COLLOQUIUM Fall 2003

Sonja Petrovic

Student, Department of Mathematics,
University of Tennessee at Chattanooga

Thursday, August 7, EMCS Room 422, 3:30pm.

Oscillation of Solutions of Dynamic Equations on Time Scales:
The Sturm-Picone Comparison Theorem

Sonja is a graduating student from Mathematics Program who has written an Honors Project under the direction of Professor John Graef. Other members of the Committee are R. Smith, B. Belinskiy, and N. Ozbek.

Abstract.
Presented here are the basic properties of time scales and operations on them. We consider two generalized derivatives on time scales, namely, the delta and nabla derivatives. We further discuss integration on time scales with respect to both of these derivatives. The delta derivative, an equivalent of the forward difference operator on Z, is described in more detail. The analogous results for nabla derivative, the equivalent of a backward difference on Z, follow similarly. Finally, we focus on second order dynamic equations, which are the time-scale equivalents of second order differential and difference equations on their respective domains.

The particular problem we study in this paper is a generalized version of the well-known Sturm-Picone Comparison Theorem. We focus on the second order delta-derivative self-adjoint equations of a particular form and derive the analogous result for time scales. The result is proved directly, avoiding the usual Riccati type transformations. The possibility for further research stems from the final result which may be considered for a more general form of self-adjoint equations that includes not only delta, but also the nabla derivative, and also some nonlinear cases.

Raymond H. Phillippi, Ph.D.

BlueCross BlueShield of Tennessee

Tuesday, August 26, EMCS 205, 2:00pm.

The PPA Quality Index: A Universal Measure of Health Practice Quality

Abstract.
As health costs have continued to increase dramatically over the years, health insurers have turned to provider evaluations as a way to ensure that health care is delivered efficiently with a high degree of quality. These evaluations sometimes called profiles or report cards have traditionally been based on specific utilization parameters such as the frequency of hysterectomies or the number of MRIs performed. This method of evaluating providers, however, has too drawbacks. First providers do not like being evaluated on single procedures and secondly, the approach required the creation of a specialty by specialty evaluation procedure.
In response to these concerns, BlueCross BlueShield of Tennessee developed an evaluation procedure called Practice Pattern Analysis that was based on episodes of care, universal in its approach to all physicians regardless of specialty, and relatively easy to produce on a mass basis. The one drawback to this approach is that it is primarily based on measures of efficiency and does not have an obvious quality measure.
As a result, there is a need to develop a universal measure of practice quality that would apply equally to all specialties. This is a problem that is not easily solved when considered from a health care prospective, but can be solved when considered from a statistical prospective. This colloquium will discuss current research into developing this universal measure of health practice quality.

Students are encouraged to attend.

Zuzana Dosla

Masaryk University,

Brno, Czech Republic

Thursday, October 9, EMCS 422, 3:00pm.

ON PRINCIPAL SOLUTIONS OF HALF-LINEAR DIFFERENTIAL EQUATIONS

Abstract.
We present some recent results for the half-linear differential equation

$$(a(t)\Phi_p(x'))' = b(t)\Phi_p(x) \quad (E)$$

where the functions $a(t)$ and $b(t)$ are continuous, $a(t) > 0$, and $\Phi_p(u) = |u|^{p-2}u$ with $p > 1$.

The notion of principal solution of the nonoscillatory linear equation was introduced by W. Leighton, M. Morse and P. Hartman as a "smallest solution in a neighborhood of infinity." Following the Riccati equation approach, the notion of principal solution has been extended to (E) independently by J. Mirzov and by A. Elbert & T. Kusano. We show that the limit and integral characterizations of principal solutions hold for (E) as well.

Bo Zhang

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Thursday, October 16, EMCS 238, 2:00pm.

A Fixed Point Theorem of Krasnoselskii Type
and Its Applications in Periodicity and Control of Neutral Systems

Abstract.
It is well-known that a combination of the contraction mapping theorem and Schauder's fixed point theorem (known as Krasnoselskii's theorem) can be used in the study of a neutral differential equation by converting it to an integral equation, say

$$x(t) = h(t, x_t) + \int_0^t G(s, x_s)ds$$

with a view of proving $h(t, x_t)$ is a contraction and the integral term is compact when G is small enough.

