Temple University Mathematics Colloquium

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Duke University

will speak on

A Variational Multiscale Finite Element Method for Solid Mechanics and Fluid-Structure Interactions

ABSTRACT: We present a new approach to stabilize the finite element methods for explicit transient solid mechanics using linear simplicial finite elements, and its extension to fluid-structure interactions. In these problems, triangular/tetrahedral elements are usually preferred because they allow efficient and automated mesh generation for complicated geometries. However, standard Galerkin formulation typically leads to volume locking or instability on these elements in the case of nearly incompressible solid dynamics.

To overcome these difficulties, we describe a stabilized method that is based on a mixed formulation, in which the usual momentum equation is complemented by a rate equation for the evolution of the pressure field. The stabilization is derived using a variational multiscale approach, and it leads to provable energy stability, at least in the case of linear elasticity. The method is then extended to nonlinear solid dynamics with more complicated materials, including the elastoplastic and viscoelastic ones. Extensive numerical results in these contexts are presented to assess the accuracy and stability properties of the proposed VMS-FEM for general solid mechanics.

Finally, we describe a similar VMS-based finite element method for shock hydrodynamics, and conclude the talk by coupling the two methods to perform challenging shock-solid interaction computations.

Tuesday, January 20, 2015
Lecture at 2:00 pm
Coffee, tea, and refreshments from 1:45 pm
Room 617, Wachman Hall
Department of Mathematics