

## Contents

	<i>Preface to the Second Edition</i>	page ix
	<i>Preface</i>	xi
<b>1</b>	<b>Introduction and Problem Formulation</b>	1
	1.1 History, Background and Rationale	1
	1.2 Initial-Value Concepts and Stability Bases	11
	1.3 Classical Treatment: Modal Expansions	14
	1.4 Transient Dynamics	18
	1.5 Asymptotic Behavior	20
	1.6 Role of Viscosity	21
	1.7 Geometries of Relevance	23
	1.8 Spatial Stability Bases	23
<b>2</b>	<b>Temporal Stability of Inviscid Incompressible Flows</b>	26
	2.1 General Equations	26
	2.2 Kelvin–Helmholtz Theory	41
	2.3 Piecewise Linear Profile	44
	2.4 Inviscid Temporal Theory	50
	2.5 Critical Layer Concept	57
	2.6 Continuous Profiles	61
	2.7 Exercises	69
<b>3</b>	<b>Temporal Stability of Viscous Incompressible Flows</b>	76
	3.1 Introduction	76
	3.2 Channel Flows	77
	3.3 Blasius Boundary Layer	83
	3.4 Falkner–Skan Flow Family	86
	3.5 Unbounded Flows	88
	3.6 Discrete and Continuous Spectra	90
	3.7 Exercises	94

<b>4</b>	<b>Spatial Stability of Incompressible Flows</b>	98
4.1	Introduction	98
4.2	Gaster's Transformation	99
4.3	Incompressible Inviscid Flow	101
4.4	Absolute and Convective Instabilities	112
4.5	Incompressible Viscous Flow	116
4.6	Discrete and Continuous Spectra	120
4.7	Exercises	126
<b>5</b>	<b>Stability of Compressible Flows</b>	128
5.1	Introduction	128
5.2	Compressible Mixing Layer	129
5.3	Compressible Boundary Layer	151
5.4	Exercises	165
<b>6</b>	<b>Centrifugal Stability</b>	168
6.1	Coordinate Systems	168
6.2	Taylor Problem	170
6.3	Görtler Vortices	177
6.4	Pipe Flow	180
6.5	Rotating Disk	182
6.6	Trailing Vortex	185
6.7	Round Jet	187
6.8	Exercises	190
<b>7</b>	<b>Geophysical Flow</b>	191
7.1	General Properties	191
7.2	Stratified Flow	192
7.3	Effects of Rotation	208
7.4	Baroclinic Flow	213
7.5	The Ekman Layer	216
7.6	Exercises	222
<b>8</b>	<b>Transient Dynamics</b>	225
8.1	The Initial-Value Problem	225
8.2	Laplace Transforms	229
8.3	Moving Coordinates and Exact Solutions	232
8.4	Multiple Scale, Multiple Time Analysis	240
8.5	Numerical Solution of Governing Partial Differential Equations	244
8.6	Optimizing Initial Conditions	248
8.7	Exercises	257

<i>Contents</i>		vii
<b>9</b>	<b>Nonlinear Stability</b>	259
9.1	Energy Equation	259
9.2	Weakly Nonlinear Theory	261
9.3	Secondary Instability Theory	263
9.4	Resonant Wave Interactions	272
9.5	PSE Theory	278
9.6	Exercises	285
<b>10</b>	<b>Transition and Receptivity</b>	287
10.1	Introduction	287
10.2	Influence of Free Stream Turbulence and Receptivity	288
10.3	Tollmien–Schlichting Breakdown	291
10.4	Oblique Wave Breakdown	292
10.5	Crossflow Vortex Breakdown	294
10.6	Dean–Taylor–Görtler Vortex Breakdown	298
10.7	Transition Prediction	301
10.8	Exercises	315
<b>11</b>	<b>Direct Numerical Simulation</b>	316
11.1	Introduction	316
11.2	Governing Equations	317
11.3	Temporal DNS Formulation	320
11.4	Spatial DNS Formulation	321
11.5	Large Eddy Simulation	332
11.6	Applications	333
11.7	Summary	346
11.8	Exercises	348
<b>12</b>	<b>Flow Control and Optimization</b>	351
12.1	Introduction	351
12.2	Effects of Flexible Boundaries	352
12.3	Wave Induced Forcing	367
12.4	Feed-Forward and Feedback Control	368
12.5	Optimal Control Theory	371
12.6	Exercises	388
<b>13</b>	<b>Investigating Hydrodynamic Instabilities with Experiments</b>	389
13.1	Experimental Facility	389
13.2	Model Configuration	391
13.3	Inducing Hydrodynamics Instabilities	392
13.4	Measurement Instrumentation	393
13.5	Signal Analysis	396
13.6	Summary	397

<i>Appendix A</i>	<b>Mathematical Formulas</b>	399
<i>Appendix B</i>	<b>Numerical Methods</b>	401
<i>Appendix C</i>	<b>Solutions to Exercises</b>	413
	<i>References</i>	517
	<i>Author Index</i>	544
	<i>Subject Index</i>	549