In this paper, we prove a fixed point theorem which is a combination of the contraction mapping theorem and a variant (Browder-Potter theorem) of the nonlinear alternative of Leray-Schauder degree theory which requires a less restrictive growth condition on the functions involved. We use this fixed point theorem to study the existence of periodic solutions and controllability in a system of neutral differential equations (NDEs). Due to the topological nature of the approach, the theorem applies as well to NDEs of mixed type and NDEs with state-dependent delays for which the fundamental theory of solutions has not been well developed. Some comparisons between our results and the existing ones in the literature are also provided.

The presentation will be of interest for physicists and engineers. Students (especially math majors) are encouraged to attend.

Liancheng Wang

Department of Mathematical Sciences,
Georgia Southern University

Friday, October 31, EMCS 239, 2:00pm.

Mathematical Analysis of the Global Dynamics of a Model for HIV Infection of CD4+ T cells

Abstract.
A mathematical model that describes the interaction of HIV infection and CD4 $^+$ T cells is studied. Global dynamics analysis is rigorously established. After identifying a basic reproduction number R0, we establish that, if $R_0 \leq 1$, the HIV infection dies out; if $R_0 > 1$, the HIV infection persists, solutions approach either the unique endemically infected steady state or periodic orbits.

The presentation will be of special interest for faculty and students in Mathematics and Biological Science.

Amin Boumenir

Department of Mathematics,
State University of West Georgia, Carrollton

Friday, November 7, EMCS 211, 1:00pm.

The Recovery of Analytical Potentials

Abstract.
In 1951, I. M. Gelfand and B. M. Levitan have solved the inverse spectral problem for the Strum-Liouville

$$-y''(x) + q(x)y(x) = \lambda y(x) \quad \text{for } x \in [0, \infty)$$

by integral methods. A year later, M.G. Krein solved the inverse problem for the string operator

$$-y''(x) = \lambda w(x)y(x) \quad \text{for } x \in [0, L)$$

using the theory of entire functions and Stieltjes continuous fractions. In fact he had developed a set of rules, allowing him to recover the density $w(x)$ explicitly. Twenty years later Debranges, proved the uniqueness for the string.

Since then, the inverse problem community has wondered whether we can borrow M.G. Krein's methods to recover $q(x)$. A brief comparison of both methods from the operator theoretic view point will summarize the first part of the talk.

In the second part, we introduce a new method which reconstructs analytical potentials, using the method of coefficient identification. Among its advantages, is the possibility of working with complex eigenvalues and boundary conditions depending on the spectral parameter. We show how to recover an analytic potential from two spectra. The proof involves solving recurrence relations using combinatorics and Roman calculus.

Numerical experiments, convergence and open problems will be discussed at the end.

The presentation will be of special interest for physicists and engineers. Students (especially math majors) are encouraged to attend.

Aniekan Ebiefung

Department of Mathematics,
University of Tennessee at Chattanooga

Thursday, November 13, EMCS 211, 2:00pm.

RESPONSIBLE USE OF THE INTERNET IN EDUCATION
Evaluation, Citation, and Fair Use of Web Materials

Abstract.
The Internet has been successfully used in commerce and in personal communication. Educators are still experimenting on how to efficiently use it to advance the processes of teaching, research, and collaborative projects. This book examines the set of issues involved in using the Internet in education. It contains instructional materials used for the Tennessee Higher Education Commission sponsored workshops for Chattanooga area teachers. In this presentation, I would share with you the motivations for writing the book and what I consider a responsible use of the Internet in education.

USAGE: This book will be valuable to any one who uses the Internet for communication, teaching or collaborative projects; especially parents and teachers who help children use the Internet in learning. The book can also be used as a supplement to courses in Educational Technology courses offered in colleges of education, which relates to teaching using the Internet. It may also be used as a supplement to general education courses in computer literacy where students are expected to master the rudiments of effective use of the Internet.

The book contains information from teaching instructional guides on how to use the Internet in the classroom. Thus the book naturally satisfies the service needs of many K-12 teachers and school administrators. College professors will find this book to be an important source of reference on effective and responsible use of the Internet.

Biography: Dr. Aniekan Ebiefung is a University of Chattanooga Foundation Professor of Mathematics at UTC. He holds a Ph.D in Mathematical Sciences from Clemson University. Professor Ebiefung has received many research and teaching awards. These include the 1993 Oakridge Associated Universities Junior Faculty Enhancement Award in Mathematics and Computer Science, University of Chattanooga Foundation Professorship 1994, Student Government Association Outstanding Professor Award 1994, and the 1998 Southeastern Institute for Operations Research and the Management Sciences Best Paper Award in Quantitative Theory and Methods Track. He has also organized workshops, seminars, and discussion groups on problem solving and on teaching using the Internet, both locally and internationally.

