

1. Record Nr.	UNINA9910822321503321
Autore	Pert Geoffrey
Titolo	Introductory fluid mechanics : for physicists and mathematicians // Geoffrey Pert
Pubbl/distr/stampa	Chichester, England, : John Wiley & Sons, c2013
ISBN	1118574052 9781118574058
Edizione	[1st ed.]
Descrizione fisica	1 online resource (xx, 468 p.) : ill
Classificazione	423.8 532
Disciplina	620.106
Soggetti	Fluid mechanics Heat - Transmission Hydrodynamics
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Note generali	Includes bibliographical references (p. 455-462) and index
Nota di bibliografia	Includes bibliographical references and index.
Nota di contenuto	Cover -- Title Page -- Copyright -- Contents -- Preface -- Chapter 1 Introduction -- 1.1 Fluids as a State of Matter -- 1.2 The Fundamental Equations for Flow of a Dissipationless Fluid -- 1.3 Lagrangian Frame -- 1.3.1 Conservation of Mass -- 1.3.2 Conservation of Momentum-Euler's Equation -- 1.3.3 Conservation of Angular Momentum -- 1.3.4 Conservation of Energy -- 1.3.5 Conservation of Entropy -- 1.4 Eulerian Frame -- 1.4.1 Conservation of Mass-Equation of Continuity -- 1.4.2 Conservation of Momentum -- 1.4.3 Conservation of Angular Momentum -- 1.4.4 Conservation of Energy -- 1.4.5 Conservation of Entropy -- 1.5 Hydrostatics -- 1.5.1 Isothermal Fluid-Thermal and Mechanical Equilibrium -- 1.5.2 Adiabatic Fluid-Lapse Rate -- 1.5.3 Stability of an Equilibrium Configuration -- 1.6 Streamlines -- 1.7 Bernoulli's Equation: Weak Form -- 1.8 Polytopic Gases -- 1.8.1 Applications of Bernoulli's Theorem -- 1.8.1.1 Vena Contracta -- 1.8.1.2 Flow of gas along a pipe of varying cross-section -- Case study 1.1 Munroe Effect-Shaped Charge Explosive -- Chapter 2 Flow of Ideal Fluids -- 2.1 Introduction -- 2.2 Kelvin's Theorem -- 2.2.1 Vorticity and Helmholtz's Theorems -- 2.2.1.1 Simple or rectilinear vortex -- 2.2.1.2 Vortex sheet -- 2.3 Irrotational Flow -- 2.3.1 Crocco's Equation

