Model Order Reduction Techniques for Control and Optimization of Automotive Energy Conversion and Storage Systems

Presented by:
Dr. Marcello Canova
Assistant Professor, Department of Mechanical and Aerospace Engineering
Associate Fellow, Center for Automotive Research
The Ohio State University

Automotive propulsion technologies have become considerably complex as manufacturers strive to improve fuel economy, emissions, safety and the driver experience. Such complexity requires the adoption of model-based control and estimation algorithms. The state of the art in this field, however, relies almost exclusively on low-fidelity plant models developed with heuristic methods and by oversimplifying the physical system, ultimately leading to a loss of fidelity.

This seminar introduces a novel framework that generates control-oriented models for thermal, fluid and chemical systems. The proposed approach consists of applying projection-based Model Order Reduction (MOR) to analytically generate reduced order models directly from physical equations in nonlinear Partial Differential Equation (PDE) form. This unique approach systematically transfers the accuracy and fidelity of physics-based models into low-order models suitable for control design, virtually eliminating the need for calibration, and provides the necessary tools to control engineers who need to employ high-fidelity models with considerably reduced mathematical complexity.

The proposed MOR approach will be illustrated in conjunction with applications to industry-relevant problems, such as the real-time prediction of state of charge and temperature in Li-ion batteries, and the estimation of pressure wave propagation in the manifolds of downsized boosted IC engines.

Speaker Bio:

Marcello Canova earned his *Diploma di Laurea "Summa Cum Laude"* and his Ph.D. in Mechanical Engineering from the University of Parma (Italy) in 2002 and 2006, respectively. Since 2011, he is Assistant Professor at the Department of Mechanical and Aerospace Engineering at The Ohio State University and Associate Fellow of the Ohio State university Center for Automotive Research (OSU-CAR).

Dr. Canova conducts research in the broad area of fluid and thermal sciences and energy systems, with emphasis on modeling, optimization and associated dynamic systems and control problems. His research has been funded by, among others, Ford, General Motors, Chrysler, Cummins, the National Science Foundation and the US Department of Energy. Dr. Canova's research and educational activities were acknowledged by the National Science Foundation with a CAREER Award in January 2016.

Dr. Canova is a recipient of the Kappa Delta Distinguished Faculty Award and the SAE Vincent Bendix Automotive Electronics Engineering Award (2011), the Lumley Interdisciplinary Research Award (2012), and the SAE Ralph Teetor Educational Award (2016). He has published over 100 articles in refereed journals and refereed proceedings.