

# Contents

Preface to the First Edition	vii
Preface to the Second Edition	xi
Acknowledgments	xiii

## 1. Introduction

1.1 What is computational fluid dynamics?	1
1.2 Advantages of computational fluid dynamics	4
1.3 Application of computational fluid dynamics	6
1.4 The future of computational fluid dynamics	26
1.5 Summary	27
Review questions	28

## 2. CFD Solution Procedure—A Beginning

2.1 Introduction	31
2.2 Problem setup—pre-process	34
2.3 Numerical solution—CFD solver	43
2.4 Result report and visualization—post-process	49
2.5 Summary	58
Review questions	60

## 3. Governing Equations for CFD—Fundamentals

3.1 Introduction	61
3.2 The continuity equation	61
3.3 The momentum equation	70
3.4 The energy equation	84
3.5 The additional equations for turbulent flow	94
3.6 Generic form of the governing equations for CFD	104
3.7 Physical boundary conditions of the governing equations	113
3.8 Summary	116
Review questions	118

## 4. CFD Techniques—The Basics

4.1 Introduction	123
4.2 Discretization of governing equations	125
4.3 Converting governing equations to algebraic equation system	136

4.4 Numerical solutions to algebraic equations	150
4.5 Pressure–velocity coupling—“SIMPLE” scheme	160
4.6 Multi-grid method	170
4.7 Summary	172
Review questions	173
<b>5. CFD Solution Analysis—Essentials</b>	
5.1 Introduction	177
5.2 Consistency	178
5.3 Stability	182
5.4 Convergence	188
5.5 Accuracy	195
5.6 Efficiency	205
5.7 Case studies	206
5.8 Summary	215
Review questions	216
<b>6. Practical Guidelines for CFD Simulation and Analysis</b>	
6.1 Introduction	219
6.2 Guidelines on grid generation	220
6.3 Guidelines for boundary conditions	242
6.4 Guidelines for turbulence modeling	249
6.5 Summary	268
Review questions	269
<b>7. Some Applications of CFD with Examples</b>	
7.1 Introduction	275
7.2 To assist in the design process—as a design tool	276
7.3 To enhance understanding—as a research tool	282
7.4 Other important applications	288
7.5 Summary	340
Review questions	343
<b>8. Some Advanced Topics in CFD</b>	
8.1 Introduction	349
8.2 Advances in numerical methods and techniques	349
8.3 Advances in computational models	367
8.4 Other numerical approaches for CFD	383
8.5 Summary	391
Review questions	392

Contents

<b>Appendix A</b>	<b>Full Derivation of Conservation Equations</b>	<b>395</b>
<b>Appendix B</b>	<b>Upwind Schemes</b>	<b>401</b>
<b>Appendix C</b>	<b>Explicit and Implicit Methods</b>	<b>403</b>
<b>Appendix D</b>	<b>Learning Program</b>	<b>405</b>
<b>Appendix E</b>	<b>CFD Assignments and Guideline for CFD Project</b>	<b>407</b>
References		421
Index		435