

Contents

Preface	7
1 Ideal Fluids	13
1.1 Modelling by Euler's Equations	13
1.2 Characteristics and Singularities	24
1.3 Potential Flows and (Dynamic) Buoyancy	30
1.4 Motionless Fluids and Sound Propagation	47
2 Weak Solutions of Conservation Laws	51
2.1 Generalization of what will be called a Solution	51
2.2 Traffic Flow Example with Loss of Uniqueness	56
2.3 The Rankine-Hugoniot Condition	62
3 Entropy Conditions	69
3.1 Entropy in Case of Ideal Fluids	69
3.2 Generalization of the Entropy Condition	74
3.3 Uniqueness of Entropy Solutions	80
3.4 The Ansatz due to Kruzkov	92
4 The Riemann Problem	97
4.1 Numerical Importance of the Riemann Problem	97
4.2 The Riemann Problem in the Case of Linear Systems	99
5 Real Fluids	103
5.1 The Navier-Stokes Equations Model	103
5.2 Drag Force and the Hagen-Poiseuille Law	111
5.3 Stokes Approximation and Artificial Time	116
5.4 Foundations of the Boundary Layer Theory; Flow Separation	122
5.5 Stability of Laminar Flows	131

6	Existence Proof for Entropy Solutions by Means of Discretization Procedures	135
6.1	Some Historical Remarks	135
6.2	Reduction to Properties of Operator Sequences	136
6.3	Convergence Theorems	140
6.4	Example	143
7	Types of Discretization Principles	151
7.1	Some General Remarks	151
7.2	The Finite Difference Calculus	156
7.3	The CFL Condition	160
7.4	Lax-Richtmyer Theory	162
7.5	The von Neumann Stability Criterion	168
7.6	The Modified Equation	171
7.7	Difference Schemes in Conservation Form	173
7.8	The Finite Volume Method on Unstructured Grids	176
	Some Extensive Monographs	181
	Index	183