Contents

Pr	eface		page vi	
No	men	clature	xi	
1	Int	roduction	1	
	1.1	The fact of turbulent flow	1	
	1.2	Broad options in modelling	2	
	1.3	A preview of the mean-strain generation processes in the		
		stress-transport equation	5	
	1.4	Some consequences of the no-slip boundary condition		
		at a wall	Ģ	
	1.5	Sequencing of the material	11	
2	The	e exact equations	13	
	2.1	The underpinning conservation equations	13	
	2.2	The Reynolds equations	15	
	2.3	The second-moment equations	23	
3	Cha	aracterization of stress and flux dynamics: elements		
	req	uired for modelling	33	
	3.1	Introduction	33	
	3.2	Energy flow processes in turbulence	33	
	3.3	The spectral character of turbulence	38	
	3.4	The ε -equation	43	
	3.5	Transport equation for the mean-square scalar variance, $\overline{\theta^2}$	46	
	3.6	Transport equation for dissipation of scalar variance, $\varepsilon_{\theta\theta}$	49	
	3.7	Turbulence anisotropy, invariants and realizability	50	
4	Approaches to closure			
	4.1	General remarks and basic guidelines	60	
	4.2	Pressure interactions, Φ_{ij} and $\Phi_{\theta j}$: the Poisson equation	63	

V

vi Contents

	4.3	The basic second-moment closure for high-Re _t flow regions	67			
	4.4	Pressure-strain models from tensor expansion	86			
	4.5	Turbulence affected by force fields	113			
	4.6	Modelling the triple moments	134			
5	Modelling the scale-determining equations					
	5.1	The energy dissipation rate, ε	143			
	5.2	Other scale-determining equations	156			
	5.3	Multi-scale approaches	160			
	5.4	Determining $\varepsilon_{\theta\theta}$, the dissipation rate of $\overline{\theta^2}$	167			
6	Modelling in the immediate wall vicinity and at low Re _t					
	6.1	The nature of viscous and wall effects: options for modelling	170			
	6.2	The structure of the near-wall sublayer	173			
	6.3	Wall integration (WIN) schemes	188			
	6.4	Illustration of the performance of two near-wall models	214			
	6.5	Elliptic relaxation concept	229			
7	Simplified schemes					
	7.1	Rationale and organization	240			
	7.2	Reduced transport-equation models	241			
	7.3	Algebraic truncations of the second-moment equations	247			
	7.4	Linear eddy-viscosity models	270			
	7.5	The use of ASMs and linear EVMs within an unsteady RANS				
		framework	301			
8	Wa	ll functions	313			
	8.1	Early proposals	313			
	8.2	Towards a generalization of the wall-function concept:				
		preliminaries	319			
	8.3	Analytical wall functions (AWF): the Manchester scheme	322			
	8.4	A Simplified AWF (SAWF): the Delft scheme	331			
	8.5	Blended wall treatment (BWT)	335			
	8.6	Numerical wall functions (NWF)	341			
Re	References					
Inc	Index					