Toro, Eleuterio F.
Riemann solvers and numerical methods for fluid dynamics. A practical introduction.
(English) [Zbl 0888.76001]
Berlin: Springer. xviii, 592 p. (1997).

The book is devoted to a detailed presentation of modern numerical methods for solving hyperbolic conservation laws. The first part presents the derivation of the governing equations of fluid dynamics. Therefore, the Euler equations are introduced in the differential form, and additional viscous diffusion and heat transfer effects are considered. Furthermore, the integral form of the equations is introduced. After this, some elementary properties of a class of hyperbolic partial differential equations are studied in order to present the basic background for the derivation and implementation of numerical schemes. The main topic of the book is the presentation of Godunov methods. Therefore, the exact solution of the Riemann problem is discussed in detail. In addition, a great variety of approximate Riemann solvers like the Roe method, Osher's scheme and the HLL-method as well as flux vector splitting methods like the Steger-Warming splitting, the scheme of van Leer and the Liou-Steffen method are studied and investigated through several test cases. High-order methods of WAF-type and MUSCL-type as well as total variation diminishing methods are presented for scalar problems and nonlinear systems, and are carried out through the time-dependent Euler equations. A short chapter is concerned with numerical methods for solving nonlinear systems of hyperbolic conservation laws with source terms. Furthermore, two approaches for solving multidimensional partial differential equations are presented, namely the dimensional splitting and the finite volume method. The book is well suited for scientists and engineers and can also be used as a teaching aid.

Reviewer: A.Meister (Hamburg)

MSC:

76-02	Research exposition (monographs, survey articles) pertaining to fluid mechanics
76M20	Finite difference methods applied to problems in fluid mechanics
76M25	Other numerical methods (fluid mechanics) (MSC2010)

Cited in **4** Reviews
Cited in **302** Documents

Keywords:

hyperbolic conservation laws; Euler equations; viscous diffusion; heat transfer; Godunov methods; Roe method; Osher's scheme; HLL-method; flux vector splitting methods; Steger-Warming splitting; scheme of van Leer; Liou-Steffen method; total variation diminishing methods; dimensional splitting; finite volume method

Software:

HE-E1GODF