Contents

PREFACE ix

I. Introduction to Wave Propagation 1
Wallace D. Hayes

1. Oscillatory Motions 1
2. Linear Nondissipative Propagating Waves 6
3. Simple One-dimensional Wave Equation 19
4. Physical Problems 27
5. Other Examples of Waves in a Single Space Coordinate 36
6. Strongly Dispersive Waves 39

II. Linear Dispersive Waves 44
Stephen A. Thau

1. Examples of Dispersive Waves. Phase and Group Velocities 45
2. Harmonic Waves in Dispersive Media 48
3. Transient Waves in Dispersive Media 50
4. Kinematic Energy Approach for Dispersive Waves 74
5. Effects of Dissipation 78

III. Quasilinear Hyperbolic Systems that Result from Conservation Laws 82
Constantine M. Dafermos

1. Conservation Laws and Field Equations 83
2. Hyperbolic Systems 84
3. Generalized Solutions 89
4. Admissibility Criteria for Generalized Solutions 96
5. The Riemann Problem 99

6. Existence, Uniqueness, and Computation of Generalized Solutions 100

IV. Examples of Dissipative and Dispersive Systems Leading to the Burgers and the Korteweg-deVries Equations 103
Sidney Leibovich and *A. Richard Seebass*

1. Perturbation Techniques 104
2. Dissipative Gas Dynamics and the Burgers Equation 112
3. Shallow-Water Waves and the Korteweg-deVries Equation 125

V. Dispersive Waves and Variational Principles 139
Gerald B. Whitham

1. Dispersive Waves 140
2. Fourier Synthesis and Asymptotic Behavior 145
3. Simple Derivation of Group Velocity Concepts for Linear Problems 149
4. Extensions and Examples 152
5. Variational Principles 155
6. Adiabatic Invariants, Wave Action, and Energy 162
7. Nonlinear Group Velocity—Stability of Periodic Waves 164
8. Formal Perturbation Theory 166

VI. Conservation of Wave Action 170
Wallace D. Hayes

1. Discrete Dynamic Systems 171
2. Action Conservation for a Family of Solutions 173
3. Steady Oscillating System 173
4. Action Conservation for a Slowly Varying System 176
5. Continuous Media 178
6. Waves 180
7. Comparison of Action and Energy Conservation 183
8. Wave Propagation Theory 184

VII. Wave Interactions 186
Owen M. Phillips

1. The Resonance Conditions 188
2. The Interaction Equations 192
3. Interactions among Surface Gravity Waves 198

VIII. The Korteweg-deVries Equation: A Model Equation for Nonlinear Dispersive Waves 212
Robert M. Miura

1. Conservation Laws and a Nonlinear Transformation 215
2. Method of Exact Solution 220
3. A Nonlinear WKB Method of Solution 227

IX. Structure of Collisionless Shocks 235
Richard E. Meyer

1. Steady Shocks 236
2. Sets of Limits 238
3. Double Asymptotics 242
4. Plasma Model 244
5. Stretching 247
6. Scale Conditions 251
7. Transients 254
8. Final Waveforms 259

X. Wave Motion in Stratified Fluids 263
Chia-Shun Yih

1. Waves of Small Amplitude 263
2. Waves of Finite Amplitude 275
3. Stability 281

XI. Invariant Functionals of Nonlinear Equations of Evolution 291
Peter D. Lax

1. Nonlinear Equations Associated with Linear Operators 294
2. Nonlinear Hyperbolic Systems of Conservation Laws 303
3. Nonlinear Wave Equations 308

References 311

Index 323