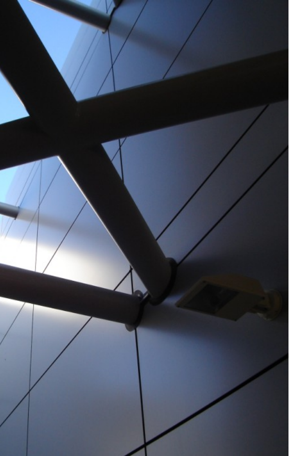

Colloquium
Mechanical Engineering

The Department of Mechanical Engineering presents:

Elisa Franco, Ph.D.

California Institute of Technology
Department of Control and Dynamical Systems

Friday, April 22, 2011
10:30AM-11:30AM
Bourns Hall A265
Faculty Only: 11:30AM-12:00

Design and Synthesis of Molecular Networks

Abstract:
How do living organisms process information and implement their responses to external stimuli? Even in the simplest cells, sensing, computation and actuation are structurally embedded in the biochemistry of complex molecular networks, which we often fail to systematically explain. Quoting Richard Feynman, what we cannot create, we do not understand: by building simple molecular networks from the bottom-up, in a controlled environment, we have an opportunity to gain insight into the design principles of their more complicated, naturally occurring counterparts. In this talk I will describe the design, modeling and synthesis of in vitro molecular circuits using simple building blocks: DNA, RNA and proteins. In particular, I will present my research on two specific challenges: flow regulation and scalability of biochemical networks. Cellular pathways rely heavily on a regulated flow of nucleic acids, enzymes and other metabolites. I will demonstrate how negative feedback can be used to coordinate and match the activity of two synthetic genes, minimizing waste of chemical reagents. The proposed architecture is robust with respect to initial conditions and specific uncertain parameters. Scaling up our perspective to the coordination of a large number of molecular circuits, biochemical oscillators promise to have a role analogous to digital clocks, which can drive millions of transistors. As a starting point, we have used a tunable biosynthetic oscillator to drive conformational changes of a DNA nano-mechanical device called "DNA tweezers". However, due to the imperfect modularity of the system, the operating point of the oscillator is remarkably deteriorated by high concentrations of its "load". This retroactivity effect is well known in engineered systems, and classical examples are given by voltage drops in power grids or pressure losses in pipe networks. This undesired back-action was reduced by engineering an "insulator circuit", the molecular equivalent of an operational amplifier, which improved the modularity and scalability of the system.

About the Speaker:
Elisa Franco is currently a graduate student at the California Institute of Technology, in the department of Control and Dynamical Systems. She received her Laurea degree in Power Systems Engineering from the University of Trieste, Italy, where she also earned a PhD in Automatic Control. Her current research interests are in the field of synthetic and systems biology.

Refreshments Served 15 minutes in advance of Colloquium