ANALYSIS, NUMERICAL METHODS, AND APPLICATIONS OF MULTISCALE PROBLEMS

ALEXANDRE L. MADUREIRA
LABORATÓRIO NACIONAL DE COMPUTAÇÃO CIENTÍFICA — LNCC
BRAZIL

Short Course at the Math Department at CU Denver

Web Page: www.lncc.br/∼alm/cursos/asymp.html
Location and dates: We shall meet at room 641 (Seminar Room) of the Math Department. From September 9, 2002 to November 25, 2002. The meetings will be held on Mondays, from 11am untill noon. There will be a total of 12 hours (12 lectures).

Course Description: Multiscale Problems are omnipresent in real world applications, and present a challenge in terms of numerical approximations. Well-known examples include modeling of plates and shells, composites, flow in porous media, among other examples.

The PDEs that model these problems are characterized by either the presence of a small parameter in the equation (e.g., the viscosity of a turbulent flow), or in the domain itself (as in shell problems). These PDEs are commonly denominated *singular perturbed*.

In this course, I plan to discuss the modeling of some singular perturbed PDEs. Modeling here has two meanings. It can be in the sense of approximating the original PDE by another PDE that's easier to solve, as in plate and shell theory. It can also be in numerical approximation point of view, where the final goal is to develop a numerical scheme that is robust, i.e., that works well for a wide range of parameters.

The techniques involved will be introduced by means of examples. In all cases discussed, we shall derive modeling error estimates by means of asymptotic analysis. The problems I plan to describe are the Reaction–Diffusion Equation, Problem in domain with Rough Boundaries (think of a golf ball), and Plate problems. If time permits, I'll describe new techniques just developed to deal with PDEs with oscillating coefficients.

References: There's no single book I'll follow. Some modern papers dealing with the topic will be refereed to whenever necessary. I will also distribute typed notes.

Pre-requisites: I'll assume basic knowledge of analysis and Finite Element Methods. The main tools will be developed as the course goes.