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## THE FIELDS INSTITUTE FOR RESEARCH IN MATHEMATICAL SCIENCES

## GEOMETRIC MECHANICS SEMINAR

**SPEAKER:**

**SCOTT BORTOFF**
Department of Electrical Engineering
University of Toronto

On the Topic:

### "The Acrobot as a Testbed for Nonlinear Control"

The acrobot is an underactuated two-link robotic manipulator, or double pendulum. It has only one input, which is a torque applied between both links. The stabilization of the Acrobot about all of its vertical "balanced" equilibria, called the equilibrium manifold, is a challenging control problem for several reasons. First, the Acrobot is not feedback linearizable. Second, considering the link angles as outputs, the Acrobot is nonminimum phase. Finally, the device is highly nonlinear. For these reasons, standard linear control will always yield a very small region of attraction.

We present the Acrobot as a testbed for new results in nonlinear control theory. We show that the Acrobot can be stabilized, about its entire equilibrium manifold using pseudolinearization. Although computational complexity prohibits the construction of the controller, we may construct a computationally efficient approximation using spline function interpolation. This engineering result is illustrated with a video tape showing an Acrobot, which the author recently constructed at the University of Illinois, moving along its equilibrium manifold. Next, we show how the Acrobot can be "semiglobally" stabilized with a discontinuous controller which switches between a high-gain control and the spline-based pseudolinearization. The high-gain controller forces the Acrobot to its equilibrium manifold and into the region of attraction of the psuedolinear control. We discuss the generalization of this switching control to a class of nonlinear systems, which is a subject of ongoing research at the University of Toronto.

**Tuesday, June 29, 1993**

**3:30 pm, room 3018**

**at**

**The Fields Institute**

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