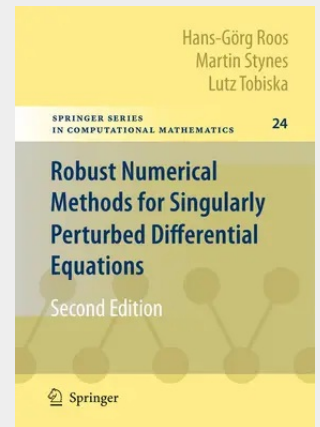


Robust Numerical Methods for Singularly Perturbed Differential Equations

Convection-Diffusion-Reaction and Flow Problems

The analysis of singular perturbed differential equations began early in the twentieth century, when approximate solutions were constructed from asymptotic expansions. (Preliminary attempts appear in the nineteenth century – see [vd94].) This technique has flourished since the mid-1960s and its principal ideas and methods are described in several textbooks; nevertheless, asymptotic expansions may be impossible to construct or may fail to simplify the given problem and then numerical approximations are often the only option. The systematic study of numerical methods for singular perturbation problems started somewhat later – in the 1970s. From this time onwards the research frontier has steadily expanded, but the exposition of new developments in the analysis of these numerical methods has not received its due attention. The first textbook that concentrated on this analysis was [DMS80], which collected various results for ordinary differential equations. But after 1980 no further textbook appeared until 1996, when three books were published: Miller et al. [MOS96], which specializes in upwind finite difference methods on Shishkin meshes, Morton's book [Mor96], which is a general introduction to numerical methods for convection-diffusion problems with an emphasis on the cell-vertex finite volume method, and [RST96], the first edition of the present book. Nevertheless many methods and techniques that are important today, especially for partial differential equations, were developed after 1996.

Beginning with ordinary differential equations, then moving on to parabolic and elliptic problems and culminating with the Navier-Stokes equations, the reader is led through the theoretical and practical aspects of the most important methods used to compute numerical solutions for singular perturbation problems.



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