

CONTENTS

Prefaces to the English editions	ix/x
E. M. Lifshitz	xi
Notation	xiii

I. IDEAL FLUIDS

§1. The equation of continuity	1
§2. Euler's equation	2
§3. Hydrostatics	5
§4. The condition that convection be absent	7
§5. Bernoulli's equation	8
§6. The energy flux	9
§7. The momentum flux	11
§8. The conservation of circulation	12
§9. Potential flow	14
§10. Incompressible fluids	17
§11. The drag force in potential flow past a body	26
§12. Gravity waves	31
§13. Internal waves in an incompressible fluid	37
§14. Waves in a rotating fluid	40

II. VISCOUS FLUIDS

§15. The equations of motion of a viscous fluid	44
§16. Energy dissipation in an incompressible fluid	50
§17. Flow in a pipe	51
§18. Flow between rotating cylinders	55
§19. The law of similarity	56
§20. Flow with small Reynolds numbers	58
§21. The laminar wake	67
§22. The viscosity of suspensions	73
§23. Exact solutions of the equations of motion for a viscous fluid	75
§24. Oscillatory motion in a viscous fluid	83
§25. Damping of gravity waves	92

III. TURBULENCE

§26. Stability of steady flow	95
§27. Stability of rotary flow	99
§28. Stability of flow in a pipe	103
§29. Instability of tangential discontinuities	106
§30. Quasi-periodic flow and frequency locking	108
§31. Strange attractors	113
§32. Transition to turbulence by period doubling	118

§33. Fully developed turbulence	129
§34. The velocity correlation functions	135
§35. The turbulent region and the phenomenon of separation	146
§36. The turbulent jet	147
§37. The turbulent wake	152
§38. Zhukovskii's theorem	153

IV. BOUNDARY LAYERS

§39. The laminar boundary layer	157
§40. Flow near the line of separation	163
§41. Stability of flow in the laminar boundary layer	167
§42. The logarithmic velocity profile	172
§43. Turbulent flow in pipes	176
§44. The turbulent boundary layer	178
§45. The drag crisis	180
§46. Flow past streamlined bodies	183
§47. Induced drag	185
§48. The lift of a thin wing	189

V. THERMAL CONDUCTION IN FLUIDS

§49. The general equation of heat transfer	192
§50. Thermal conduction in an incompressible fluid	196
§51. Thermal conduction in an infinite medium	200
§52. Thermal conduction in a finite medium	203
§53. The similarity law for heat transfer	208
§54. Heat transfer in a boundary layer	210
§55. Heating of a body in a moving fluid	215
§56. Free convection	217
§57. Convective instability of a fluid at rest	221

VI. DIFFUSION

§58. The equations of fluid dynamics for a mixture of fluids	227
§59. Coefficients of mass transfer and thermal diffusion	230
§60. Diffusion of particles suspended in a fluid	235

VII. SURFACE PHENOMENA

§61. Laplace's formula	238
§62. Capillary waves	244
§63. The effect of adsorbed films on the motion of a liquid	248

VIII. SOUND

§64. Sound waves	251
§65. The energy and momentum of sound waves	255
§66. Reflection and refraction of sound waves	259
§67. Geometrical acoustics	260
§68. Propagation of sound in a moving medium	263
§69. Characteristic vibrations	266

§70. Spherical waves	269
§71. Cylindrical waves	271
§72. The general solution of the wave equation	273
§73. The lateral wave	276
§74. The emission of sound	281
§75. Sound excitation by turbulence	289
§76. The reciprocity principle	292
§77. Propagation of sound in a tube	294
§78. Scattering of sound	297
§79. Absorption of sound	300
§80. Acoustic streaming	305
§81. Second viscosity	308

IX. SHOCK WAVES

§82. Propagation of disturbances in a moving gas	313
§83. Steady flow of a gas	316
§84. Surfaces of discontinuity	320
§85. The shock adiabat	324
§86. Weak shock waves	327
§87. The direction of variation of quantities in a shock wave	329
§88. Evolutionary shock waves	331
§89. Shock waves in a polytropic gas	333
§90. Corrugation instability of shock waves	336
§91. Shock wave propagation in a pipe	343
§92. Oblique shock waves	345
§93. The thickness of shock waves	350
§94. Shock waves in a relaxing medium	355
§95. The isothermal discontinuity	356
§96. Weak discontinuities	358

X. ONE-DIMENSIONAL GAS FLOW

§97. Flow of gas through a nozzle	361
§98. Flow of a viscous gas in a pipe	364
§99. One-dimensional similarity flow	366
§100. Discontinuities in the initial conditions	373
§101. One-dimensional travelling waves	378
§102. Formation of discontinuities in a sound wave	385
§103. Characteristics	391
§104. Riemann invariants	394
§105. Arbitrary one-dimensional gas flow	397
§106. A strong explosion	403
§107. An imploding spherical shock wave	406
§108. Shallow-water theory	411

XI. THE INTERSECTION OF SURFACES OF DISCONTINUITY

§109. Rarefaction waves	414
§110. Classification of intersections of surfaces of discontinuity	419

§111.	The intersection of shock waves with a solid surface	425
§112.	Supersonic flow round an angle	427
§113.	Flow past a conical obstacle	432
XII. TWO-DIMENSIONAL GAS FLOW		
§114.	Potential flow of a gas	435
§115.	Steady simple waves	438
§116.	Chaplygin's equation: the general problem of steady two-dimensional gas flow	442
§117.	Characteristics in steady two-dimensional flow	445
§118.	The Euler-Tricomi equation. Transonic flow	447
§119.	Solutions of the Euler-Tricomi equation near non-singular points of the sonic surface	452
§120.	Flow at the velocity of sound	456
§121.	The reflection of a weak discontinuity from the sonic line	461
XIII. FLOW PAST FINITE BODIES		
§122.	The formation of shock waves in supersonic flow past bodies	467
§123.	Supersonic flow past a pointed body	470
§124.	Subsonic flow past a thin wing	474
§125.	Supersonic flow past a wing	476
§126.	The law of transonic similarity	479
§127.	The law of hypersonic similarity	481
XIV. FLUID DYNAMICS OF COMBUSTION		
§128.	Slow combustion	484
§129.	Detonation	489
§130.	The propagation of a detonation wave	494
§131.	The relation between the different modes of combustion	500
§132.	Condensation discontinuities	503
XV. RELATIVISTIC FLUID DYNAMICS		
§133.	The energy-momentum tensor	505
§134.	The equations of relativistic fluid dynamics	506
§135.	Shock waves in relativistic fluid dynamics	510
§136.	Relativistic equations for flow with viscosity and thermal conduction	512
XVI. DYNAMICS OF SUPERFLUIDS		
§137.	Principal properties of superfluids	515
§138.	The thermo-mechanical effect	517
§139.	The equations of superfluid dynamics	518
§140.	Dissipative processes in superfluids	524
§141.	The propagation of sound in superfluids	526
	Index	533