Speaker:

Prof. Jay Gopalakrishnan is a computational mathematician, whose research centers around the design of numerical methods for partial differential equations and their rapid solution by iterative techniques. He co-invented two classes of numerical methods, the Hybridizable Discontinuous Galerkin methods, and the Discontinuous Petrov-Galerkin methods, now simply known as HDG and DPG methods, and has authored over eighty publications. He currently serves in the editorial board of a journal of the Society of Industrial and Applied Mathematics, and has also served other journals, including as managing editor of one. In 1995, he obtained his first degree at Indian Institute of Technology Kanpur. He then gained a PhD under the guidance of James Bramble and Joseph Pasciak at Texas A&M University. He has worked at Bell Labs, Medtronic Inc, University of Minnesota, and for over a decade, at University of Florida. In 2012 he resigned his full professorship at University of Florida to take up the Maseeh Distinguished Chair in Mathematical Sciences at Portland State University. In and around Portland, he is active in regional synergistic activities to bolster scientific computation.

Title of the talk: Structure preserving methods for approximating fluid stresses

Abstract:

This talk will focus on finite element techniques for simulating incompressible fluid flow. An age-old subject of discussion in computational fluid dynamics is the proper treatment of the incompressibility constraint on the fluid velocity u, namely div(u)=0. A new twist in this topic arising from a series of recent developments by multiple authors is the treatment of the incompressibility constraint using the Sobolev space H(div), the space of vector fields whose components and whose divergence are square integrable. Instead of using the standard Lagrange finite element spaces, the use of H(div)-conforming finite elements for velocity approximation brings new tools into play. A natural question to ask in this context is this: what is a natural Sobolev space for viscous fluid stresses to pair with an

H(div) velocity? We report on results obtained in our search for a mixed formulation with a stress space that pairs well with H(div)-spaces for velocity. The main new insight is that stresses should lie in a nonstandard Sobolev space H(curl div). The need to study this space and develop finite elements for it will be amply evident in this presentation. We will show that structure-preservation properties like mass conservation and pressure robustness are immediate in the newly introduced framework.

Date: October 7, 2020

Time: 8 AM – 9 AM

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