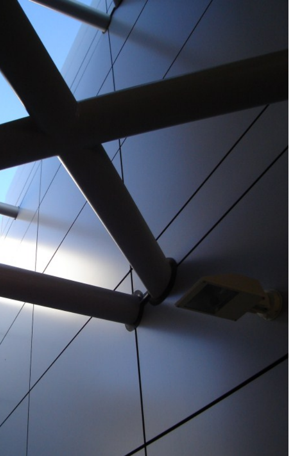

Colloquium
Mechanical Engineering

The Department of Mechanical Engineering presents:

Elisa Franco, Ph.D.

Assistant Professor
University of California Riverside

Friday, October 7, 2011
11:10AM-12:00PM
Bourns Hall A265

Analysis, design and in vitro implementation of molecular circuits

Abstract

The functionalities of every living organism are wired in the biochemical interactions among proteins, nucleic acids and all the other molecules that constitute life's building blocks. Understanding the general design principles of this "hardware of life" is an exciting and challenging task for modern bioengineers. In this talk, I will focus on design rules to achieve robustness and modularity in molecular networks. Experimental verifications of such rules is carried out using in vitro transcriptional circuits, a minimal analogue of cellular genetic networks.

The first problem I will consider is flux control. I will describe a simple model problem where two reagents bind stoichiometrically to form an output product. To match the reagents flux, robustly with respect to the open loop rates, I will propose the use of negative or positive feedback schemes that rely on competitive binding. Such schemes are modeled through ordinary differential equations and implemented using transcriptional circuits.

The second topic will be the functional robustness of interconnected networks: molecular devices characterized in isolation may lose their properties once interconnected. This challenge will be illustrated with a case study: a synthetic transcriptional clock will be used to time conformational changes in a molecular nano-machine called DNA tweezers. Mass conservation introduces parasitic interactions that perturb the oscillator trajectories proportionally to the total amount of tweezers ``load''. To overcome this problem, we can use a genetic switch that acts as a buffer amplifier, achieving signal propagation and at the same time reducing the perturbations on the source of signal.

Finally, I will outline current and future research directions in the area of biological circuits programming. In particular, I will focus on theoretical and experimental challenges in the design of robust and tunable biochemical oscillators.

Biography

Elisa Franco received her B.S. and M.S. (Laurea Degree) in Power Systems Engineering from the University of Trieste (Italy) in 2002, summa cum laude. In 2007, she received her Ph. D. in Automation from the same institution. In 2011, she completed her second Ph. D. at the California Institute of Technology, Pasadena, in Control and Dynamical Systems.

Dr. Franco's main interests are in the area of biological feedback systems. In particular, her research focuses on bottom-up approaches to the design and synthesis of controllers, sensors and actuators in biochemical reaction networks, using nucleic acids and proteins. She also works on robustness analysis of natural biochemical systems. In the past, Dr. Franco worked in the field of cooperative control and distributed estimation.