



Spectral Elements for Transport-Dominated Equations (Lecture Notes in Computational Science and Engineering)

Daniele Funaro

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In the last few years there has been a growing interest in the development of numerical techniques appropriate for the approximation of differential model problems presenting multiscale solutions. This is the case, for instance, with functions displaying a smooth behavior, except in certain regions where sudden and sharp variations are localized. Typical examples are internal or boundary layers. When the number of degrees of freedom in the discretization process is not sufficient to ensure a fine resolution of the layers, some stabilization procedures are needed to avoid unpleasant oscillatory effects, without adding too much artificial viscosity to the scheme. In the field of finite elements, the streamline diffusion method, the Galerkin least-squares method, the bubble function approach, and other recent similar techniques provide excellent treatments of transport equations of elliptic type with small diffusive terms, referred to in fluid dynamics as advection-diffusion (or convection-diffusion) equations. Goals This book is an attempt to guide the reader in the construction of a computational code based on the spectral collocation method, using algebraic polynomials. The main topic is the approximation of elliptic type boundary-value partial differential equations in 2-D, with special attention to transport-diffusion equations, where the second-order diffusive terms are strongly dominated by the first-order advective terms. Applications will be considered especially in the case where nonlinear systems of partial differential equations can be reduced to a sequence of transport-diffusion equations.

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