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Nota di contenuto	Preface; Acknowledgments; Contents; 1 Fundamentals of Fluid Dynamics; 1.1 Basic Fluid Kinematics; 1.1.1 Description and Visualization of Fluid Motion; 1.1.2 Dilatation and Vorticity; 1.1.3 Velocity Gradient and Its Decompositions; 1.1.4 Local and Global Material Derivatives; 1.2 Dynamic Equations of Fluid Motion; 1.2.1 Dynamic Equations for General Fluids; 1.2.2 Constitutive Relations and Thermodynamics; 1.2.3 Navier-Stokes Equations and Perfect Gas; 1.2.4 Dominant Non-dimensional Parameters; 1.3 Wall-Bounded Flows; 1.3.1 Boundary Conditions; 1.3.2 Fluid Reaction to Solid Boundaries 1.4 Problems for Chapter 12 Fundamental Processes in Fluid Motion; 2.1 Preliminary Observations; 2.2 Intrinsic Decomposition of Fundamental Processes; 2.2.1 Helmholtz Decomposition; 2.2.2 Dynamic Equations for Vorticity and Dilatation; 2.3 Coupling and Splitting of Fundamental Processes; 2.3.1 Process Nonlinearity and

Coupling Inside the Flow; 2.3.2 Process Linear Coupling on Boundaries; 2.3.3 Linearized Process Splitting in Unbounded Space; 2.4 Far-Field Asymptotics in Unbounded Flow; 2.4.1 Vorticity and Dilatation Far Fields; 2.4.2 Velocity Far Field 2.4.3 Far-Field Asymptotics for Steady Flow 2.5 A Decoupled Model Flow: Inviscid Gas Dynamics; 2.5.1 Basic Equations; 2.5.2 Unsteady Potential Flows; 2.5.3 Steady Isentropic Flow; 2.6 Minimally-Coupled Model: Incompressible Flow; 2.6.1 Momentum Formulation versus Vorticity Formulation; 2.6.2 Incompressible Potential Flow; 2.6.3 Accelerated Body Motion and Virtual Mass; 2.6.4 Force on a Body in Steady Flow; 2.7 Problems for Chapter 2; 3 Vorticity Dynamics; 3.1 Kinematic Properties of Vorticity Field; 3.1.1 Vorticity Tube and Circulation; 3.1.2 Geometric Relation of Velocity and Vorticity 3.1.3 Two-Dimensional and Axisymmetric Vortical Flows 3.1.4 Biot-Savart Formulas; 3.2 Vorticity Kinetic Vector and Circulation-Preserving Flow; 3.2.1 General Evolution Formulas; 3.2.2 Local Material Invariants; 3.2.3 Vorticity-Tube Stretching and Tilting; 3.2.4 Bernoulli Integrals; 3.3 Vorticity Integrals and Their Invariance; 3.3.1 Total Vorticity and Circulation; 3.3.2 Lamb-Vector Integrals; 3.3.3 Vortical and Potential Impulses; 3.3.4 Helicity; 3.3.5 Total Kinetic Energy; 3.4 Physical Causes of Vorticity Kinetics; 3.4.1 Coriolis Force in Rotating Fluid; 3.4.2 Baroclinicity 3.4.3 Vorticity Diffusion and Enstrophy Dissipation 3.4.4 Vorticity Creation at Boundary; 3.5 Problems for Chapter 3; 4 Attached and Free Vortex Layers; 4.1 Parallel Shear Flows on Upper-Half Plane; 4.1.1 General Solution in Vorticity Formulation; 4.1.2 Singular BVF: Stokes First Problem (Rayleigh Problem); 4.1.3 Oscillatory BVF: Stokes Second Problem; 4.2 Boundary Layers: Formulation and Physics; 4.2.1 From d'Alembert's Paradox to Prandtl's Theory; 4.2.2 From Rayleigh Problem to Boundary Layer Equations; 4.2.3 Blasius Boundary Layers; 4.2.4 Further Issues 4.2.5 Vorticity Dynamics in Boundary Layer

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Sommario/riassunto

This book is a comprehensive and intensive book for graduate students in fluid dynamics as well as scientists, engineers and applied mathematicians. Offering a systematic introduction to the physical theory of vortical flows at graduate level, it considers the theory of vortical flows as a branch of fluid dynamics focusing on shearing process in fluid motion, measured by vorticity. It studies vortical flows according to their natural evolution stages, from being generated to dissipated. As preparation, the first three chapters of the book provide background knowledge for entering vortical flows. The rest of the book deals with vortices and vortical flows, following their natural evolution stages. Of various vortices the primary form is layer-like vortices or shear layers, and secondary but stronger form is axial vortices mainly formed by the rolling up of shear layers. Problems are given at the end of each chapter and Appendix, some for helping understanding the basic theories, and some involving specific applications; but the emphasis of both is always on physical thinking.

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