-- 2.4 Irrotational Flow-Velocity Potential and the Strong Form of Bernoulli's Equation -- 2.5 Incompressible Flow-Streamfunction -- 2.5.1 Planar Systems -- 2.5.2 Axisymmetric Flow-Stokes Streamfunction -- 2.6 Irrotational Incompressible Flow -- 2.6.1 Simply and Multiply Connected Spaces -- 2.7 Induced Velocity -- 2.7.1 Streamlined Flow around a Body Treated as a Vortex Sheet -- 2.8 Sources and Sinks -- 2.8.1 Doublet Sources -- 2.8.1.1 Doublet sheets -- 2.8.2 Flow Around a Body Treated as a Source Sheet -- 2.8.3 Irrotational Incompressible Flow Around a Sphere. Case study 2.I Rankine Ovals -- 2.9 Two-Dimensional Flow -- 2.9.1 Irrotational Incompressible Flow -- 2.10 Applications of Analytic Functions in Fluid Mechanics -- 2.10.1 Flow from a Simple Source and a Simple Vortex -- 2.10.1.1 Free vortex -- 2.10.1.2 Two-dimensional doublets and vortex loops -- 2.10.2 Flow Around a Body Treated as a Sheet of Complex Sources and Doublets -- Case study 2.II Application of Complex Function Analysis to the Flow around a Thin Wing -- 2.10.3 Flow Around a Cylinder with Zero Circulation -- 2.10.4 Flow Around a Cylinder with Circulation -- 2.10.5 The Flow Around a Corner -- 2.11 Force on a Body in Steady Two-Dimensional Incompressible Ideal Flow -- 2.12 Conformal Transforms -- Appendix 2.A Drag in Ideal Flow -- 2.A.1 Helmholtz's Flow and Separation -- 2.A.2 Lines of Vortices -- 2.A.2.1 Single infinite row of vortices -- 2.A.2.2 Two parallel symmetric rows of vortices -- 2.A.2.3 Two parallel alternating rows of vortices -- Chapter 3 Viscous Fluids -- 3.1 Basic Concept of Viscosity -- 3.2 Differential Motion of a Fluid Element -- 3.3 Strain Rate -- 3.4 Stress -- 3.5 Viscous Stress -- 3.5.1 Momentum Equation -- 3.5.2 Energy Equation -- 3.5.3 Entropy Creation Rate -- 3.6 Incompressible Flow-Navier-Stokes Equation -- 3.6.1 Vorticity Diffusion -- 3.6.2 Couette or Plane Poiseuille Flow -- 3.7 Stokes' or Creeping Flow -- 3.7.1 Stokes' Flow around a Sphere -- 3.7.1.1 Oseen's correction -- 3.7.1.2 Proudman and Pearson's solution -- 3.7.1.3 Lamb's solution for a cylinder -- 3.8 Dimensionless Analysis and Similarity -- 3.8.1 Similarity and Modelling -- 3.8.2 Self-similarity -- Appendix 3.A Buckingham's II Theorem and the Complete Set of Dimensionless Products -- Chapter 4 Waves and Instabilities in Fluids -- 4.1 Introduction -- 4.2 Small-Amplitude Surface Waves -- 4.2.1 Surface Waves at a Free Boundary of a Finite Medium. 4.2.1.1 Capillary waves -- 4.2.1.2 Gravity waves -- 4.2.1.3 Transmission of energy -- Case study 4.I The Wake of a Ship-Wave Drag -- 4.1.i Two-dimensional wake, Kelvin wedge -- 4.3 Surface Waves in Infinite fluids -- 4.3.1 Surface Wave at a Contact Discontinuity -- 4.3.2 Rayleigh-Taylor Instability -- 4.4 Surface Waves with Velocity Shear Across a Contact Discontinuity -- 4.5 Shallow Water Waves -- 4.6 Waves in a Stratified Fluid -- 4.7 Stability of Laminar Shear Flow -- 4.8 Nonlinear Instability -- Chapter 5 Turbulent Flow -- 5.1 Introduction -- 5.1.1 The Generation of Turbulence -- 5.2 Fully Developed Turbulence -- 5.3 Turbulent Stress-Reynolds Stresses -- 5.4 Similarity Model of Shear in a Turbulent Flow-von Karman's Hypothesis -- 5.5 Velocity Profile near a Wall in Fully Developed Turbulence-Law of the Wall -- 5.6 Turbulent Flow Through a Duct -- 5.6.1 Prandtl's Distribution Law -- 5.6.2 Von Karman's Distribution Law -- Case study 5.I Turbulent Flow Through a Horizontal Uniform Pipe -- 5.1.i Blasius wall stress correlation -- Appendix 5.A Prandtl's Mixing Length Model -- Chapter 6 Boundary Layer Flow -- 6.1 Introduction -- 6.2 The Laminar Boundary Layer in Steady Incompressible Two-Dimensional Flow-Prandtl's Approximation -- 6.3 Laminar Boundary Layer over an Infinite Flat Plate-Blasius's Solution -- 6.4 Laminar Boundary Layer-von Karman's Momentum Integral Method -- 6.4.1 Application to Boundary

Layers with an Applied Pressure Gradient -- 6.5 Boundary Layer Instability and the Onset of Turbulence-Tollmein-Schlichting Instability -- 6.6 Turbulent Boundary Layer on a Flat Smooth Plate -- 6.6.1 Turbulent Boundary Layer-Power Law Distribution -- 6.7 Boundary Layer Separation -- 6.7.1 Viscous Flow Over a Cylinder -- 6.8 Drag -- Case study 6.1 Control of Separation in Aerodynamic Structures -- 6.9 Laminar Wake.

