Faculty of Engineering and Applied Science
Chemical Engineering Seminar Series

Modelling and control of structured models for multi-physics systems

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Dupuis Hall, Room 215

ABSTRACT

In this presentation, I will address the problems of modelling, analysis, control, and numerical simulations associated to the class of multi-physical systems and distributed parameters systems, in particular, non-homogeneous systems described by conservation laws (Partial Differential Equations). The talk focus is motivated and illustrated by the control of plasma profiles in Tokamak reactors. Tokamak reactors are experimental fusion reactors aiming to prove the feasibility and viability of fusion reaction for the production of clean and renewable energy. To describe the plasma dynamics, one requires to develop balance equations in the electric, magnetic, momentum, mass, thermal, and entropic domains. As control and observation of plasma profiles are impossible to achieve from the description of the plasma at the microscopic level (using Boltzmann equations), a model of the plasma is derived at the macroscopic level using fluid-like dynamics coupled with the Maxwell equations. The balance equations describing the system are nonlinear and coupled through poorly known transports coefficients. Moreover, dynamics of the plasma evolution occur on different time scales. The complexity of such system requires a larger point of view to address the control problem. Here, a special class of physically-based structure, the Port-Hamiltonian formulation, is considered.

The talk is organized as follows. The plasma control problem is first presented as an example of a structured formulation for multi-physics systems. The modelling steps are presented and a control perspective is discussed. To illustrate the advantages of the physical-based structure approach, a simple thermos-acoustic multi-physics system, the Rijke Tube, is presented.

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