

# BI-CO MATHEMATICS COLLOQUIUM

**Emese Kennedy**

Muhlenberg College

## *“Swing-up and Stabilization of a Single Inverted Pendulum on a Cart”*

**Monday, October 26, 2015**

Talk at 4:00 – Park 338

Tea at 3:30 – Park 355, Math Lounge

### **Abstract:**

In 1990 the International Federation of Automatic Control (IFAC) Theory Committee published a set of real world control problems that can be used to compare the benefits of new and existing control methods, called benchmark problems. One of these is the control of an inverted pendulum. Despite its simple structure, the inverted pendulum is among the most difficult systems to control. This difficulty arises because the equations of motion governing the system are inherently nonlinear and because the upright position is an unstable equilibrium. Furthermore, the system is under-actuated as it has two degrees of freedom, one for the cart's horizontal motion and one for the pendulum's angular motion, but only the cart's position is actuated, while the pendulum's angular motion is indirectly controlled.

In the first part of this talk, we will discuss the successful real-time implementation of a nonlinear stabilization controller based on the power series approximation to the Hamilton Jacobi Bellman (HJB) equation. In the second part of this talk, we present a modified energy based swing-up controller that considers the effects of viscous damping, and incorporates physical restrictions like the maximum deliverable voltage by the amplifier, the capacity of the DC motor that drives the cart, and the finite track length.

**BRYN MAWR COLLEGE**