Contents

Pret	face to Fifth Edition	х
Pret	face to Fourth Edition	xi
	out the Authors	xiii
Syn	nbols	xiv
1	Properties of Fluids	
	1.1 Introduction	1
	1.2 Engineering units	1
	1.3 Mass density and specific weight	1
	1.4 Relative density	2
	1.5 Viscosity of fluids	2
	1.6 Compressibility and elasticity of fluids	2
	1.7 Vapour pressure of liquids	2
	1.8 Surface tension and capillarity	2 2 2 3 3 3 5
	Worked examples	3
	References and recommended reading	
	Problems	5
2	Fluid Statics	
	2.1 Introduction	6
	2.2 Pascal's law	6
	2.3 Pressure variation with depth in a static incompressible fluid	
	2.4 Pressure measurement	8
	2.5 Hydrostatic thrust on plane surfaces	10
	2.6 Pressure diagrams	13
	2.7 Hydrostatic thrust on curved surfaces	14
	2.8 Hydrostatic buoyant thrust	16
	2.9 Stability of floating bodies	16
	2.10 Determination of metacentre	17
	2.11 Periodic time of rolling (or oscillation) of a floating body	19
	2.12 Liquid ballast and the effective metacentric height	19
	2.13 Relative equilibrium	21

	Worked examples	23
	References and recommended reading	40
	Problems	40
3	Fluid Flow Concepts and Measurements	45
	3.1 Kinematics of fluids	45
	3.2 Steady and unsteady flows	46
	3.3 Uniform and non-uniform flows	46
	3.4 Rotational and irrotational flows	47
	3.5 One-, two- and three-dimensional flows	47
	3.6 Streamtube and continuity equation	47
	3.7 Accelerations of fluid particles	48
	3.8 Two kinds of fluid flow	49
	3.9 Dynamics of fluid flow	50
	3.10 Energy equation for an ideal fluid flow	50
	3.11 Modified energy equation for real fluid flows	50
	3.12 Separation and cavitation in fluid flow	52
	3.13 Impulse-momentum equation	54
	3.14 Energy losses in sudden transitions	55
	3.15 Flow measurement through pipes	56
	3.16 Flow measurement through orifices and mouthpieces	58
	3.17 Flow measurement in channels	62
	Worked examples	67
	References and recommended reading	83
	Problems	83
4	Flow of Incompressible Fluids in Pipelines	87
	4.1 Resistance in circular pipelines flowing full	87
	4.2 Resistance to flow in non-circular sections	92
	4.3 Local losses	92
	Worked examples	93
	References and recommended reading	113
	Problems	113
5	Pipe Network Analysis	116
	5.1 Introduction	116
	5.2 The head balance method ('loop' method)	117
	5.3 The quantity balance method ('nodal' method)	118
	5.4 The gradient method	120
	Worked examples	122
	References and recommended reading	139
	Problems	140
6	Pump-Pipeline System Analysis and Design	145
	6.1 Introduction	145
	6.2 Hydraulic gradient in pump-pipeline systems	146
	6.3 Multiple pump systems	147

	6.4	Variable-speed pump operation	149	
	6.5	Suction lift limitations	149	
	Work	xed examples	150	
		ences and recommended reading	164	
	Probl	ems	164	
7	Boundary Layers on Flat Plates and in Ducts			
	7.1	Introduction	167	
	7.2	The laminar boundary layer	167	
	7.3	The turbulent boundary layer	168	
	7.4	Combined drag due to both laminar and turbulent boundary layers	169	
	7.5	The displacement thickness	169	
	7.6	Boundary layers in turbulent pipe flow	170	
	7.7	The laminar sub-layer	172	
		ted examples	174	
	Refer	ences and recommended reading	181	
	Probl	ems	181	
8	Steac	ly Flow in Open Channels	183	
	8.1	Introduction	183	
	8.2	Uniform flow resistance	184	
	8.3	Channels of composite roughness	185	
	8.4	Channels of compound section	186	
	8.5	Channel design	187	
	8.6	Uniform flow in part-full circular pipes	190	
	8.7	Steady, rapidly varied channel flow energy principles	191	
	8.8	The momentum equation and the hydraulic jump	192	
	8.9	Steady gradually varied open channel flow	194	
	8.10	Computations of gradually varied flow	195	
	8.11	The direct step method	195	
	8.12	The standard step method	196	
	8.13	Canal delivery problems	197	
	8.14	Culvert flow	198	
	8.15	Spatially varied flow in open channels	199	
		ted examples	201	
		ences and recommended reading	237	
	Probl	ems	237	
9	Dimensional Analysis, Similitude and Hydraulic Models			
	9.1	Introduction	242	
	9.2	Dimensional analysis	243	
	9.3	Physical significance of non-dimensional groups	243	
	9.4	The Buckingham π theorem	244	
	9.5	Similitude and model studies	244	
		ted examples	245 257	
	References and recommended reading			
	Problems		258	

