

Table of Contents

Preface	
Acknowledgements	
Frequently Used Symbols	ix
Milestones in Boundary-Layer Transition	xiii
A Preview of Transition	xv
Part I – Before and After	
1. Basic Equations	3
1.1 Elements of Fluid Mechanics	3
1.2 Equations for Fluctuating Flow	5
1.3 Equations for Two-Dimensional Flow	10
1.4 Prandtl’s Boundary-Layer Theory	11
1.5 Other Definitions and Equations	16
References	20
2. Laminar Boundary Layers	21
2.1 A Steady Boundary Layer –Blasius’ Solution	21
2.2 Unsteady Boundary Layers without a Mean Flow	25
2.3 Unsteady Boundary Layers with a Mean Flow	28
References	47
3. Turbulent Boundary Layers	49
3.1 Isotropic Turbulence	49
3.2 A Phenomenological Approach	54
3.3 A Differential Approach	62
3.4 Free-Stream Turbulence	73
3.5 Near-Wall Turbulence	77
References	84
Part II – In Between	
4. Pre-Transitional Flow	91
4.1 Seeds of Transition	92
4.2 Path to Natural Transition	94
4.3 Path to Bypass Transition	114
References	135
5. Turbulent Spots	141
5.1 Anatomy of a Spot	142
5.2 Emmons’ Turbulent Spot Theory	154
5.3 Spot Kinematics	175
5.4 Spot Propagation Parameters	192
References	197
6. Transition Correlations	201
6.1 Beginning and End of Transition	201
6.2 Zero Pressure-Gradient Flows	207
6.3 Nonzero Pressure-Gradient Flows	218
6.4 Effect of Surface Curvature	223
6.5 Effect of Surface Roughness	224
References	226

Elements of Transitional Boundary-Layer Flow

7. Transitional Boundary Layers	231
7.1 Classical Approach	232
7.2 Zonal Approach	239
7.3 Intermittency Models	254
7.4 Some Typical Errors	269
References	273
Part III – And Beyond	
8. The Other Modes of Transition	279
8.1 Wake-Induced Transition	279
8.2 Multimode Transition	290
8.3 Separated-Flow Transition	299
8.4 Post- and Reverse Transition	314
References	315
Appendices	
A – Blasius' Function	323
B – Turbulence Spectral Functions	325
C – Another Reynolds-Stress Closure	329
D – Stability Results	331
E – Transition with Anisotropic Turbulence	335
F – A Line of Point Sources	339
G – Intermittency Measurements	343
H – Intermittency Profile Corrections	345
I – Translating Between Spot Areas	347
J – Transition Conversion Tables	351
K – A Conditioned Reynolds-Stress Equation	353
L – Free Shear Layer Stability	355
Bibliography	357
Index	367