

CONTENTS

	<i>Foreword</i>	<i>page</i> ix
	<i>Note on the text</i>	xii
1	Introduction	1
	1.1 Definition and scope	1
	1.2 The hydrologic cycle	2
	1.3 Some estimates of the global water balance	3
	1.4 Methodologies and procedures	7
	1.5 Conservation laws: the equations of motion	12
	References	18
	Problems	19
Part I	Water in the atmosphere	
2	Water aloft: fluid mechanics of the lower atmosphere	23
	2.1 Water vapor in air	23
	2.2 Hydrostatics and atmospheric stability	28
	2.3 Turbulent transport of water vapor	34
	2.4 The atmospheric boundary layer	36
	2.5 Turbulence similarity	41
	2.6 Surface boundary condition: the energy budget constraint	55
	References	72
	Problems	76
3	Precipitation	79
	3.1 Formation of precipitation	79
	3.2 Major precipitation weather systems	82
	3.3 Precipitation distribution on the ground	92
	3.4 Interception	100
	3.5 Reliability of operational precipitation measurements	106
	References	111
	Problems	116

CONTENTS		vi
4	Evaporation	117
	4.1 Evaporation mechanisms	117
	4.2 Mass transfer formulations	118
	4.3 Energy budget and related formulations	123
	4.4 Water budget methods	142
	4.5 Evaporation climatology	148
	References	151
	Problems	156
 Part II Water on the surface		
5	Water on the land surface: fluid mechanics of free surface flow	161
	5.1 Free surface flow	161
	5.2 Hydraulic theory: shallow water equations	163
	5.3 Friction slope	167
	5.4 General considerations and some features of free surface flow	174
	References	194
	Problems	196
6	Overland flow	198
	6.1 The standard formulation	198
	6.2 Kinematic wave approach	201
	6.3 Lumped kinematic approach	210
	References	213
	Problems	213
7	Streamflow routing	216
	7.1 Two extreme cases of large flood wave propagation	217
	7.2 A lumped kinematic approach: the Muskingum method	224
	7.3 Estimation of the Muskingum parameters	232
	References	241
	Problems	242
 Part III Water below the surface		
8	Water beneath the ground: fluid mechanics in porous materials	249
	8.1 Porous materials	249
	8.2 Hydrostatics of pore-filling water in the presence of air	251
	8.3 Water transport in a porous material	268
	8.4 Field equations of mass and momentum conservation	287
	References	298
	Problems	303

CONTENTS	vii
9 Infiltration and related unsaturated flows	307
9.1 General features of the infiltration phenomenon	307
9.2 Infiltration in the absence of gravity: sorption	310
9.3 Infiltration capacity	326
9.4 Rain infiltration	332
9.5 Catchment-scale infiltration and other “losses”	343
9.6 Capillary rise and evaporation at the soil surface	346
References	357
Problems	361
10 Groundwater outflow and base flow	366
10.1 Flow in an unconfined riparian aquifer	366
10.2 Free surface flow: a first approximation	377
10.3 Hydraulic groundwater theory: a second approximation	382
10.4 Linearized hydraulic groundwater theory: a third approximation	398
10.5 Kinematic wave in sloping aquifers: a fourth approximation	415
10.6 Catchment-scale base flow parameterizations	416
References	431
Problems	433
Part IV Flows at the catchment scale in response to precipitation	
11 Streamflow generation: mechanisms and parameterization	441
11.1 Riparian areas and headwater basins	441
11.2 Storm runoff mechanisms in riparian areas	443
11.3 Summary of mechanisms and parameterization options	457
References	461
12 Streamflow response at the catchment scale	465
12.1 Stationary linear response: the unit hydrograph	465
12.2 Identification of linear response functions	472
12.3 Stationary nonlinear lumped response	493
12.4 Non-stationary linear response	498
References	501
Problems	503
13 Elements of frequency analysis in hydrology	509
13.1 Random variables and probability	509
13.2 Summary descriptors of a probability distribution function	511
13.3 Some probability distributions for discrete variables	519
13.4 Some probability distributions for continuous variables	523
13.5 Extension of available records	543
References	550
Problems	553

CONTENTS	viii
14 Afterword – a short historical sketch of theories about the water circulation on Earth	557
14.1 Earliest concepts: the atmospheric water cycle	557
14.2 Greek antiquity	559
14.3 The Latin era	566
14.4 From philosophy to science by experimentation	572
14.5 Closing comments	585
References	586
Appendix Some useful mathematical concepts	590
A1 Differentiation of an integral	590
A2 The general response of a linear stationary system	590
A3 The general response of a nonlinear system	597
References	598
<i>Index</i>	599