Stanford | ENGINEERING
Mechanical Engineering

FLUID MECHANICS SEMINAR

ENGR 298
May 8, 2018
4:30 pm
Bldg. 300, Rm 300

Refreshments served at 4:15 pm

A Unified Continuum and Variational Multiscale Formulation For Fluids, Solids, And Fluid-Structure Interaction

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There has been a dichotomy in computational mechanics: the governing equations for fluids are typically written in terms of the velocity and pressure using the Eulerian description, while the governing equations for solids are often written in terms of the displacement using the Lagrangian description. This difference is partly due to different stress responses in the constitutive laws, and it leads to the development of different numerical strategies for fluids and solids. It is desirable to formulate a unified framework for fluids and solids to facilitate the construction of consistent numerical methods. This will benefit the algorithm design for fluid-structure interaction problems. Dr. Liu will first present a unified continuum modeling framework for viscous fluids and hyperelastic solids using the Gibbs free energy as the thermodynamic potential. This framework naturally leads to a pressure primitive variable formulation for the continuum body, which is well-behaved in both compressible and incompressible regimes. Then the variational multiscale (VMS) analysis is performed for this continuum body. The resulting VMS formulation recovers the residual-based variational multiscale formulation for the Navier-Stokes equations. For hyperelastic materials, the VMS formulation provides a mechanism to circumvent the inf-sup condition for low-order tetrahedral elements. Dr. Liu will also discuss a novel formulation for fluid-solid coupled problems, showing that the proposed numerical scheme enjoys several appealing numerical properties. Numerical examples will be presented to provide corroboration. It is hoped that this work will spark further research on developing numerical formulations for computational mechanics and enable CFD experts to readily bring their expertise to bear on solid mechanics.

Bio: Dr. Ju Liu obtained his PhD in December 2014 from the computational mechanics group at ICES, the University of Texas at Austin. His graduate research work has been awarded the Robert J. Melosh medal from Duke University. He is currently a postdoctoral fellow working in the Cardiovascular Biomechanics Computational Lab at Stanford University.