Department of Applied and Computational Mathematics and Statistics Colloquium

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Capturing nonlinear interaction between fluids and fiber-reinforced composite materials: a unified mathematical framework

Mesh-reinforced structures and fiber-reinforced structures arise in many engineering and biological applications. Examples include air domes and space inflatable habitats, vascular stents supporting a compliant vascular wall, and aortic valve leaflets. In all these examples a mesh or a collection of fibers is used to support an elastic structure, and the resulting composite structure has novel mechanical characteristics preferred over the characteristics of each individual component. These structures interact with the surrounding deformable medium, e.g., blood flow or air flow, or another elastic structure. Modeling and computer simulation of this class of problems is important for manufacturing and design of novel materials, for a design of space habitats, and for a design of novel medical constructs.

In this talk we present a *unified approach* to the study of mesh or fiber-reinforced shells and their interaction with incompressible, viscous fluids and 3D elastic structures. The approach is based on dimension reduction and operator splitting strategy. Mesh-like structures are modeled as mathematical 1D hyperbolic nets using dimension reduction. The resulting model is coupled to the elastodynamics of a membrane or a shell, and this mesh-reinforced shell model is then coupled to the flow of a viscous incompressible fluid and/or the elastodynamics of a 3D structure. Two-way coupling is enforced between all the different physical models in this multi-physics problem. An operator-splitting strategy is employed to solve the problems numerically, and in the main steps of the existence proof.

This talk will provide an overview of the modeling, numerical method development and analysis of this class of problems. Numerical simulations will be presented to illustrate the results.

This is a joint work with J. Tambaca, B. Muha and M. Bukac.

Thursday, October 5, 2017
4:30 PM – 5:30 PM
127 Hayes-Healy Center

Colloquium Tea 4:00 PM to 4:30 PM Hurley Hall Globe Area