogers,North Carolina State University

The Quadratic Eigenvalue Problem (QEP) has received a great deal of attention because its formation has frequently arisen in several different disciplines, including applied and fluid mechanics, electrical oscillation, seismic tomography, damage detection, and finite-element model updating in aerospace and automobile industries. The scope of activities and range of application strongly signifies the importance of the Quadratic Inverse Eigenvalue Problem (QIEP). The concern in the direct QEP is expressing dynamical behavior in terms of physical parameters versus the QIEP's concern of expressing physical parameters in terms of dynamical its observed or expected behavior. These physical parameters include, but are not limited to mass, resistance, spring constants, capacitance, damping, inductance, length, and elasticity. In particular, the QIEP aims to find three symmetric matrices, known as the mass, the damping and the stiffness matrices, correspondingly such that they satisfy the deliberate data and are contiguous to the specified analytical matrices. With the aid of mathematical computer software, focus was placed on the QEP by exploring its dynamic behavior when the physical parameters are manually controlled. Consequently, appealing results were obtained graphically that gave direction for the present QIEP focused research. A broad-spectrum code is currently being developed that will allow users to acquire affirmative answers on whether their specifically configured systems can be built and, if yes, how the parameters should be valued. As progression for developing a successful code for the QIEP slowly progresses, it has been found that the inverse problem is just as significant as the direct problem in application, yet more intricate. Ultimately, a code will be developed that permits civilization to cost-effectively build and test computer and VLSI chips.

A Graph Theoretic Model for Optimizing Walking Bass Lines
Pat Rossi, Troy University

The Walking Bass Line is the orthodox bass line for all swing, jazz standards. The speaker presents a graph theoretic algorithm for obtaining an "optimal" walking bass line.

Efficient Multiple Domination
Robert R. Rubalcaba* and Peter Slater, University of Alabama in Huntsville

A dominating set S of a graph G is called efficient if |N[v]\S| = 1 for every vertex v 2 V (G). That is, a dominating set S is efficient if and only if every vertex is dominated exactly once. There are several types of multiple domination defined in the literature, including k-tuple domination and {k}-domination. A set S is a k-tuple dominating set if |N[v] \ S| _ k for all vertices v 2 V (G). A function f : V (G) ! {0, 1, . . . , k} is a {k}-dominating function if f(N[v]) _ k for all vertices v 2 V (G), where f(N[v]) = Px2N[v] f(x). Here we define a function f : V (G) ! {0, 1, . . . , j} to be a (j, k)-dominating function if f(N[v]) _ k for all vertices v 2 V (G). Note that a (1, k)-dominating function corresponds to a k-tuple dominating set, and a (k, k)-dominating function is a {k}-dominating function. In this talk, we investigate efficient (j, k)-domination.
We also focus on the following set partitioning problem and then generalize this to functions. Every double dominating set of a tree T can be partitioned into two dominating sets. We show that for every (j, k)-dominating function on a tree T, f : V (T) ! {0, 1, . . . , j} there are k dominating sets for which each v 2 V (T) is in at most f(v) of them.

Polly Rudoff, Western Carolina University
Zero-Phobia

Fibonacci: A History and Patterns
James Ruff, Western Carolina University

Evolution of a No-Resistance Behavior
***Jan Rychtar, University of North Carolina Greensboro, and Mark Broom, University of Sussex**

Kleptoparasitism, the stealing of food items, is a common biological phenomenon that has been observed in many contexts. It is especially common amongst seabirds. When searching for food items, foragers can find a bird who as already discovered it. It may or may not be advantageous to make a stealing attempt, depending on the number of parameters such as value of the item, the chance of success and the cost of the contest (injury, time loss). And, it may or may not be advantageous to resist such a stealing attempt. Kleptoparasitism thus falls within the cost-benefit economic framework and can be modeled using the game-theoretic approach. We consider a polymorphic population consisting of four different bird types: a) Hawk – always try to steal, always resist stealing, b) Dove – never steal, never resist, c) Marauder – always try to steal, never resist, d) Retaliator – never steal, always resist. We show that depending on different parameter values, each strategy can be evolutionarily stable. However, only mixtures of Marauders and Dove (i.e. no resisting in the population), or Hawks and Retaliators (i.e. all birds resist) are stable, all other mixtures will evolve towards the above mixtures or a monomorphic population. One of the main findings is that no matter what are the other parameters, Marauder is always evolutionarily stable when the density of the population is large.

