WICHITA STATE UNIVERSITY

Department of Mathematics and Statistics

The Lecture Series in the Mathematical Sciences Presents Our Guest:

Dr. Bartosz Protas

McMaster University, Hamilton, Ontario, Canada

"Vortex Methods and Vortex Models for Flow Control Problems"

Abstract:

In this presentation we will discuss two Lagrangian approaches to the problem of flow control: a vortex method used as a tool for solution of adjoint equations arising in flow optimization problems, and a point vortex model used as an "ultimate reduced order model" for feedback control design. Both these strategies are derived using methods of Modern Control Theory and their precise mathematical characterization will be presented together with computational results. The two approaches represent two opposite extremes as regards complexity of the underlying models and to fix attention in the talk we will focus on rotational control of laminar vortex shedding in the wake behind a circular cylinder. In the first strategy we seek to determine the optimal control for the full Navier-Stokes system by minimizing a cost functional which represents the drag. The cost functional gradient is determined using adjoint equations which are solved in the Lagrangian (vorticity) formulation. This control strategy leads to significant sustained drag reduction obtained with a very small control effort. The method, however, is very costly as regards the computational cost. In the second approach we use the Foppl system (1913) as a reduced order model for vortex shedding in the cylinder wake. This model will be characterized from the control-theoretic perspective. It will be shown that the cylinder wake can be stabilized using a Linear-Quadratic-Gaussian (LQG) feedback control design based on the Foppl model. The two approaches will be compared and perspectives will be outlined as regards design of intermediate approaches that could bridge vortex methods and vortex models for flow control purposes.

Friday, January 21, 2005
3:00 PM in 372 Jabara Hall

Please come join us for refreshments before the lecture at 2:30 p.m. in room 353 Jabara Hall.