CONTENTS

Prefa	ce	. v										
Chap	ter 1. General Introduction and Concepts	. 1										
1-1.	Definition of Turbulence and Introductory Concepts	. 1										
1-2.	Equations of Motion for Turbulent Flow; Reynolds Stresses	. 13										
1-3. Equation for the Conservation of a Transferable Scalar Quantity in a												
	Turbulent Flow	. 24										
1-4.	Double Correlations between Turbulence-velocity Components	. 26										
1-5.	Change in Double Velocity Correlations with Time; Introduction of	of										
	Triple Velocity Correlations	. 30										
1-6.	Features of the Double Longitudinal and Lateral Correlations in a Homo)-										
	geneous Turbulence	. 34										
1-7.	Macro or Integral Scale of Turbulence	. 37										
1-8.	Eulerian Correlations with Respect to Time	. 39										
1-9.	Turbulent Diffusion of Fluid Particles; Lagrangian Correlations	. 42										
1-10.	Recapitulation of Correlations	. 49										
1-11.	Empirical Formulas for Double-correlation Curves	. 51										
1-12.	Taylor's One-dimensional Energy Spectrum	. 54										
1-13.	Energy Relations in Turbulent Flows.	. 62										
Chan	ter 2 Principles of Methods and Techniques in the Measurement	hf										
unup	Turbulent Flows	. 73										
2-1	Introduction	73										
2-2	The Hot_wire Anemometer	. 15										
2-3.	Constant-current Method	. 10										
2-4.	Measurement of Turbulence Characteristics with the Hot-wire Anemore	· · ·										
	eter: Constant-current Method	102										
2-5.	Measurement of Temperature and Concentration Fluctuations with the	ie ie										
	Hot-wire Anemometer: Constant-current Method	. 112										
2-6.	Constant-temperature Method.	. 116										
2-7.	Limitations of the Hot-wire Anemometer	. 119										
2-8.	Electric-discharge Anemometer.	. 122										
2-9.	The Method of Electromagnetic Induction	. 125										
2-10.	Methods Based upon Flow Visualization	. 126										
2-11.	Measurement of Mean Values of Static Pressure and Velocity	. 132										
Chap	ter 3. Isotronic Turbulence	142										
3_1		149										
3-2	Correlation Tensors	. 142										
3-3	Differential Equation for the Dynamic Behavior of an Isotronic Turb	1- 1-										
- 0.	lence	u- 158										
		. 100										
	V11											

CONTENTS

3-4. 3-5. 3-6. 3-7. 3-8. 3-9.	The Three-dimensional Energy Spectrum.	165 174 204 219 239 243									
Chap	ter 4. Nonisotropic Turbulence	2 49									
4-1.	Introduction	249									
4-2.	Dynamics of the One-point velocity Correlation $u_i u_j$.	250									
4-3. 4-4.	Dynamics of the Two-point Velocity Correlation $(u_i)_A(u_j)_B$ The Dynamic Equation for the Energy Spectrum	256 260									
Chap	ter 5. Transport Processes in Turbulent Flows	275									
5-1	Introduction	275									
5-2.	Mixing-length and Phenomenological Theories	277									
5-3.	Analogies in Turbulence Transport	293									
5-4.	Diffusion in Homogeneous Turbulence	302									
5-5.	Diffusion from a Fixed Source in a Uniform Flow	324									
5-6.	Diffusion from a Fixed Source in a Turbulent Shear Flow	342									
5-7.	Diffusion of Discrete Particles in a Homogeneous Turbulence	352									
5-8.	Effect of Compressibility	365									
Chapter 6. Nonisotropic Free Turbulence											
6-1.	Introduction	376									
6-2.	Approximations Applied to the Equations of Motion	378									
6-3.	Velocity Distribution Behind a Cylinder According to the Classical										
	Theories	384									
6-4.	The Transport of a Scalar Quantity in the Wake Flow of a Cylinder.	390									
6-5.	Measurements of Mean-velocity and Mean-temperature Distribution in										
	the Wake Flow of a Cylinder	393									
6-6.	Measurements of Turbulence Quantities in the Wake Flow of a Cylinder	396									
6-7.	Velocity Distribution in a Round Free Jet According to the Classical										
• • •	Theories	404									
6-8	The Transport of a Scalar Quantity in a Bound Free Jet	416									
6-9.	Measurements of Mean-velocity and Mean-temperature Distribution	-10									
	in a Round Free Jet	420									
6-10.	Measurements of Turbulence Quantities in a Bound Free let	431									
6-11.	The Structure of Free Turbulent Shear Flow and Transport Processes.	439									
Chapter 7. Nonisotropic "Wall" Turbulence											
7-1.	Introduction	451									
7-2.	Approximations to the Equations of Motion, and Their Integral Relations	453									
7-3.	The Laminar Boundary Layer and Transition	462									
7-4	Turbulent Boundary Laver Along a Flat Plate. Classical Theories	465									
7-5	Measurements on Mean-velocity Distribution	476									
7-6.	Measurements on Turbulence Quantities in a Boundary Laver	487									
7-7.	Recapitulation and New Expressions for Mean-velocity and Shear-stress	-0.									
- -	Distribution	503									
7-8.	Turbulent Flow through a Straight Circular Pipe. Mean-velocity Dis-										
	tribution	514									

viii

7-9. Mea 7-10. The 7-11. Tran 7-12. Min	suren Struc nsport	ture of s	of 7 of 7 Sca Drol	Furb Surbi lar (ulenc ulent Quant	e Qu Pipe ity i	ianti e Flo in Wa	ties w all	s in Tur	Pip bul	e F enc	low e.	• • •	•	•	•		• • •	520 533 537 552
Appendix.	celland . Ele	eous men	ts of	Car	s in v tesiai	van 1 Te	nsors	5 UI	ence	• •	•	•	•	•		•	•	•	553 567
Name Ind	lex.	•		•	•	• •	•	•	•	•	•	•	·	•	•	•	•	•	577
Subject Ir	iaex	·	• •	•	•	• •	•	·	·	·	·	·	·	·	·	·	·	·	991

ix