****Performance based decisions under uncertainty for complex systems**
Sundeep Samson and James. A. Reneke, Clemson University

Decision problems under conditions of uncertainty and risk are challenging. To begin with uncertainty and risk representations in the literature are typically problem specific and the methodologies that can handle these formulations are computationally demanding.

In the methodology presented here, an attempt as been made to expand the representation and modeling of uncertainty and risk to be applicable to a wide class of decision problems. Separable stochastic approximations of random fields and functional representations of risk are the major tools of this methodology.

This methodology has the potential of resolving complex problems such as multicriteria portfolio selection, engineering design problems, etc, beyond the scope of conventional mathematical programming and data analysis.

Teaching Non-Euclidean Geometry with Euclidean Technology
Subhash C. Saxena, Coastal Carolina University

Beltrami, Klein, and Poincare created consistent Euclidean models, but they did not have the technology. The latest versions of Geometer's Sketchpad, Cabri Geometry II Plus, and Cinderella enable us to create custom tools, macros, and the environment for doing non-Euclidean geometry using Beltrami-Klein model and Poincare models. These macros and tools enable us to teach several advanced topics effectively and visually. The presentation will deal with some of them.

Clearing the Fog from Linear Algebra Class Using the Fundamental Theorem of Linear Algebra
Damon Scott, Francis Marion University

For over a decade it has been a common observation that a "fog" passes over the course in Linear Algebra once abstract vector spaces are presented. In this presentation we show how this fog may be cleared by playing up a result billed as "The Fundamental Theorem of Linear Algebra". It is that every vector space is isomorphic to a canonical vector space (that is, R^n for some cardinal ordinal n) and every linear transformation is isomorphic to a canonical linear transformation (that is, matrix multiplication from R^m to R^n for cardinal ordinals m and n). We show how this theorem, limited down to finite m and n, can be used to assist students to solve "abstract" vector space problems by translating them to canonical settings, which not only are far more "concrete" for the students, but also are endowed with the power of various matrix-crunching software packages. In this way, students even of average abilities are able to solve abstract vector-space problems clearly, easily, and "foglessly".

Perfect Matchings: Extendability of Cartesian Product Graphs
Christopher Sharon, Samford University

A *perfect matching* of a graph *G* is an independent set of edges in *G* that will cover all of the vertices of *G*. Early studies of perfect matchings centered on the problem of

enumeration. How many perfect matchings are contained in a given graph G? While the problem has since been shown to be computationally hard for general graphs *G*, it has been studied for infinite families of special graphs. More recently, studies of perfect matchings have included defining characterizations of *n*-extendable graphs. A graph *G* of order greater than 2*n* and having a perfect matching is defined to be *n-extendable* if every independent set of edges of size *n* can be extended to a perfect matching in *G*. We explore the properties of extendability in graphs of the form $G = H \times K_2$.

Different Approaches for Solving Predator-Prey Problems
Hugh Sanders, Georgia College and State University

Some approaches to predator-prey problems deal with the animals in groups while others deal with the animals as individuals. This session will look at software models of predator-prey problems using these different approaches.

Retrieving H.G.Wells from the Ocean Floor
Andy Simoson, King College

One hundred years ago, Wells wrote a story about a differential equation. A spherical submersible is attached by a tether to a spherical sinker. In two minutes, the sinker hits the ocean floor. Wells makes many contradictory guesses as to partial descent rates and ascension rates. He needs a differential equations class as an advisor. In particular, how long does the tether need to be in order for the submersible not to hit the floor; and once the tether is severed, how long will it take for the submersible to reach the surface? This is a good exercise when studying the falling-body-with-resistance problem.

****Equitable Efficiency in Multiple Criteria Optimization**
Vijay K. Singh* and Michael M. Kostreva, Clemson University

Multiple criteria optimization plays an important role in decision analysis. Standard multiple criteria optimization problems are primarily concerned with the generation/approximation of efficient or Pareto solutions without paying much attention to the nature of the criterion involved.

Many applications, though, require the criteria to be treated uniformly or impartially. This might happen when all the criteria represent the same physical entity having the same practical interpretation. Treatment of criteria uniformly brings up the issue of equity among solutions, thereby giving rise to the notion of equitable efficiency in multiple criteria optimization.

This talk will define the relatively new concept of equitable efficiency, discuss some related solution concepts and explore some possible applications of the concept.

Links Between Packing and Covering
Ed Smith, Jacksonville State University

It has been known for some time that for an arbitrary convex body in the plane, its packing density divided by its covering density is greater then or equal to $3/4$. A quick nw proof is given for this result and an entirely new result is given for the analogous problem in three dimensions.

