Course Announcement
MATH 450 - Fall 2005
Mathematical Modeling of the Physical World

Time: TR 9:45 - 11:00 AM    Schedule Number: 550483
Location: 018 Henderson (Tues) & 107 Sackett (Thurs)

Instructor: Andrew Belmonte†

The purpose of the course is to introduce mathematical modeling, i.e., the construction of mathematical structures which capture relevant physical phenomena. Over the semester we will explore mathematical ideas and tools used to study the natural world. Particular emphasis will be placed on the process of creating a mathematical model starting from a physical scenario - The Art of Modeling. Typically this process will begin with an experiment either demonstrated in the W. G. Pritchard Lab or performed by the students in class.

Once a particular model has been developed, students will use mathematical analysis and experimentation to determine the properties and relevance of the model, and to make predictions. While the first model may be satisfactory, often one finds new features of the system that are not adequately accounted for in the model, or predictions which are not borne out... and the process begins again. It is this cycle the course will emphasize.

A significant aspect of this mathematics course is its laboratory component: the students will perform experiments and observe demonstrations. However, the main emphasis will be on creating and analyzing mathematical models. Instead of concentrating on a finely tuned model for a physical phenomenon, this course will try to convey some of the heuristic, intuitive, and mathematical ideas used to make the model.

The target audience for the course are advanced students majoring in mathematics, engineering, earth sciences, chemistry, or physics, as well as students in the biological sciences.

Modeling Topics: Some of the systems we will be modeling this semester include: simple and compound pendulum motion, stick-slip motion, ice permeability, fluctuations and diffusion, fragmentation and fracture, fluid and granular flow, chaotic systems, and possibly some biological phenomena (heart rate variability, eye movement). Students will be encouraged to propose additional topics!

Math Tools: We will focus on some of the mathematical tools which are often not included in the curriculum: scaling laws and similarity solutions for differential equations; linear stability and normal mode analysis; introduction to stochastic differential equations; asymptotics.

Note that the class size is limited to 20 students.

† Office: 009E Thomas Bldg (to be changed); email: belmonte@math.psu.edu; webpage: http://www.math.psu.edu/belmonte/math450_05.html