1. Record Nr. UNINA9910865289703321

Autore	Demasi Luciano
Titolo	Introduction to Unsteady Aerodynamics and Dynamic Aeroelasticity
Pubbl/distr/stampa	Cham : , : Springer, , 2024 ©2024
ISBN	9783031500541 9783031500534
Edizione	[1st ed.]
Descrizione fisica	1 online resource (804 pages)
Disciplina	629.132362
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Nota di contenuto	Intro -- Endorsement -- Preface -- Contents -- 1 Introduction: Learning Aeroelasticity -- 1.1 What Is Aeroelasticity? -- 1.1.1 Intuitive Concepts on Aeroelasticity -- 1.2 What Is New in This Book -- 1.3 Learning/Teaching Aeroelasticity -- 1.4 How Could Aeroelasticity Be Presented/Learned -- 1.5 Education of Engineers -- Part I Review of Mathematical Concepts -- 2 Finite-Part Integrals -- 2.1 An Introduction to Cauchy Principal Value -- 2.2 A More General Example of Cauchy Principal Value Integrals -- 2.2.1 A Sufficient Condition to Assure the Existence of Cauchy Principal Value Integral -- 2.3 An Introduction to Hadamard Finite-Part Integrals -- 2.4 Case of Hadamard Finite-Part Integrals Obtained by Using Cauchy Principal Value Integrals -- 2.5 Hadamard Finite-Part Surface Integrals -- 2.6 Competency Questions -- 3 Convolution and Duhamel Integrals -- 3.1 Review of Convolution Integrals for Linear Systems -- 3.1.1 Example of Convolution Integral -- 3.2 Review on Duhamel Integral (Step Response) -- 3.2.1 Relationship Between Step and Impulse Responses -- 3.3 Competency Questions -- 4 Laplace and Fourier Transforms -- 4.1 Fourier Transforms -- 4.2 Laplace Transforms -- 4.3 Competency Questions -- 5 Review of the Least Square Method -- 5.1 Definition of the Problem -- 5.2 Definition and Minimization of the Error -- 5.3 Competency Questions -- 6 Vector Identities Used in Aerodynamics -- 6.1 Vectors -- 6.2 Second-Order Tensors -- 6.3 Summation

Convention -- 6.4 Kronecker's Delta and Permutation Symbol -- 6.5 Applications of Kronecker's Delta and Permutation Symbols -- 6.5.1 Scalar Product -- 6.5.2 Cross Product -- 6.5.3 - Identity -- 6.5.4 Double Cross Product -- 6.6 Dyadic Product -- 6.6.1 Definition -- 6.6.2 Properties -- 6.7 Del Operator -- 6.8 A Vectorial Relationship Used in the Definition of Potential Flows.
6.9 A Vectorial Relationship Used in Definition of Vorticity -- 6.10 A Vectorial Relationship Used in Biot and Savart Law -- 6.11 First-Order Substantial Derivative Operator -- 6.11.1 Physical Interpretation -- 6.12 Competency Questions -- Part II Fundamental Equations of Aerodynamics -- 7 Reynolds Transport Theorem, Isentropic, Continuity, and Momentum Equations -- 7.1 Introduction -- 7.2 General Concepts -- 7.2.1 Boundary Layer, Wake, and Generation of Vortices -- 7.3 Leibniz Rule of Differentiation of Integrals -- 7.3.1 Leibniz Rule for the 3D Case -- 7.4 Continuity Equation Written by Using Reynolds Transport Theorem -- 7.4.1 Continuity Equation Expressed in Terms of Substantial Derivative -- 7.5 Momentum Equation Written by Using Reynolds Transport Theorem -- 7.5.1 Simplification of the Momentum Equation -- 7.5.2 Momentum Equation Expressed in Terms of Substantial Derivative -- 7.6 State Equation for Air -- 7.7 The Isentropic Relationship -- 7.8 Mach Number and Speed of Sound -- 7.8.1 Explicit Expression of the Speed of Sound -- 7.9 Competency Questions -- 8 Vorticity and Kelvin's Circulation Theorem -- 8.1 Angular Velocity and Vorticity -- 8.1.1 Divergence of Vorticity -- 8.1.2 Vortex Line, Surface, and Tube -- 8.1.3 Strength of a Vortex Tube -- 8.1.4 Kelvin's Circulation Theorem -- 8.1.5 Consequence of Kelvin's Circulation Theorem on Vortex Dynamics -- 8.2 Competency Questions -- Part III Velocity and Acceleration Potentials -- 9 Velocity and Acceleration Potentials -- 9.1 Introduction -- 9.2 Definition of Velocity Potential -- 9.3 Generalized Bernoulli Equation -- 9.4 The Lord Kelvin Equation -- 9.5 The Coefficient of Pressure Written in Terms of Velocity Potential -- 9.6 Speed of Sound Expressed in Terms of Velocity Potential -- 9.7 Derivation of the Velocity Potential Equation (Compressible Case).
9.8 Derivation of the Velocity Potential Equation (Incompressible Case) -- 9.9 Velocity Potential and Wake Discontinuities -- 9.10 The Acceleration Potential -- 9.10.1 Velocity Potential Equation Expressed in Terms of Acceleration Potential -- 9.11 Competency Questions -- 10 The Biot-Savart Law for Incompressible Fluids -- 10.1 Introduction -- 10.2 Demonstration of the Biot-Savart Law -- 10.3 The Biot-Savart Law Applied to an Infinite Straight Filament -- 10.4 The Biot-Savart Law Applied to a Semi-infinite Straight Filament -- 10.5 The Biot-Savart Law Applied to a Finite Portion of a Straight Filament -- 10.6 Semi-infinite Straight Filament: The Numerical Formula -- 10.7 The Case of Point Exactly on the Vortex -- 10.8 Vortex Filament and Laplace's Equation -- 10.9 Competency Questions -- Part IV Fluid-Structure Boundary Condition -- 11 The Fluid-Structure Boundary Condition -- 11.1 Introduction -- 11.2 Derivation of the Dynamic Aeroelastic Boundary Condition -- 11.3 Boundary Condition for a Wing Surface Referred to the x-y Plane -- 11.4 Boundary Condition for a Wing Surface Referred to a Cylindrical Surface -- 11.5 Derivation of the Steady Aeroelastic Boundary Condition -- 11.6 Competency Questions -- Part V Aerodynamic Force for the Steady Incompressible Ideal Flow -- 12 The Aerodynamic Force for the Steady Incompressible Ideal Flow -- 12.1 Determination of the Aerodynamic Force (Incompressible Steady Flow) -- 12.2 Competency Questions -- Part VI Theory of Small Perturbations -- 13 Small Perturbation Theory -- 13.1 Introduction -- 13.2 Modeling of the Wake, Thickness, and Camber -- 13.3 Small