10	Ideal Fluid Flow and Curvilinear Flow		
	10.1	Ideal fluid flow	260
	10.2	Streamlines, the stream function	260
	10.3	Relationship between discharge and stream function	261
	10.4	Circulation and the velocity potential function	262
	10.5	Stream functions for basic flow patterns	262
	10.6	Combinations of basic flow patterns	264
	10.7	Pressure at points in the flow field	264
	10.8	The use of flow nets and numerical methods	265
	10.9		268
		Free and forced vortices	269
	Worked examples		269
	References and recommended reading		280
	Proble	ms	280
11	Gradu	ally Varied Unsteady Flow from Reservoirs	283
	11.1	Discharge between reservoirs under varying head	283
	11.2	Unsteady flow over a spillway	285
	11.3	Flow establishment	286
		ed examples	287
		nces and recommended reading	296
	Proble	ems	296
12	Mass Oscillations and Pressure Transients in Pipelines		298
	12.1	Mass oscillation in pipe systems - surge chamber operation	298
	12.2	Solution neglecting tunnel friction and throttle losses for	
		sudden discharge stoppage	299
	12.3	Solution including tunnel and surge chamber losses for	
		sudden discharge stoppage	300
	12.4	Finite difference methods in the solution of the surge	
	12.5	chamber equations	301
	12.5	Pressure transients in pipelines (waterhammer)	302
	12.6	The basic differential equations of waterhammer	304
	12.7 12.8	Solutions of the waterhammer equations	305 305
	12.8	The Allievi equations Alternative formulation	303
			308
	Worked examples References and recomended reading		315
	Problems		315
13	Unsteady Flow in Channels		316
	13.1	Introduction	316
	13.2	Gradually varied unsteady flow	316
	13.3	Surges in open channels	317
	13.4	The upstream positive surge	318
	13.5	The downstream positive surge	319
	13.6	Negative surge waves	320

		The dam break d examples nces and recommended reading ms	322 323 326 326
14	Uniform Flow in Loose-Boundary Channels		
	14.1	Introduction	327
	14.2	Flow regimes	327
	14.3	Incipient (threshold) motion	327
	14.4	Resistance to flow in alluvial (loose-bed) channels	329
	14.5	Velocity distributions in loose-boundary channels	331
	14.6	Sediment transport	331
	14.7	Bed load transport	332
	14.8	Suspended load transport	334
	14.9	Total load transport	337
	14.10		338
	14.11	Rigid-bed channels with sediment transport	342
	Worked examples		344
	References and recommended reading		358
	Proble	ns	359
15	Hydraulic Structures		361
	15.1	Introduction	361
	15.2	Spillways	361
	15.3	Energy dissipators and downstream scour protection	366
	Worke	d examples	369
	Referen	nces and recommended reading	379
	Proble	ms	380
16	Enviro	nmental Hydraulics and Engineering Hydrology	382
	16.1	Introduction	382
	16.2	Analysis of gauged river flow data	382
	16.3		384
	16.4	6	385
	16.5	Project appraisal	386
	Worked examples		387
	References and recommended reading		394
	Problems .		395
Ans	wers		397

An on-line solutions manual is published on the publisher's website: www.wiley.com/go/marriott