Gottlieb, David; **Hussaini, M. Yousuff**; **Orszag, Steven A.**
Theory and applications of spectral methods. (English) [Zbl 0599.65079]
Spectral methods for partial differential equations, Proc. Symp., NASA Langley Res. Cent. 1982, 1-54 (1984).

[For the entire collection see Zbl 0534.00017.]

The monograph by the first and the third author [Numerical analysis of spectral methods: Theory and applications (1977; Zbl 0412.65058)] reviewed the state of the art, at that time, of spectral methods. The theory presented in that work centered on the Galerkin and tau methods and the fluid dynamical applications were confined to incompressible flows. In the past several years, there has been extensive activity in both the theory and application of spectral methods. This activity has been mainly concentrated in the area of pseudospectral methods. For the theory, functional analysis has proved to be a powerful tool for obtaining useful error estimates. For spectral techniques, improved iteration methods have been developed that make possible large-scale calculations of complicated physical phenomena. For applications, first results for compressible flow problems have been obtained for rather complicated flow fields including shock waves, and significant progress has been made on transition and turbulence in incompressible flows.

The aim of this article is to review some of the major developments that have been made since 1977. We concentrate on pseudospectral techniques, as the analysis of Galerkin and tau methods is adequately covered in our 1977 monograph. The review is divided into two main parts. First, we give a summary of results that explain the nature of pseudospectral methods, the correct way to implement them and the error behavior that should be expected to be produced by them. The part on applications contains two major subsections, namely compressible and incompressible flows.

MSC:

65N35	Spectral, collocation and related methods for boundary value problems involving PDEs	Cited in **91** Documents
35Q99	Partial differential equations of mathematical physics and other areas of application	
76B10	Jets and cavities, cavitation, free-streamline theory, water-entry problems, airfoil and hydrofoil theory, sloshing	
76D10	Boundary-layer theory, separation and reattachment, higher-order effects	
76L05	Shock waves and blast waves in fluid mechanics	

Keywords:

spectral methods; Galerkin; tau methods; pseudospectral methods; error estimates; iteration methods; shock waves; turbulence