Generating Enthusiasm in Precalculus and Calculus
Karen Smith and Scott Sykes, University of West Georgia

As part of an NSF grant to Generate Enthusiasm in Math and Science (GEMS), the University of West Georgia has introduced workshops into special sections of its Precalculus and Calculus classes beginning in the Fall of 2005. The workshops are a fifth hour of class and are run by a student assistant. This talk will explain what we have done in these workshops and in the class in general to help to generate enthusiasm in mathematics.

Model Development and Control Design for Nonlinear Smart Material Systems
Ralph C. Smith, North Carolina State University

High performance transducers utilizing piezoceramic, electrostrictive, magnetostrictive or shape memory elements offer novel control capabilities in applications ranging from flow control to precision placement for nanoconstruction. To achieve the full potential of these materials, however, models, numerical methods and control designs which accommodate the constitutive nonlinearities and hysteresis inherent to the compounds must be employed. Furthermore, it is advantageous to consider material characterization, model development, numerical approximation, and control design in concert to fully exploit the novel sensor and actuator capabilities of these materials in coupled systems.

In this presentation, the speaker will discuss recent advances in the development of model-based control strategies for high performance smart material systems. The presentation will focus on the development of unified nonlinear hysteresis models, inverse compensators, reduced-order approximation techniques, and nonlinear control strategies for high precision or high drive regimes. The range for which linear models and control methods are applicable will also be outlined. Examples will be drawn from problems arising in structural acoustics, high speed milling, deformable mirror design, artificial muscle development, tendon design to minimize earthquake damage, and atomic force microscopy.

Mentoring Partnerships - A First Step into Inquiry-Based Teaching,
Barry Spieler, Birmingham-Southern College, and Cornelius Stallmann, Augusta State University

Inquiry based learning (IBL) in mathematics has a long and distinguished tradition as well as a proven track record of producing successful researchers and leaders in academia and industry. This teaching strategy is not always well received by faculty and students, however, and successful implementation by a novice can be quite difficult without some guidance. We describe a collaborative mentoring arrangement in which a prospective

IBL practitioner is paired with a relatively new but committed practitioner for whom the difficulty of getting started is still a vivid memory. Such an arrangement is a very real possibility for those who are looking to make the change to this rewarding and effective teaching style.

Existence and Uniqueness in q-Gevrey asymptotics
*** Michael Spurr and David Pravica, East Carolina University**

Formal power series solutions to advanced-delayed differential equations can extend to solutions analytic on a sector, under certain growth restrictions. We discuss existence and uniqueness results in this setting.

Student Centered College Algebra
Cornelius Stallmann, Augusta State University

Traditional college algebra courses often suffer from poor student performance, low retention rates, and inadequate preparation for follow up courses. I will discuss a strategy that I use at Augusta State University that addresses these issues and yet does not involve a huge investment of time and energy on the part of the instructor. The focus of each class period is student work at the board, usually in groups. I will explain how I get students to buy into what I'm doing and how my classes are run.

A College Algebra Explanation of Linear Regression
Richard Stephens, Tennessee Wesleyan College

When modeling bivariate numerical data with a linear function, $f(x) = ax + b$, what do (or should) we mean by the line of best fit? Can we develop such a function using only basic algebra? If so, why have I not seen this explanation in any elementary statistics book? All that is required for this discussion is a few basic statistics definitions, basic college algebra level knowledge of quadratic functions and familiarity with sigma summation notation. This should be of special interest to the SIGMAA on Statistics Education.

Testing Saari's Conjecture on mechanical systems: Examples and Counterexamples
April Stepp, Western Carolina University

Saari's Conjecture says that a planar planetary system is in relative equilibrium if and only if it has a constant moment of inertia about its center of mass. Recent work motivates us to test the conjecture on other mechanical systems with rotational symmetry. Our strategy will involve decomposing the equations of motion into motion in the symmetry direction and motion transverse to that direction. By direct calculation in this decomposition we will verify that Saari's Conjecture holds for the 2-body problem and for the simple spherical pendulum. Then we will test the conjecture on a system of coupled rigid bodies and on the double spherical pendulum.

Mathematics is Not a Spectator Sport

David R. Stone, Georgia Southern University

For a mathematician or a student of mathematics, doing mathematics is essential. Teaching requires us to get students to actually do problems and become involved as participants in the subject. Our collection of teaching tools should include interesting problems, historical associations, a wealth of subject knowledge, connections to other areas, exciting applications, intriguing patterns, carrots and sticks. We'll look at examples of problems, strategies and approaches – field-tested over many years.

