

Contents

Foreword	vii
Chapter 1. Basic Notions	1
Chapter 2. Finite Speed of Propagation of Signals	5
References	14
Chapter 3. Hyperbolic Equations with Constant Coefficients	15
3.1. The Domain of Influence	15
3.2. Spacelike Hypersurfaces	19
3.3. The Initial Value Problem on Spacelike Hypersurfaces	23
3.4. Characteristic Surfaces	25
3.5. Solution of the Initial Value Problem by the Radon Transform	29
3.6. Conservation of Energy	33
References	34
Chapter 4. Hyperbolic Equations with Variable Coefficients	37
4.1. Equations with a Single Space Variable	37
4.2. Characteristic Surfaces	39
4.3. Energy Inequalities for Symmetric Hyperbolic Systems	41
4.4. Energy Inequalities for Solutions of Second-Order Hyperbolic Equations	45
4.5. Energy Inequalities for Higher-Order Hyperbolic Equations	46
References	53
Chapter 5. Pseudodifferential Operators and Energy Inequalities	55
References	60
Chapter 6. Existence of Solutions	61
6.1. Equivalence of the Initial Value Problem and the Periodic Problem	61
6.2. Negative Norms	63
6.3. Solution of the Periodic Problem	65
6.4. A Local Uniqueness Theorem	66
References	67
Chapter 7. Waves and Rays	69
Introduction	69
7.1. The Initial Value Problem for Distributions	71
7.2. Progressing Waves	74
7.3. Integrals of Compound Distributions	77

7.4. An Approximate Riemann Function and the Generalized Huygens Principle	79
References	82
Chapter 8. Finite Difference Approximation to Hyperbolic Equations	83
8.1. Consistency	83
8.2. Domain of Dependence	84
8.3. Stability and Convergence	85
8.4. Higher-Order Schemes and Their Stability	88
8.5. The Gibbs Phenomenon	96
8.6. The Computation of Discontinuous Solutions of Linear Hyperbolic Equations	98
8.7. Schemes in More Than One Space Variable	103
8.8. The Stability of Difference Schemes	108
References	119
Chapter 9. Scattering Theory	121
9.1. Asymptotic Behavior of Solutions of the Wave Equation	121
9.2. The Lax-Phillips Scattering Theory	125
9.3. The Associated Semigroup	129
9.4. Back to the Wave Equation in the Exterior of an Obstacle	132
9.5. The Semigroup Associated with Scattering by an Obstacle	139
9.6. Analytic Form of the Scattering Matrix	144
9.7. Scattering of Automorphic Waves	154
References	163
Chapter 10. Hyperbolic Systems of Conservation Laws	165
10.1. Scalar Equations; Basics	165
10.2. The Initial Value Problem for Admissible Solutions	169
10.3. Hyperbolic Systems of Conservation Laws	178
10.4. The Viscosity Method and Entropy	184
10.5. Finite Difference Methods	189
10.6. The Flow of Compressible Fluids	193
References	197
Appendix A. Huygens' Principle for the Wave Equation on Odd-Dimensional Spheres	201
References	202
Appendix B. Hyperbolic Polynomials	205
References	206
Appendix C. The Multiplicity of Eigenvalues	207
References	209
Appendix D. Mixed Initial and Boundary Value Problems	211
References	214
Appendix E. Energy Decay for Star-Shaped Obstacles by <i>Cathleen S. Morawetz</i>	215