

TEACHING PHYSIOLOGY WITH SIMULINK

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The Biomedical Engineering Department is a joint venture between the Emory University School of Medicine and the Georgia Institute of Technology College of Engineering. We developed and implemented an innovative new Ph.D. program in 1999 that integrates graduate students with diverse backgrounds in the biological sciences and engineering. Simulink is an essential tool in both the introductory engineering course and the capstone physiology course.

Quantitative Modeling and Analysis

In the Modeling and Systems course, Simulink labs introduce students to quantitative modeling and analysis in a biological context. These labs are designed to be open-ended and challenging. The Simulink environment provides both a virtual experimental environment and a modeling and analysis tool. Students are introduced to the Simulink environment in the first lab session by demonstrating drug concentration in the bloodstream as a function of time. Drug metabolism is modeled as a simple electrical circuit analog, as shown in Figure 1.

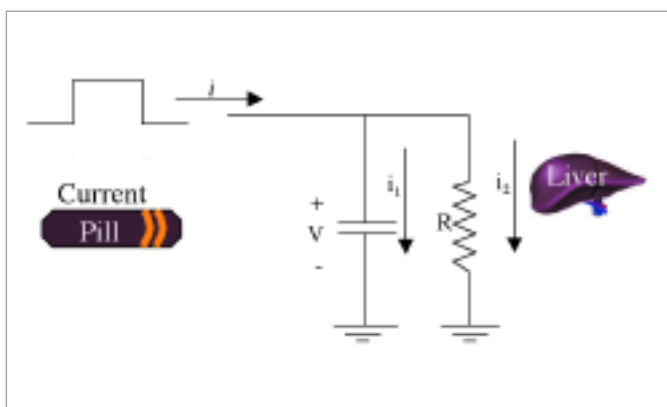


Figure 1: Electrical circuit model of drug metabolism.

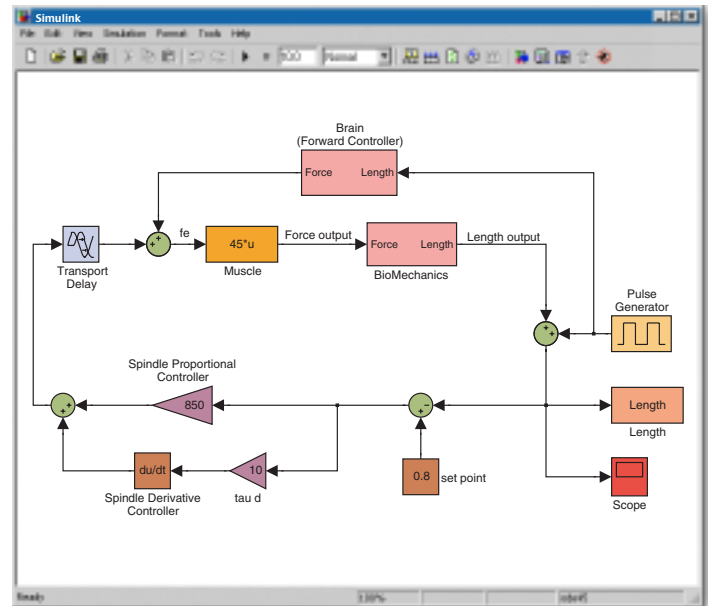


Figure 2: Simulink knee-jerk reflex model with feed-forward control.

Exploring Feedback Loops

In the Physiologic Systems course, second-year students integrate their engineering and biology backgrounds to build new Simulink models of physiologic processes. The course focuses on control and feedback regulation in the body. While feedback control has been recognized for centuries as one of the most critical aspects of physiologic function, biologists have typically used static descriptions of feedback processes for even very complex and nested control loops. Simulink provides an ideal environment for students to explore the dynamic and temporal aspects of long and slow feedback loops. As part of the final project, students generate a Simulink model of a physiologic function, usually related to their research area. Recent projects include hormonal regulation of bone density, neural mechanisms of pain modulation, and mechanisms for drug delivery to tumor cells. See Figure 2 for an example of the nonlinear model of a knee-jerk reflex.

For more information, visit

Simulink www.mathworks.com/nn_simulink

Khoo, M., (1999) *Physiological Control Systems*, Wiley.

www.mathworks.com/nn_physiological