On the Class of L When Every Proper Subalgebra has Class at Most n
S. Benz Suanmali, North Carolina State University

Let L denote a finite dimensional metabelian Lie algebra over an arbitrary field F. We will discuss the cases of n when every proper subalgebra of L has class at most n and L has class precisely $2n$. The construction of a metabelian nilpotent Lie algebra in the case of $n > 1$ will be demonstrated. In addition, other results in the case without metabelian assumption will be presented.

Nonconforming Finite Element Methods for the Time-Harmonic Maxwell Equations
Li-yeng Sung, Susanne C. Brenner and Fengyan Li, University of South Carolina

In this talk we present new discretizations of the time-harmonic Maxwell equations that are based on the Cruzeix-Raviart nonconforming P1 vector fields. These methods have optimal convergence rates in both the energy norm and the L2 norm on graded meshes. Both theoretical and numerical results will be discussed. This is joint work with Susanne C. Brenner and Fengyan Li.

An Unknotting Operation for Algebraic Knots
Ron Taylor, Jr., Berry College, Ryan Hansen, West Virginia University and Matt Leonard, University of Wyoming

We provide a proof of the algebraic case of a conjecture of Nakanishi concerning a proposed unknotting operation. Specifically, we show, using only basic knot theory techniques, that any algebraic knot or link can be unknotted by a sequence of so-called $(2,2)$-moves.

Collocation for Stochastic PDE's: The Linear Case
Raul Tempone, Florida State University

We present a stochastic collocation method to solve linear partial differential equations whose coefficients and forcing terms depend on a finite number of random variables. The method uses a Galerkin approximation in space and a collocation in the zeros of suitable tensor-product orthogonal polynomials (Gauss points) in the probability space. This naturally leads to the solution of uncoupled deterministic problems, as in the Monte Carlo approach. It can be seen as a generalization of the Stochastic Galerkin method proposed in [Babuska-Tempone-Zouraris, SIAM J. Num. Anal. 42(2004)]. We give a complete

convergence analysis for the case of a linear elliptic operator. We demonstrate exponential convergence of the "probability error" with respect to the number of Gauss points, under some regularity assumptions on the random input data. Numerical examples will show the effectiveness of the method.

Sagbi Bases and Multiplicative Invariants
Mohammed Tesemma, Spelman College

Let A be free abelian group of finite rank n and G a subgroup of $GL(A)$. Then G acts on the group algebra $k[A], k$ a field. The subalgebra, $k[A], G$, of elements of $k[A]$ that are fixed under the G-action is called algebra of multiplicative invariants. The ring theoretic property of the invariant ring in relation to $k[A]$ is one of the main themes of invariant theory. A commonly used technique to compute multiplicative invariants is the method of SAGBI bases (Subalgebra Analogue to Gröbner Bases for Ideals). I will talk about computational issues using SAGBI bases and some examples of multiplicative invariants that my students presented at the poster session in San Antonio TX last January.

Optimal Control for an MHD System
Catalin Trenchea, Florida State University

We consider the mathematical formulation and the analysis of an optimal control problem associated with the tracking of the velocity and the magnetic field of a viscous, incompressible, electrically conducting fluid in a bounded two-dimensional domain through the adjustment of distributed controls. Existence of optimal solutions is proved and first-order necessary conditions for optimality are used to derive an optimality system of partial differential equations whose solutions provide optimal states and controls. Finite element approximations are defined and a priori estimates are used to show their convergence to the exact optimal solution. Some results of the computational experiments are presented.

Zero Knowledge Proof
Tishun N. Turknett, Spelman College

Je le vois, mais je ne le crois pas: Attempting to Understand Infinity
Caroline Turnage, Wofford College

Heart Rate Regulation During the Postural Change from Sitting to Standing
Robert Benim, University of Portland, Sarah Lynn Joyner, Meredith College, Eamonn Tweedy*, North Carolina State University, Chris Vogl, Illinois Wesleyan University, Mette Olufsen, Hien Tran, Laura Ellwein, North Carolina State University

During postural change from sitting to standing, blood pools in the lower extremities of the body. This effect leads to a decrease in blood pressure in the upper body and the brain and an increase in blood pressure in the legs. In subjects who suffer from orthostatic intolerance, postural change may cause dizziness, light-headedness, or even fainting. The exact function

of the cardiovascular and respiratory regulatory mechanisms is not well understood, and this work aims to develop a mathematical model that can help describe these regulatory mechanisms in more detail. As part of a larger model developed to understand these regulation mechanisms, this submodel explains heart rate changes observed during postural change from sitting to standing. In this model, blood pressure is used as an input to determine nervous system responses and corresponding chemical changes, which directly affect heart rate. Key elements of the heart rate model include a time-delay between sympathetic and parasympathetic nervous responses and an impulse function that accounts for the subject's physical muscular preparation for standing. Model parameters were optimized to create a curve that best fit the heart rate data gathered from a young subject, and model analysis has been performed to validate this model against groups of healthy young, healthy elderly, and hypertensive elderly subjects.