6.10 Separation in the Turbulent Boundary Layer -- 6.10.1 Turbulent Wake -- Appendix 6.A Singular Perturbation Problems and the Method of Matched Asymptotic Expansion -- Chapter 7 Convective Heat Transfer -- 7.1 Introduction -- 7.2 Forced Convection -- 7.2.1 Empirical Heat Transfer Rates from a Flowing Fluid -- 7.2.1.1 Heat transfer from a fluid flowing along a pipe -- 7.2.1.2 Heat transfer from a fluid flowing across a pipe -- 7.2.1.3 Heat exchanger design -- 7.2.1.4 Logarithmic mean temperature -- 7.2.2 Friction and Heat Transfer Analogies in Turbulent Flow -- 7.2.2.1 Reynolds analogy -- 7.2.2.2 Prandtl-Taylor correction -- 7.2.2.3 Von Karman's correction -- 7.2.2.4 Martinelli's correction -- 7.2.2.5 Colburn's modification -- 7.3 Heat Transfer in a Laminar Boundary Layer -- 7.3.1 Boundary Integral Method -- 7.4 Heat Transfer in a Turbulent Boundary Layer on a Smooth Flat Plate -- 7.5 Free or Natural Convection -- 7.5.1 Boussinesq Approximation -- 7.5.2 Free Convection from a Vertical Plate -- 7.5.2.1 Similarity analysis -- 7.5.2.2 Boundary layer integral approximation -- 7.5.3 Free Convection from a Heated Horizontal Plate -- 7.5.4 Free Convection between Parallel Horizontal Plates -- 7.5.4.1 Rayleigh-Bénard instability -- 7.5.5 Free Convection around a Heated Horizontal Cylinder -- Case study 7.1 Positive Column of an Arc -- Chapter 8 Compressible Flow and Sound Waves -- 8.1 Introduction -- 8.2 Propagation of Small Disturbances -- 8.2.1 Plane Waves -- 8.2.2 Energy of Sound Waves -- 8.3 Reflection and Transmission of a Sound Wave at an Interface -- 8.4 Spherical Sound Waves -- 8.5 Cylindrical Sound Waves -- Chapter 9 Characteristics and Rarefactions -- 9.1 Mach Lines and Characteristics -- 9.2 Characteristics -- 9.2.1 Uniqueness Theorem -- 9.2.2 Weak Discontinuities -- 9.2.3 The Hodograph Plane -- 9.2.4 Simple Waves.

9.3 One-Dimensional Time-Dependent Expansion -- 9.3.1 The Centred Rarefaction -- 9.3.2 Reflected Rarefaction -- 9.3.3 Isothermal Rarefaction -- 9.4 Steady Two-Dimensional Irrotational Expansion -- 9.4.1 Characteristic Invariants -- 9.4.2 Expanding Supersonic Flow around a Corner -- 9.4.3 Flow around a Sharp Corner-Centred Rarefaction -- 9.4.3.1 The complete Prandtl-Meyer flow -- 9.4.3.2 Weak rarefaction -- Chapter 10 Shock Waves -- 10.1 Introduction -- 10.2 The Shock Transition and the Rankine-Hugoniot Equations -- 10.2.1 Rankine-Hugoniot Equations for a Polytropic Gas -- 10.2.1.1 Strong shocks -- 10.3 The Shock Adabat -- 10.3.1 Weak Shocks and the Entropy Jump -- 10.4 Shocks in Real Gases -- 10.5 The Hydrodynamic Structure of the Shock Front -- 10.5.1 Polytropic Gas Shocks -- 10.5.1.1 Shocks supported by heat transfer -- 10.5.2 Weak Shocks -- 10.6 The Shock Front in Real Gases -- 10.7 Shock Tubes -- 10.7.1 Shock Tube Theory -- 10.8 Shock Interaction -- 10.8.1 Planar Shock Reflection at a Rigid Wall -- 10.8.1.1 Collision between two planar shocks -- 10.8.2 Overtaking Interactions -- 10.8.2.1 Shock overtaking a shock -- 10.8.2.2 Shock-rarefaction overtaking -- 10.8.2.3 Shock interaction with a contact surface -- 10.9 Oblique Shocks -- 10.9.1 Large Mach Number -- 10.9.2 The Shock Polar -- 10.9.3 Supersonic Flow Incident on a Body -- 10.10 Adiabatic Compression -- Appendix 10.A An Alternative Approach to the General Conservation Law Form of the Fluid Equations -- 10.A.1 Hyperbolic

Equations -- 10.A.2 Formal Solution -- 10.A.3 Discontinuities -- 10.A.4 Weak Solutions -- Chapter 11 Aerofoils in Low-Speed Incompressible Flow -- 11.1 Introduction -- 11.1.1 Aerofoils -- 11.2 Two-Dimensional Aerofoils -- 11.2.1 Kutta Condition -- 11.3 Generation of Lift on an Aerofoil -- 11.4 Pitching Moment about the Wing -- 11.5 Lift from a Thin Wing.  
11.6 Application of Conformal Transforms to the Properties of Aerofoils.

---

Sommario/riassunto

This textbook presents essential methodology for physicists of the theory and applications of fluid mechanics within a single volume. Building steadily through a syllabus, it will be relevant to almost all undergraduate physics degrees which include an option on hydrodynamics, or a course in which hydrodynamics figures prominently.

---