Control of Infinite Dimensional Systems with Applications to Energy Efficient Buildings

Ingram Lecture Series

Friday, April 15, 3:45 – 5:00 pm

213 Butler-Carlton Hall

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Abstract: Buildings are responsible for a significant fraction of the energy consumption and greenhouse gas emissions in the U.S. and worldwide. Consequently, the design, optimization and control of energy efficient buildings can have a tremendous impact on energy cost and greenhouse gas emission. Buildings are complex, multi-scale in time and space, multi-physics and highly uncertain dynamic systems with wide varieties of disturbances. Recent results have shown that by considering the whole building as an integrated system and applying modern estimation and control techniques to optimize the whole building system, one can achieve greater efficiencies than obtained by optimizing individual building components such as lighting and HVAC. In order to control a whole building for energy minimization one must address a variety of theoretical and computational science problems at various levels from room to complete building envelopes. In this presentation we discuss optimization and control problems for a distributed parameter model of a single room. In particular, we show that distributed parameter control theory, coupled with high performance computing, can provide insight and computational algorithms for the optimal placement of sensors and actuators and the design of supervisory building control systems. Numerical examples are provided to illustrate the approach. We also discuss the problems of design and optimization (for energy and CO2 reduction) and control (both local and supervisory) of multi-room and whole buildings and demonstrate how sensitivities can be used to address these problems.

Biographical Sketch: John Burns is the Hatcher Professor of Mathematics at Virginia Tech and the Technical Director of the Interdisciplinary Center for Applied Mathematics. He served as Vice President of SIAM, is the past Chair of the SIAM Activity Group on Systems and Control and is a Fellow of the IEEE. Dr. Burns was recently named as the winner of the 2010 Reid Prize for his fundamental contributions in computational methods for and applications in control, design and optimization of complex systems. Dr. Burns' primary interests concern the development of rigorous and practical computational algorithms for model reduction, design, control and optimization and sensitivity analysis of engineering and biological systems. Dr. Burns has been a consultant and advisor to Booz Allen & Hamilton, NASA Langley Research Center, The Air Force Research Labs, DARPA, The Babcock and Wilcox Company, Solers Inc., United Technologies and has held several visiting positions in the USA, Europe and Asia. Dr. Burns currently is working with United Technologies Research Center on several projects concerning reduced order modeling and control of energy efficient buildings and he is a Co-PI on the recent $122 Million DOE Energy-Efficient Building Systems Design HUB led by Penn State.

Seminar sponsored by: Ingram Lecture Fund, Missouri Institute for Computational and Applied Mathematical Sciences (MICAMS), Department of Mathematics and Statistics, Office of Sponsored Programs