DK Minicourse

March 07, 2016, 14:00 - 15:15
March 08, 2016, 09:30 - 10:45
March 10, 2016, 14:00 - 15:15

Vienna University of Technology,
Freihaus, green area, 3th floor, room 03 B

Professor Alan Lindsay

Dept. of Applied & Computational Math & Statistics
University of Notre Dame

Modeling, analysis and numerical simulation of micro-electro mechanical systems

Micro-electro mechanical systems (MEMS) are a family of devices which incorporate circuitry and mobile elastic components on miniature scales to perform a variety of tasks. Miniaturization allows for greater performance together with lower power and fabrication costs. Large surface area to volume ratios prevalent in these tiny devices mean that the moving elastic structures in MEMS are typically actuated by electrostatic forces. However, the elastic components of the device may come into contact with possible destructive effects, if the electrostatic forces acting on them are too large. This loss of a stable operational state is known as pull-in instability and the event where the surfaces come into physical contact is called touchdown. This event may be a hindrance to certain type of devices such as sensors while being essential in others such as switches or pumps.

In these talks I will discuss mathematical modeling and analysis of the pull-in instability, with particular reference to why, how, when and where this phenomena occurs. The mathematical framework consists of systems of nonlinear high order partial differential equations (PDEs). The pull-in instability is manifested in these system by the loss of a stable solution

and touchdown by a finite time singularity of these equations. Many insights can be obtained by formulating singular perturbation problems in terms of small physical parameters coupled with accurate adaptive numerical strategies. One of the mathematical aspects that will be empathized throughout is the mathematical challenge and curious qualitative behavior associated with high order (derivatives greater than two) PDEs.

Selected References (Available here):

- Modeling MEMS and NEMS, John A. Pelesko.
- Lindsay, Lega, Glasner, Regularized Model of Post-Touchdown Configurations in Electrostatic MEMS: Interface Dynamics. (2015) 80(6)
- Lindsay, Lega, Glasner, Regularized Model of Post-Touchdown Configurations in Electrostatic MEMS: Interface Dynamics. (2015) 80(6)
- Lindsay, Lega, Glasner, Regularized model of post-touchdown configurations in electrostatic MEMS: Equilibrium Analysis. Physics D (2014) Vol. 280-281
- Lindsay, Lega, Sayas, The quenching set of a MEMS capacitor in two-dimensional geometries. (2013), Journal of Nonlinear Science, 23(5)