Advances in Wave Propagation with the Discontinuous Galerkin Method
Tim Warburton, Rice University

Two important features relating to the discontinuous Galerkin (DG) method for wave propagation will be discussed.

Recent investigations of the spectral properties of the discrete DG operators have revealed important connections with their continuous Galerkin counter parts. Theoretical and numerical results will be shown which demonstrate the correct asymptotic behavior of these methods and precludes spurious solutions under mild assumptions.

Given the suitability of DG for solving Maxwell's equations and their ability to propagate waves over long distance, it is natural to seek effective boundary treatments for artificial radiation boundary conditions. A new family of far field boundary conditions will be introduced which gracefully transmit propagating and evanescent components out of the domain. These conditions are specifically formulated with DG discretizations in mind, however they are also relevant for a range of numerical methods.

Collocation for Stochastic PDE's: The Nonlinear Case
Clayton Webster, Florida State University

We propose and analyze a stochastic collocation method to solve nonlinear partial differential equations whose coefficients and forcing terms depend on a finite number of random variables. The method consists of a Galerkin approximation in space and a collocation in the zeros of suitable tensor product orthogonal polynomials (Gauss points) in the probability space. This work is an extension of [Babuska, Nobile and Tempone, Submitted SIAM J. Num. Anal. (2005)] a collocation method for linear elliptic PDEs with random input data. Our methods allow one to treat easily a wider range of situations, such as: input data that depend nonlinearly on the random variables, diffusivity coefficients with unbounded second moments, random variables that are correlated or have unbounded support. We provide a rigorous convergence analysis. Numerical examples will demonstrate the effectiveness of the method.

Adaptive FEM for Phase Field Simulation of Vesicle Membranes
***Jian Zhang and Qiang Du, Pennsylvania State University**

A 3-dimensional adaptive finite element method is developed for a variational phase field model of vesicle membrane deformations under bending elastic energy. A mixed finite element formulation is used in the discretization. The mesh adaptivity is based on a residual type a posteriori error estimator. The effectiveness of the method is demonstrated through numerical simulation examples.

Using the Finite Element Approximation of Steklov Eigenfunctions to Solve the Laplace Equation Efficiently with Multiple Boundary Data
Jennifer L. Wightman, Coastal Carolina University

We present a method for construction of an approximate basis of the trace space $H^{1/2}$ based on a combination of the Steklov spectral method and a finite element approximation. Specifically, we approximate the Steklov eigenfunctions with respect to a particular finite element basis. Then solutions of elliptic boundary value problems with Dirichlet boundary conditions can be efficiently and accurately expanded in the discrete Steklov basis. We provide a reformulation of the discrete Steklov eigenproblem as a generalized eigenproblem that we solve by the implicitly restarted Arnoldi method of ARPACK. Computational results will be shown for solving the Laplace equation with various boundary condition data. The efficiency of this method for problems with multiple boundary data will be explored.

A Class of Integro-Differential Equations and Connections to One-Dimensional Inverse Problems
Yilian Zhang, University of South Carolina--Aiken

A new approach to one-dimensional inverse problem was recently introduced by Barry Simon. We continue the study on an intermediate object A, which satisfies a nonlinear integro-differential equation. We prove local solvability of this A-equation and find a necessary condition for global solvability. Stability result and some exact solutions are also obtained. Numerical tests are presented to illustrate the theoretical results.

Teaching First-Semester Calculus Courses Using a Computer Algebra System: The Role of Lab
Yilian Zhang, University of South Carolina—Aiken

Technology has been used extensively in college mathematic courses. Most courses consist of lectures and lab. In our university, we have used Mathematica in our calculus courses for many years. Though technology enables students to focus on core concepts, we notice some common problems throughout these years. The presentation will discuss different type of lab exercise and their impact on students learning. The presentation will address the following questions: Should we use complex real-world applications problem or simplified versions? Should we give detailed instructions in the lab exercises or similar

examples? How to adapt lab exercises to student group with weak mathematical skills? And whether lab exercises on mathematical software should be included.