

TABLE OF CONTENTS

CHAPTER

I.	INTRODUCTION	1
II.	BOUNDARY-CONFORMING COORDINATE SYSTEMS	7
	1. Basic Concepts	7
	2. Generalization	15
	A. Boundary-value problem-physical region	16
	3. Transformed Region Configurations	19
	A. Simply-connected regions	20
	B. Multiply-connected regions	27
	C. Embedded regions	40
	D. Other configurations	51
	E. Three-dimensional regions	53
	4. Composite Grids	56
	A. Simply-connected regions	59
	B. Mutiply-connected regions	61
	C. Embedded regions	63
	D. Three-dimensional regions	66
	E. Overlaid grids	69
	5. Branch Cuts	70
	A. Point correspondence	70
	B. Derivative correspondence	71
	6. Implementation	76
	Exercises	91
III.	TRANSFORMATION RELATIONS	95
	1. Base Vectors	96
	A. Covariant	96
	B. Contravariant	97
	C. Orthogonality	98
	2. Differential Elements	99
	A. Covariant metric tensor	99
	B. Arc length element	100

C.	Surface area element	100
D.	Volume element	101
3.	Derivative Operators	102
A.	Divergence	104
B.	Curl	106
C.	Gradient	106
D.	Laplacian	107
4.	Relations Between Covariant and Contravariant Metrics	108
A.	Base vectors	108
B.	Metric tensors	109
5.	Restatement of Derivative Operators	110
A.	Conservative	111
B.	Non-conservative	114
6.	Normal and Tangential Derivatives	117
A.	Tangent to coordinate lines	117
B.	Normal to coordinate surfaces	118
C.	Normal to coordinate lines and tangent to coordinate surfaces	118
7.	Integrals	120
A.	Surface integral	120
B.	Volume integral	121
C.	Line integrals	121
8.	Two-Dimensional Forms	122
A.	Metric elements	122
B.	Transformation relations	124
9.	Time Derivatives	128
A.	First derivative	128
B.	Convective terms	129
C.	Second derivative	132
	Exercises	134
IV.	NUMERICAL IMPLEMENTATION	136
1.	Transformed Equations	136

2.	Discrete Representation of Derivatives	140
3.	Special Points	148
4.	Metric Identities	158
5.	Implementation Procedure	166
	Exercises	170
V.	TRUNCATION ERROR	171
1.	Order on Nonuniform Spacing	172
	A. Order with fixed distribution function	174
	B. Order with fixed number of points	176
2.	Effect of Numerical Metric Coefficients	177
3.	Evaluation of Distribution Functions	179
4.	Two-Dimensional Forms	180
	Exercises	185
VI.	ELLIPTIC GENERATION SYSTEMS	188
1.	Generation Equations	189
	A. Laplace system	191
	B. Poisson system	193
	C. Effect of boundary point distribution	195
	D. General Poisson-type systems	197
	E. Other systems	202
2.	Control Functions	205
	A. Attraction to coordinate lines/points	206
	B. Attraction to lines/points in space	212
	C. Evaluation along a coordinate line	215
	D. Evaluation on a coordinate surface	222
	E. Evaluation from boundary point distribution	226
	F. Iterative determination	228
3.	Surface Grid Generation Systems	237
	A. Surface grid generation	238
	B. Three-dimensional grids	249
4.	Implementation	251
	A. Difference equations	251

B.	Control functions	255
C.	Surface generation systems	260
	Exercises	263
VII.	PARABOLIC AND HYPERBOLIC GENERATION SYSTEMS	272
1.	Hyperbolic Grid Generation	272
2.	Parabolic Grid Generation	277
VIII.	ALGEBRAIC GENERATION SYSTEMS	279
1.	Unidirectional Interpolation	279
A.	Lagrange interpolation	280
B.	Hermite interpolation	282
C.	Other forms of polynomial interpolation	285
D.	Splines	288
E.	Tension splines	290
F.	B-splines	291
G.	Multi-surface interpolation	294
H.	Uniformity	303
I.	Functions other than polynomials	305
2.	Multi-Directional Interpolation	310
A.	Transfinite interpolation	310
B.	Projectors	315
	Exercises	327
IX.	ORTHOGONAL SYSTEMS	331
1.	General Formulation	332
2.	Two-Dimensional Orthogonal Coordinates	334
A.	Conformal systems	338
B.	Other systems	341
C.	Systems based on first-order equations	344
3.	Three-Dimensional Orthogonal Coordinates	345
4.	Nearly-Orthogonal Systems	346
	Exercises	348
X.	CONFORMAL MAPPING	350
1.	Construction by Finite-Differences	352

2.	Schwarz-Christoffel transformation	358
3.	Construction from Integral Equations	360
4.	Elementary Complex Transformations	363
XI.	ADAPTIVE GRIDS	367
1.	One-Dimensional Adaption	369
	A. Equidistribution	369
	B. Equidistribution by transformation	370
	C. Weight functions	378
2.	Multiple-Dimensional Adaption	387
	A. Adaption along fixed lines	387
	B. Uncoupled adaption	390
	C. Coupled adaption	390
	D. Weight functions	391
3.	Variational Approach	393
	A. Variational formulation	393
	B. Euler equations	398
	C. Brackbill-Saltzman construction	400
	D. Applications	410
	E. Extensions	412
4.	Other Approaches	413
	A. Attraction-Repulsion	414
	B. Reaction analogy	416
	C. Moving finite elements	417
5.	Correlations	417
	Exercises	419
APPENDICES		
A.	DIFFERENTIAL GEOMETRY OF SPACE CURVES AND SURFACES	422
B.	EULER EQUATIONS	437
C.	CODE DEVELOPMENT AND COMPUTER EXERCISES	450
REFERENCES		463
GRID ILLUSTRATION REFERENCE		470
INDEX		477