Perturbation Velocity Potential -- 13.4 Linearized First and Second Substantial Derivatives -- 13.5 Linearized Pressure -- 13.6 Linearized Coefficient of Pressure -- 13.7 Linearized Velocity Potential Equation. 13.8 Linearized Velocity Potential Equation Written in the Fourier Domain -- 13.9 Linearized Velocity Potential and Wake Discontinuities -- 13.10 Linearized Aeroelastic Boundary Condition -- 13.10.1 Boundary Condition for a Wing Surface Referred to the x-y Plane -- 13.10.2 Boundary Condition for a Wing Surface Referred to a Cylindrical Surface -- 13.10.3 Perturbation from a Reference Equilibrium Configuration -- 13.11 Competency Questions -- 14 Small Perturbation Acceleration Potential -- 14.1 Linearization Process -- 14.2 Differential Equation the Small Perturbation Acceleration Potential Needs to Satisfy -- 14.3 Behavior of the Small Perturbation Acceleration Potential Across the Wake -- 14.4 The Integral Relationship Between Small Perturbation Velocity and Acceleration Potentials -- 14.5 Competency Questions -- Part VII Fundamental Solutions of the Small Perturbation Velocity Potential Equation -- 15 Compressible Fluid at Rest -- 15.1 Introduction -- 15.2 Explicit Form of the Partial Differential Equation and Boundary Conditions -- 15.3 Strategy to Solve the Partial Differential Equations and Introduce the Doublet Lattice Method -- 15.4 The Source as Fundamental Solution for the Fluid at Rest -- 15.4.1 Definition of the Source/Sink (Steady Case) -- 15.4.2 Source with Intensity Kept Constant After Activation -- 15.4.3 Source with Intensity Changing with Time -- 15.5 Competency Questions -- 16 Compressible Fluid in Motion -- 16.1 Introduction -- 16.2 The Source as Fundamental Solution for the Fluid in Motion -- 16.2.1 Steady Case -- 16.2.2 Unsteady Case: Spherical Source Activated at Time Zero -- 16.3 Small Perturbation Velocity Potential of a Spherical Source Pulsating with Generic Law -- 16.4 Small Perturbation Velocity Potential of a Spherical Source at a Generic Position Pulsating with Generic Law.
16.5 Small Perturbation Velocity Potential of a Spherical Source at a Generic Position Pulsating with Harmonic Law -- 16.6 Potential Induced by a Doublet (Harmonic Motion) Positioned at the Origin -- 16.7 Potential Induced by a Doublet (Harmonic Motion) Positioned at the Origin: An Alternative Approach -- 16.8 Potential Induced by a Doublet (Harmonic Motion) Positioned at a Generic Position -- 16.9 Harmonic Motion: Small Perturbation Velocity Potential of a Doublet at a Generic Position: Case of Doublets' Axes Contained in the y-z Plane -- 16.10 Competency Questions -- Part VIII Fundamental Solutions of the Small Perturbation Acceleration Potential Equation -- 17 Compressible Fluid in Motion: The Doublet Solution -- 17.1 The Formal Equality Between Small Perturbation Velocity and Acceleration Potentials -- 17.2 Solutions of Small Perturbation Acceleration Potential for the Case of Harmonic Motion -- 17.2.1 Relationship Between Pressure Jump and Doublet Amplitudes -- 17.3 Competency Questions -- Part IX Steady State Aerodynamics -- 18 Theoretical Aerodynamic Modeling of Wings -- 18.1 Introduction -- 18.2 Steady Incompressible Ideal Flow and Modeling of Wings -- 18.3 Steady Incompressible Ideal Flow and Modeling of Infinite Wings -- 18.3.1 Kutta-Joukowsky Theorem -- 18.3.2 Finding the Vortex Distribution -- 18.3.3 The Case of Flat Plate and Its Implications on the Doublet Lattice Method -- 18.4 Competency Questions -- 19 Steady Incompressible Ideal Flow and Modeling of Finite Wings -- 19.1 Introduction -- 19.2 The Vortex Lattice Method -- 19.3 Formulation of the Problem with the Vortex Lattice Method -- 19.4 Implementation of the Vortex Lattice Method -- 19.4.1 Imposition of the Symmetry Conditions -- 19.5 Vortex Lattice Formulation in Terms of Pressure -- 19.6 Prandtl-Glauert Compressibility Correction.

19.7 The Matrix of Aerodynamic Influence Coefficients for the Compressible Case.