Yongzhi Steve Xu

Department of Mathematics,
University of Tennessee at Chattanooga

Thursday, February 12, EMCS 233, 3:00pm.

Sound Wave Equation and Polarized Maxwell's Equations — Modeling, Analysis, and Numerical Simulations

Abstract.
The propagation of Sound waves in an ocean is governed by the sound wave equation, while the propagation of light waves in fiber optic is governed by Maxwell's equations. Under some conditions, both can be simplified to the Helmholtz equation in a layered half space. We combine analytical and numerical methods to study the two physical phenomena.

This talk present our resent research results of modeling, analysis and numerical simulations of the sound wave and light wave propagation and scattering. Movies of numerical simulations made by Mat lab will be shown. Two design problems of marine acoustics and fiber optics will be discussed as toy models of computational engineering.

We have carefully tailored the talk to use undergraduate mathematics. Students may see how calculus (math 151, math 161), multi-calculus (math 255), differential equations (math 245), Fourier transform (math 460), contour integrals (math 470), numerical methods (math 308, math 418), and other mathematics can be combined to solve complicated problems.

Matt Matthews

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Matt Matthews will make two presentations.

1. For faculty

Thursday, February 19, EMCS 233, 2:00pm.

Granular Flows Through Nonaxisymmetric Hoppers

Abstract.
Granular materials are a vital component of many industries, including the pharmaceutical, mining, and food industries. Often hoppers of various sizes and shapes are used in the handling of these materials. Despite the importance of these structures, most modeling is done in simple axisymmetric geometries in which the flow assumes a very simple form that is ill-suited for more general geometries. We construct a problem for similarity solutions in more general nonaxisymmetric hoppers and through computation show that the flow becomes fully three-dimensional. Furthermore, we examine the effect of the geometry on the distribution of stress along the hopper walls and indicate the importance that this work may have for design of better structures.

2. For students

Thursday, February 19, EMCS 211, 9:25am.

An Introduction to Granular Materials

Abstract.
Granular materials are a vital component of many industries, including the pharmaceutical, mining, and food industries. Equally important, however, are the mathematical and computational questions raised in the course of modeling these materials. This talk will serve as a gentle introduction to the field, covering a range of applications from Engineering and Physics and explaining how Mathematics has been brought to bear on these problems.

Terry Walters and Stephen Kuhn

Dept. of Mathematics
University of Tennessee at Chattanooga

Tuesday, March 2, EMCS 216, 3:00pm.

Why Should Teachers Use Shared Web-Based Homework

Abstract.
For several years we have been using MathClass, a web-based homework system developed at the University of Kentucky (UK) and freely available to faculty in all disciplines. MathClass shares much functionality with other web-based homework systems, including random selection of problems, immediate grading of the homework with feedback to students and faculty, and opportunities for email between student and teacher with clear problem references. However, teachers using MathClass can develop and post their own problem sets, can use and modify homework sets developed by other faculty, can display extensive mathematical symbolism with graphics, and can build their own problem generators.

In this presentation we will demonstrate the use of MathClass by students and teachers, the full sets of materials we have written for Math 136, 145, and 151, and the partial sets we have written for other courses. We will also demonstrate the creation of problem generators and the connection of problems to specific course objectives or disciplinary standards.

Our work and that at UK is supported by the National Science Foundation.

Sergei Avdonin

Department of Mathematical Sciences,
University of Alaska Fairbanks

Thursday, March 18 , EMCS 239, 3:00pm.

Control and Inverse Problems for the Wave equation on Graphs

Abstract.
Differential equations on graphs are used to describe many physical processes such as mechanical vibrations of multi-linked flexible structures usually composed of flexible beams or strings, propagation of electro-magnetic waves in networks of optical fibers, heat flow in multi-link networks, and also electron flow in quantum mechanical circuits. In this talk we describe new controllability results for the wave equation on graphs without cycles. We prove exact boundary controllability of such systems and find a sharp estimate of controllability time. Basing on these results we solve the inverse (identification) problem — recover the topology of the graph and density of the strings using boundary observations. We discuss how our results can be applied for solving control and inverse problems for the heat and Schrödinger equations.

Lucas van der Merwe,
University of Tennessee at Chattanooga,
Christine Mynhardt,
University of Victoria, Canada,
and
Teresa Haynes,
East Tennessee State University

Thursday, April 1, EMCS 422, 3:00pm.

