Temple University Mathematics Colloquium

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will speak on

Solving PDEs in complicated geometries

ABSTRACT: Engineers estimate lift and drag by solving the PDEs of fluid mechanics in a domain that corresponds to the exterior of an object (airplane, car, rocket) which can be quite complicated. The flow solution is then represented by its values at a finite set of mesh points or elements. Setting up the mesh can be as challenging and time consuming to the engineer as creating the finite difference or finite element equations and solving them. We give an overview of several approaches to this "meshing" problem. The Cartesian grid approach – our method – uses a regular rectangular mesh except for irregular "cut cells" near the boundary. It has the potential to be very accurate and efficient because most of the mesh is simple and regular. However there are many mathematical issues related to the irregular and possibly very small cut cells near the boundary.

Linear stability is one major issue. This is the necessary condition that an associated linear operator should be uniformly bounded independent of the mesh and position of the boundary. For problems with shock waves, nonlinear stability requires that artificial oscillations are not allowed to form. Particularly for viscous flows, accurate and smooth approximations to high derivatives at cut cells are a challenge, as is the lack of anisotropic refinement when the grid is not aligned with the geometry.

We discuss theoretical work on these problems and present computational results showing the power of Cartesian grid methods.

Monday, November 9, 2015, Lecture at 4:00 pm
Coffee, tea, and refreshments from 3:40 pm
Room 617, Wachman Hall
Department of Mathematics