Math 617 Introduction to Industrial Mathematics

Fall Semester, 2008

Partial Description (updated May 30)

The variety of mathematical methods used in industry covers the whole spectrum of mathematics. Given the limited time to develop valuable methodologies and discuss in some detail case studies, the methodologies and case studies will focus on *partial differential equation models*. We will initially discuss dimensional analysis and scaling, and apply the ideas to some interesting questions. Then we will develop some conservation principles and discuss constitutive relations. After that we will plunge into some case studies, some drawn directly from Mathematical Problems in Industry workshops. Because we want you to learn a certain number of principles well, and not be all over the map regarding all sorts of mathematical models, we will concentrate on modeling processes that involve transport of mass or heat energy. Each case study will involve a general (physical) problem statement, some general background, and then initial mathematical modeling a key question. Each of the case study problems will involve some transformation or approximation technique that will be developed, and applied to simpler situations, before we attack the industrial situation. Hence, you will learn about some types of questions arising in industry, learn some modeling principles, and learn some techniques for analytically attacking nonlinear (and linear) partial differential equations. Right now my *potential* list of case studies includes questions on continuous casting of steel sheets, water filtration efficiency, factory fires, laser drilling, cooking cereal grains, and glass fiber spinning.

Course grade will mainly be derived from homework exercises, but I am thinking about requiring some short reports submitted from assigned projects. The course is part of a departmental track in industrial mathematics, but is open to other students.

Prerequisites: Math 225, 404, some familiarity with a high-level programming language, or permission of instructor.

Source of material: The basic background material comes from **Continuum Modeling in the Physical Sciences**, by E. van Groesen and Jaap Molonaar (probably going to be the recommended textbook). However, I do not care for their case studies, so I am relying on most of those studies coming from **Industrial Mathematics, Case Studies in the Diffusion of Heat and Matter**, by G.R. Fulford and P. Broadbridge. (This is a very interesting text, but it has mistakes, typos, and inconsistent notation in places.) In discussing mathematical techniques, I will draw from a variety of specialized literature.