Criticality Index of Total Domination

Abstract.
A set S of vertices of a graph G is a total dominating set if every vertex of $V(G)$ is adjacent to some vertex in S. The total domination number of G, denoted by $\gamma_t(G)$, is the minimum cardinality of a total dominating set of G. We define the *criticality index* of an edge $e \in E(\overline{G})$ as $ci(e) = \gamma_t(G) - \gamma_t(G+e)$. Let $E(\overline{G}) = \{e_1, \ldots, e_{\overline{m}}\}$ and let $S = \sum_{j=1}^{\overline{m}} ci(e_j)$. Then the *criticality index* of G is $ci(G) = S/\overline{m}$. We determine the criticality index of cycles.

Michael Ahmadi * **, Steve Kuhn and Terry Walters,**

Department of Mathematics,
University of Tennessee at Chattanooga

Thursday, April 15 , EMCS 233, 3:00pm.

Authoring Web Class (WHS) Quizzes Using a Graphical Interface

Abstract.
Traditionally, quizzes for the WHS system have either been written by hand or have been tagged from the Maple command prompt via procedures found in MCtools. With the introduction of the Maplets package, Maple users may now take advantage of a set standard windowing elements in order to access the functionality of Maple. GraphicalTools is a new package that aims to harness the power of Maplets for the purpose of efficiently authoring WHS quizzes with MCtools.

* Michael graduated from UTC with majors in Mathematics and Computer science.

Charles Johnson,

Department of Mathematics,
College of William and Mary,
Williamsburg, Virginia

Thursday, April 20, EMCS 422, 3:00pm.

Sums of Matrices and an Unexpected Result for an Unnatural Problem

Abstract.
A matrix is called totally positive (nonnegative) if ALL its minors are positive (nonnegative), and a matrix with nonpositive off-diagonal entries is an M-matrix if its inverse exists and is nonnegative (entry-wise). We consider two questions: which positive matrices occur as sums of totally positive matrices and of inverse M-matrices. In each case there is an interesting surprise.

Boris Belinskiy,

Department of Mathematics,

University of Tennessee at Chattanooga,

Tuesday, June 22, EMCS 232, 2:00pm.

Control of a string: some new developments and open problems

Abstract.
It is well–known that the problem of exact controllability for the wave equation with constant (in time) parameters may be reduced to a moment problem for non–harmonic exponential functions. We consider a string with parameters that are varying in time. As a result, our moment problem is rather unusual. So far, we are able to prove a controllability result for a string under the "slowly" varying tension. We formulate some open problem.

J'anos Karsai,

Department of Mathematics,

University of Szeged,

Hungary

Wednesday, June 23, EMCS 422, 11:40am.

On the effect of nonlinearities in second order oscillatory systems

Abstract.
We investigate the asymptotic behavior of the system

$$x'' + a(t)|x'|^{\beta}\text{sign}(x') + f(x) = 0 \quad (t \geq 0, \quad a(t) \geq 0),$$

where $\beta > 0, xf(x) > 0,\ x \neq 0$, and its impulsive analog

$$x'' + f(x) = 0 \quad (t \geq 0,\ t \neq t_n), \quad x'(t_n+) = h^{b_n}(x'(t_n-))|x'(t_n-)|^{\gamma}),$$

where $t_n < t_{n+1},\ b_n \geq 0,\ 0 \leq h(u) \leq 1$.
The behavior of these systems with linear damping $\beta = 1$ and $h(u) = const.$ are known. The importance of the nonlinearity of $f(x)$ is especially characteristic in the case of the impulsive oscillations. There are also results proved for systems containing nonlinear damping terms, but, for example, the case of sublinear damping in the first system is hardly investigated as yet, although its behavior is essentially different from the linear and superlinear cases.
In the talk, we investigate the role of different kind of nonlinearities (for example, sub- and superlinear type) in both distributed and impulsive dampings.
We present computer experiments as well as new results for the asymptotic behavior of the solutions, and demonstrate the differences in the structure of the set of solutions caused by the different nonlinear damping terms.

Valery Gaiko

Department of Mathematics

Belarusian State University
of Informatics and Radioelectronics

Minsk, Belarus

Wednesday, July 14, EMCS 422, 2:30 pm.

On Global Bifurcation Theory of Polynomial Dynamical Systems

Abstract.
Two–dimensional polynomial dynamical systems are considered and the main problem of qualitative theory of such systems is discussed: Hilbert's sixteenth problem on the maximum number and relative position of limit cycles.