

TABLE OF CONTENTS

Preface	v
1. Preliminaries on Waves	1
1.1 Governing Equations of the Fluid Motion, 2 <i>Eulerian and Lagrangian Coordinates</i> , 6	
1.2 The Wave Equation, 8	
1.3 Simple Solutions : Sinusoidal Waves, 10	
1.4 Fundamental Solutions of Wave Equation, 14	
2. Sound Waves	21
2.1 Waves in Compressible Fluids, 21	
2.2 Multi-pole Radiation, 23	
2.3 Generation of Sound, 27	
2.4 Scattering of Sound, 34 <i>Scattering by a Spherical Bubble in a Liquid</i> , 39 <i>Scattering by a Small Body</i> , 42	
2.5 Nonlinear Acoustics, 45 <i>Quadrupole Radiation</i> , 45 <i>Scattering of Sound by Sound</i> , 48 <i>Acoustic Streaming</i> , 53	
2.6 Simple Wave and Shock Wave, 56	
2.7 Structure of Shock - Burgers Equation, 69	

	<i>Derivation of Burgers Equation, 70</i>	
	<i>Solution of Burgers Equation, 73</i>	
	<i>An Example to Illustrate the Shock Structure, 76</i>	
2.8	One-Dimensional Nonlinear Wave - Riemann Invariants, 81	
2.9	Sound Waves With Thermal Dissipation, 88	
3.	Water Waves	95
3.1	Governing Equations of Water Waves, 95	
3.2	Small Amplitude Waves, 99	
	<i>Gravity Wave, 103</i>	
	<i>Capillary Wave, 104</i>	
3.3	Dispersion of Waves - Group Velocity, 106	
	<i>Velocity of Energy Transport, 111</i>	
3.4	Wave Produced by a Moving Source, 115	
	<i>Wave Pattern Due to a Moving Source, 121</i>	
3.5	Weakly Nonlinear Waves and Korteweg-DeVries Equation, 129	
3.6	Solitary and Cnoidal Waves, 134	
3.7	Solitons - Inverse Scattering, 144	
3.8	Nonlinear Modulation of Gravity Waves, 153	
	<i>Stokes Waves, 156</i>	
	<i>Stability of Stokes Waves, 158</i>	
	<i>Gravity Waves in Lagrangian Coordinates, 159</i>	
3.9	Hydraulic Jumps, 165	

4.	Waves in Nonhomogeneous Media	170
4.1	Internal Waves of Layered Fluid Media, 170 <i>Upper Fluid Surface Free, 176</i>	
4.2	Waves in Continuously Stratified Fluids, 179 <i>The Case that $\rho_0 = \rho^{(0)} e^{-\beta z}$, 183</i> <i>Rigid Surface on Top, 184</i> <i>Free Surface on Top, 185</i>	
4.3	Waves in Compressible Stratified Fluids, 188	
4.4	Dynamic Equations of Bubbly Liquids, 199 <i>A Simple Model of Bubbly Liquids, 201</i>	
4.5	Waves in Bubbly Liquids, 202 <i>Sound Waves, 202</i> <i>Dead Zone and Negative Damping, 209</i> <i>Waves in Locked Bubbly Liquids, 211</i>	
5.	Stability	216
5.1	Interfacial Conditions, 217	
5.2	The Classical Rayleigh-Taylor Stability, 223	
5.3	Rayleigh-Taylor Stability with Mass and Heat Transfer Across the Interface, 229 <i>A Simplified Version, 236</i> <i>Nonlinear Stability Based on Simplified Version, 239</i>	
5.4	Stability of Spherical Bubble in Motion, 244 <i>Stability of Expanding and Collapsing Bubbles, 252</i>	

- 5.5 The Classical Kelvin-Helmholtz Stability, 254
- 5.6 Variational Method and Kelvin-Helmholtz Stability, 262
 - Nonlinear Analysis*, 268
 - Fully Nonlinear One-Mode Analysis*, 271
- 5.7 Kelvin-Helmholtz Stability for Compressible Fluids, 272
 - The Case of Semi-infinite Fluid Layers*, 277
 - Relationship with Two Phase Flows*, 281
- 5.8 The Faraday Problem, 285
 - Linear Stability*, 288
 - Nonlinear Theory*, 292
 - Stability of Oscillating Bubbles*, 294
- 5.9 The Rayleigh-Benard Problem, 296
 - Principle of Exchange of Stabilities*, 304
 - Critical Rayleigh Number*, 307
 - The Cell Patterns*, 310
 - Non-uniform Heating*, 312
- 5.10 The Taylor-Couette Problem, 313
 - Rayleigh's Criterion*, 316
 - Linear Stability Analysis*, 319
 - Narrow Gap*, 323
- 5.11 Stability of Parallel Flows, 327
 - Squire Theorem*, 330
 - Orr-Sommerfeld Equation*, 331
 - Sufficient Conditions for Stability*, 332

	<i>Parallel Flow of Inviscid Fluids</i> , 334	
	<i>Asymptotic Analysis and Comparison Equations</i> , 337	
5.12	Stability of Flow Down an Inclined Plane, 344	
	<i>Small k Expansion</i> , 349	
	<i>Hydraulic Approximation</i> , 353	
6.	Chaos	360
6.1	The Lorenz Equations, 361	
6.2	The Logistic Map, 375	
6.3	Characterization of Chaos, 384	
	<i>Lyapunov Exponents</i> , 384	
	<i>Dimensions</i> , 387	
	<i>Dynamical Information in Experimental Data</i> , 390	
6.4	Almost Ill-posed Problems and Chaos, 391	
	<i>Examples of Underlying Ellipticity</i> , 394	
	<i>Model Partial Differential Equations with Underlying Ellipticity</i> , 398	
<i>Appendix 1</i>	<i>Some Properties of Spherical Bessel Functions</i>	402
<i>Appendix 2</i>	<i>On Surface Tension</i>	404
	Books for Concurrent and Further Reading	407
	References	409
	Index	411