

Amundson Lecture Series 2013

# Abstracts

Presented by: Professor Douglas N. Arnold

## Lectures

Monday, March 4th, 2013

4:00 p.m.—5:00 p.m.

General Lecture:

“The Fundamental Theorem of Numerical Analysis”

UH Hilton, Conrad Ballroom (CD)

Tuesday, March 5th, 2013

4:00 p.m.—5:00 p.m.

Seminar Lecture:

“The Periodic Table of Finite Elements”

110 Classrooms & Business Building (CBB)

Wednesday, March 6th, 2013

4:00 p.m.—5:00 p.m.

Graduate Student Lecture:

“Mathematics Meets Golf”

110 Classrooms & Business Building (CBB)



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## The Fundamental Theorem of Numerical Analysis

Computer simulation is a powerful and indispensable tool in most areas of science and engineering, exerting major impacts on many aspects of modern life. For a vast variety of natural and human-engineered systems, simulation entails the approximate solution of a system of differential equations through a discretization which can be effectively implemented on computers. The accuracy of the simulation depends on the consistency and the stability of the discretization. The paradigm that consistency and stability together lead to convergence is a recurring theme in numerical analysis of differential equations. However, consistency and, specially, stability, can be subtle and elusive. Even relatively simple examples can yield unexpected--sometimes catastrophic--results. Traditionally numerical analysis relied on elementary tools such as Taylor expansions, Fourier series, and matrix analysis to explore convergence and stability. In response to ever more challenging problems, numerical analysts are bringing a new array of techniques to bear, including tools from differential geometry and algebraic topology that have enabled recent breakthroughs.

## The Periodic Table of Finite Elements

Finite element methodology, reinforced by deep mathematical analysis, provides one of the most important and powerful toolsets for numerical simulation. Over the past forty years a bewildering variety of different finite element spaces have been invented to meet the demands of many different problems. The relationship between these finite elements has often not been clear, and the techniques developed to analyze them can seem like a collection of ad hoc tricks. The finite element exterior calculus, developed over the last decade, has elucidated the requirements for stable finite element methods for a large class of problems, clarifying and unifying this zoo of methods, and enabling the development of new finite elements suited to previously intractable problems. In this talk, we will discuss the big picture that emerges, providing a sort of periodic table of finite element methods.

## Mathematics Meets Golf

Mathematics is everywhere, and the golf course is no exception. Many aspects of the game of golf can be illuminated or improved through mathematical modeling and analysis. We will discuss a few examples, employing mathematics ranging from simple high school algebra to computational techniques at the frontiers of contemporary research.

