

**MECHANICAL ENGINEERING DEPARTMENT  
ME/ISyE 8773-8774**

**Applying Simple Control Techniques in Fuel Cell Systems**

by

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**Wednesday, April 16, 2008**  
**3:15 p.m. — Refreshments before the seminar**  
**3:30 p.m. — Graduate Seminar**  
**Room 1130 ME**

**ABSTRACT** — Periods of transient operation during start-up, shut-down, and sudden load changes are characteristic and ubiquitous to all power producing devices. During these critical periods, fuel cell systems rely on monitoring and controlling devices and methodologies. In this talk we present how simple model-based control, optimization and estimation techniques can be used to improve the performance and robustness of Polymer Electrolyte Membrane (PEM) fuel cells. First, fundamental limitations in controlling the reactant flow of power-autonomous fuel cells will be discussed. These results provide insight on practical control strategies and calibration of fuel cell hybrid electric vehicles. Optimization tools will then be used to determine the required fuel cell-battery sizing (hybridization level) and the associated trends in fuel economy. Finally, we focus on the water management problem, and specifically, the need for controlling the water distribution inside the gas diffusion layers of PEM fuel cells. We show how time-scale decomposition allowed us to approximate the two-phase, reaction-diffusion, spatially distributed water dynamics and consequently establish a feasible boundary value control problem. Validation results using detailed liquid water prediction with neutron imaging and aggregated multi-cell stack voltage responses are also presented.

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**BIO** — **Anna G. Stefanopoulou** obtained her Diploma (1991, Nat. Tech. Univ. of Athens, Greece) in Naval Architecture and Marine Engineering and her Ph.D. (1996, University of Michigan) in Electrical Engineering and Computer Science. She is a professor of mechanical engineering at the University of Michigan. She was an assistant professor (1998-2000) at the University of California, Santa Barbara, and a technical specialist (1996-1997) at Ford Motor Company. Dr. Stefanopoulou is an ASME Fellow, a member of the IEEE Control Systems Society (CSS) Board of Governors and an Associate Editor of the IEEE Transactions on Control System Technology. She is a recipient of the 2005 Outstanding Young Investigator by the ASME DSC division, the 2005 Henry Russel award, a 2002 Ralph Teetor SAE educational award and a 1997 NSF CAREER award. She has a book on Control of Fuel Cell Power Systems, nine US patents, and 4 best paper awards. Her current work addresses the control and automation of fuel cells, biofuel combustion, and fuel processing.

Informal Faculty Luncheon: Wednesday, April 16, 2008, 12:00 noon. Meet in 1100 ME and walk to lunch with other faculty. Prof. Anna Stefanapoulou will be able to attend. Faculty Host is Prof. Rajesh Rajamani