

Contents

1.	Nonlinear Equations and Quasilinear Systems	
1.1	Waves and Wave Propagation	1
1.2	First Order Quasilinear Systems and Higher Order Equations	5
1.3	Matrix Formulation of Systems	9
1.4	Characteristics and the Cauchy Problem for a General Nonlinear First Order Equation	15
1.5	The Eikonal Equation	24
1.6	The Scalar Quasilinear First Order Equation with Two Independent Variables	29
1.7	Uniqueness of Solutions	37
1.8	Well-Posed Problems	40
2.	Hyperbolic Systems and Characteristics	
2.1	Hyperbolicity and First Order Quasilinear Systems	42
2.2	The Classification of Some Special Systems	49
2.3	Invariance of Characteristic Manifolds Under a Change of Coordinates	57
2.4	Characteristic Manifolds As Transporters of Discontinuities of Derivatives	58
2.5	Characteristic Fields of First Order Quasilinear Hyperbolic Systems in One Space Dimension and Time	62
2.6	Initial Value Problems and Mixed Initial and Boundary Value Problems	67
2.7	Examples of Characteristics, Initial and Boundary Value Problems	75
2.8	Waves Adjacent to a Constant Solution - Characteristic Equations	78
3.	Riemann Invariants and Simple Waves	
3.1	Riemann Invariants	81
3.2	Simple Waves	90
3.3	Generalised Simple Waves	94

3.4	Exceptional Condition and Genuine Nonlinearity	101
3.5	Evolution of Discontinuities in Solutions from Arbitrary Initial Data	106
3.6	Gas Motion in a Closed Tube	119
3.7	Unboundedness of Solutions	122
4.	Shock Waves	
4.1	Conservation Systems and Conditions Across a Shock	128
4.2	Conservation Equations and Shocks in Fluid Dynamics	135
4.3	Weak Solutions and Non-uniqueness	139
4.4	Conservation Equations with a Convex Extension	147
4.5	Evolutionary Condition for Shocks in Hyperbolic Systems of Conservation Type	150
4.6	Connection of Solutions by k-Shocks	157
5.	Development of Shocks from Lipschitz Continuous Data	
5.1	C^n Discontinuities and Wavefront Propagation in One Space Dimension and Time	165
5.2	Conservation System with Discontinuous Coefficients	167
5.3	Change of Coordinates and Jump Conditions	172
5.4	Transport Equations for C^1 Discontinuities	176
5.5	Conditions Across the Shock Line	178
5.6	Formation of Shock on the Wavefront	183
5.7	Special Cases	186
5.8	Bifurcation of Wavefront	192
5.9	Wavefront Propagation in $\mathbb{R}^3 \times t$	196
5.10	C^1 Wavefront Propagation in Shallow Water	196
5.11	Smooth Fronted C^2 Waves in the Shallow Water Approximation	208
	REFERENCES	216
	INDEX	226

