Mathematical Science Department
Master's Poster Session
April 30, 2003

Master of Science in Applied Mathematics Theses

Title: **A Nonlinear Viscoelastic Mooney-Rivlin Thin Wall Model for Unsteady Flow in Stenotic Arteries**
Student: **Xuewen(Wilson) Chen**
Advisor: **Dalin Tang**

Abstract:
In this thesis, a nonlinear viscoelastic model and a numerical method are introduced to study dynamic behaviors of the tube wall and viscous flow through a viscoelastic tube with a stenosis simulating blood flow in human carotid arteries. The Mooney-Rivlin material model is used to derive a nonlinear viscoelastic thin-wall model for the stenotic viscoelastic tube wall. Incompressible Navier-Stokes equations in the Arbitrary Lagrangian-Eulerian formulation are used as the governing equation for the fluid flow. Interactions between fluid flow and the viscoelastic axisymmetric tube wall are handled by an incremental boundary iteration method. A Generalized Finite Differences Method (GFD) is used to solve the fluid model. The 4th-Order Runge-Kutta method is used to deal with the viscoelastic wall model where the viscoelastic parameter is adjusted to match experimental measurements. Our result shows that viscoelasticity of tube wall causes considerable phase lag between the tube radius and input pressure. Severe stenosis causes cyclic pressure changes at the throat of the stenosis, cyclic tube compression and expansions, and shear stress change directions in the region just distal to stenosis under unsteady conditions. Clear improvements of our viscoelastic model over previous elastic model were found in simulating the phase lag between the pressure and wall motion as observed in experiments. Agreement between numerical results and experimental results is improved over the previous elastic model.

Title: **Dual-Eulerian Graphs with Applications to VLSI Design**
Student: **Andre Freeman**
Advisor: **Brigitte Servatius**

Abstract:
A Dual-Eulerian graph is a plane multigraph G that contains simultaneously an Euler trail in G and an Euler trail in the dual of G. Dual-Eulerian trails play an important role in optimizing CMOS layouts of Boolean functions. When circuits are represented by undirected multigraphs the layout area of the circuit can be optimized through finding the minimum number of disjoint dual trails that cover the graph. This paper presents a polynomial time algorithm for determining whether or not a plane multigraph is Dual-Eulerian and for finding the Dual-Eulerian trail if it exists.

Title: **Instability of a Cold Atom Interferometer**
Student: **Daniel Pulido**
Advisor: **Mayer Humi (MA), Alex Zozulya (PH)**

Abstract:
In this thesis we present a theoretical analysis of a cold atom interferometer. The interferometer splits the wave function of a Bose-Einstein Condensate with each arm of the interferometer guiding part of the wave function along different environments. Sensitivity to changes in the potential energy (i.e. the environment) causes different time evolutions of the wave function's phase. This causes interference upon recombination. The recombination process is shown to be unstable and the nature of the instability is characterized.

Title: **A Numerical Study of Globalizations of Newton-GMRES Methods**
Student: **Joseph Simonis**
Advisor: **Homer Walker**
Sponsor: **Sandia National Laboratories**

Abstract:
Newton's method is at the core of many algorithms used for solving nonlinear equations. A globalized Newton method is an implementation of Newton's method augmented with "globalization procedures" intended to enhance the likelihood of convergence to a solution from an arbitrary initial guess. A Newton-GMRES method is an implementation of Newton's method in which the iterative linear algebra method GMRES is used to solve approximately the linear system that characterizes the Newton step. A globalized Newton-GMRES method combines both globalization procedures and the GMRES scheme to develop robust and efficient algorithms for solving nonlinear equations. The aim of this project is to describe the development of some globalized Newton-GMRES methods and to compare their performances on a few benchmark fluid flow problems.

Title: **Computational Modeling of Oxygen Consumption in the Heart Based on PET Measurements**
Student: **Fu Yan**
Advisor: **Dalin Tang**

Abstract:
Many cardiovascular diseases are partly due to heart muscle malfunctions. The main dynamic function in the heart is metabolism via mitochondrial respiration. And the most direct measure of oxidative tissue metabolism is the conversion rate of oxygen to water. Finding the oxygen consumption rate in the heart vessel will help us prevent the heart diseases. A linear, three-region (capillary space, interstitial fluid space, and parenchymal cell space), and axially distributed model is introduced to simulate the oxygen consumption process and determine the oxygen conversion rate. Parameters of concentration are oxygen and water corresponding to capillary space, interstitial fluid space, and parenchymal cell space. The diffusion coefficients are largely independent of molecular motion. The blood flow happens only in capillary part. Other parameters are determined by experimental data. Using the input data, consumption rate is determined through a process minimizing the difference between the experimental and numerical output. Key parameters are verified to see their effects on oxygen concentration and consumption rate.

Master of Science in Industrial Mathematics Project

Title: **Homogenization of an Elasto-Plastic Problem**
Student: **Daniel T. Onofrei**
Advisor: **Bogdan Vernescu**

Abstract:
This project presents the homogenization analysis for a static contact problem with slip dependent friction between an elastic body and a rigid foundation. The homogenization for the static eigenvalue problem associated to this model is studied. We prove the convergence of the first eigenvalue for the ε problem to the first eigenvalue for the homogenized problem, which is the static eigenvalue problem associated with the derived limit problem. The analysis is carried out by using the Γ-convergence theory.

The material is organized as follows:

1. in the first section a general presentation of the theory of Γ-convergence is provided.
2. the second section presents results concerning the heat transfer problem trough a three dimensional body divided in two parts by a hyperplane with periodically distributed small holes.
3. in the last section, the results presented in section 2 are generalized in order to analyze the elasto-plastic contact problem. It needs to be mentioned that the last section in this project is original and will be submitted for publication.

Master of Science in Applied Statistics Project

Title: **Resident Student Perceptions of On-Campus Living and Study Environments at the University of Namibia and their Relation to Academic Performance**
Student: **Isak Neema**
Advisor: **Joseph Petruccelli**

Abstract:
This study measures resident student perceptions of on-campus living and study environments at the University of Namibia campus residence and their relation to student academic performance. Data were obtained from a stratified random sample of resident students with hostels (individual dormitory/dining halls) as strata. Student academic performance was measured by grade point average obtained from the university registrar. Student perceptions of living and study environments were obtained from a survey. Inferences were made from the sample to the population concerning: student perceptions of the adequacy of the library and campus safety, and differences in perceptions between students living in old-style and new-style hostels. To relate student perceptions to academic performance, a model regressing GPA on student perception variables was constructed. The principal findings of the analyses were that (1) Student perceptions do not differ between old and new hostels; (2) There is an association between time spent in the hostel and the type of room, ability to study in room during the day and the type of room, ability to study in room at night and the type of room, ability to study in room at night and availability of study desk in room and also between ability to study in room at night and availability of study lamp in room respectively; (3) Mean GPA differs with respect to the type of room, ability to study in room during the day, students who are self-catering, sufficiency of water supply in blocks and also with students who are enrolled in Law and B.Commerce field of study and with students receiving financial support in the form of loans.