DEPARTMENT OF
MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING SEMINAR SERIES

FLYING LIKE AN ALBATROSS: A JOURNEY INTO THE PERIODIC OPTIMAL CONTROL OF ENERGY SYSTEMS

Wednesday, February 14, 2018 | 1:00pm
2164 Martin Hall, DeWALT Seminar Room

DR. HOSAM K. FATHY

Associate Professor
Department of Mechanical & Nucelar Engineering
Pennsylvania State University

ABSTRACT

This seminar will examine periodic optimal control theory and its application to the optimal control of energy systems. The seminar is partly motivated by the degree to which optimal control systems can improve the performance, efficiency, and longevity of energy systems such as electrochemical batteries, vehicle-to-grid integration systems, building demand response systems, and large-scale datacenters. Furthermore, the seminar is inspired by the albatross, a bird that can travel tremendous distances over water with very little energy consumption. The albatross achieves this by switching periodically between (i) flying at high speeds close to the surface of the ocean, and (ii) gaining potential energy by climbing into the wind. This "dynamic soaring" pattern exploits the gradient of wind speed with respect to altitude to maximize flight energy efficiency. Dynamic soaring is just one example of a "proper" periodic optimal control problem: one whose periodic solution is superior to the best achievable steady-state solution. The seminar will briefly review the literature on periodic optimal control. The seminar will then examine some of the classical applications of periodic optimal control theory, such as pulse-and-glide driving and the periodic treatment of drug resistance dynamics. Much of the talk will focus on the application of periodic optimal control to the emerging problems of (i) optimal airborne wind energy harvesting and (ii) battery test trajectory optimization for Fisher parameter identifiability. The talk will finally conclude with a glimpse of future applications of periodic optimal control, including applications to robotic flight and vehicle connectivity/autonomy.

BIO

Hosam K. Fathy earned his B.Sc. (Summa Cum Laude), M.S., and Ph.D. degrees, all in Mechanical Engineering, from The American University in Cairo (1997), Kansas State University (1999), and University of Michigan (2003), respectively. Dr. Fathy worked as a Control Systems Engineer in the automotive industry (2003-2004), a postdoctoral Research Fellow (2004-2006, University of Michigan), and Assistant Research Scientist (2006-2010, Univ. of Michigan), prior to joining Penn State University as an Assistant Professor in 2010. Since 2015, Dr. Fathy has served as the Bryant Early Career Associate Professor of Mechanical Engineering at Penn State University. He has co-authored more than 125 peer-reviewed conference papers and journal articles, is a 2014 NSF CAREER Awardee, and has received the 2009 Outstanding Research Scientist Award from the University of Michigan's College of Engineering and the 2016 Outstanding Teaching Award from Penn State's College of Engineering. His fundamental areas of expertise are dynamic system modeling, model reduction, system identification, and optimal control. He applies the tools of these disciplines to a number of areas, mostly in the transportation, electrochemical battery storage, and energy systems domains.

A. JAMES CLARK
SCHOOL OF ENGINEERING