

Contents

Preface	xi
1 Mass flow sensing with heat waves	1
1.1 Air flow sensor	2
1.2 Steady-state heat transfer	3
1.3 Heat waves	4
1.4 Automotive air flow sensor model	6
1.5 Mathematical results	9
1.6 References	10
2 Mass transport in colloidal dispersions	12
2.1 Physical motivation	13
2.2 Modeling equilibrium	14
2.3 Kinetics: single component	17
2.4 Kinetics: multiple components	19
2.5 References	22
3 Crack propagation modeling	23
3.1 Crack propagation in a conductor	23
3.2 The hypersingular integrals	27
3.3 Open problems	30
3.4 References	31
4 Modeling of electrostatic bell sprayers	33
4.1 The coating process	33
4.2 Mathematical modeling	36
4.3 Numerical results	38
4.4 Future directions	39
4.5 References	40
5 Neural networks as controllers	41
5.1 Neural networks	41
5.2 Control of dynamical systems	44
5.3 Gradient methods for controller training	46

5.4 An example	48
5.5 The idle-speed control problem	49
5.6 Unresolved questions	51
5.7 References	52
6 Head-media interaction in magnetic recording	53
6.1 Head-tape interaction	53
6.2 The mathematical model	55
6.3 Test case	57
6.4 Open problems	59
6.5 References	61
7 Geometric path planning in rapid prototyping	62
7.1 Layered manufacturing	63
7.2 Offset curve representation	66
7.3 Pythagorean-hodograph (PH) curves	69
7.4 Bézier representation	70
7.5 References	74
8 Feature detection and tracking in three dimensional image analysis	75
8.1 Applications	75
8.2 Edge detection	78
8.3 Topographic classification	82
8.4 Image registration	83
8.5 Future research issues	83
8.6 References	84
9 Robot localization using landmarks	86
9.1 The position estimation problem	86
9.2 Linear position estimation	89
9.3 Open problems	92
9.4 References	93
10 Coordinates for mechanisms configuration spaces	95
10.1 Kinematics of closed-loop mechanisms	96
10.2 Mechanism coordinates; an example	98
10.3 Mechanism complexity	100
10.4 Mathematical modeling	101
10.5 Open problems	106
10.6 References	107

11 Pulse optimization for multi-user data communications	108
11.1 Multiple access	109
11.2 The single user case	111
11.3 The multiple user case	114
11.4 Coupled base stations	116
11.5 Open problems	118
11.6 References	119
12 Propagation of highly scattered radiation in tissue	120
12.1 Maxwell's equations	121
12.2 Radiation transport theory	122
12.3 Diffusion approximation	125
12.4 Imaging	127
12.5 References	128
13 Doping profiling by inverse device methods	130
13.1 Semiconductor devices	130
13.2 Measuring doping profile by direct measurements	136
13.3 PN junction	138
13.4 The inverse problem	142
13.5 References	145
14 Mathematical modeling in diffractive optics	147
14.1 The direct problem	149
14.2 Solution of the direct problem	151
14.3 Optimal design problem	156
14.4 Inverse problem	158
14.5 Diffractive optics in nonlinear media	161
14.6 Truncated periodic structure	163
14.7 References	163
15 Coping with complex boundaries	166
This chapter was written jointly by Jack F. Douglas and Avner Friedman	
15.1 Capacity and translational friction	167
15.2 Flow through duct having arbitrary cross-section	172
15.3 Effective properties of inhomogeneous media	177
15.4 References	182
16 A short random walk through polymer material behavior	186
16.1 Strain-stress relations	187
16.2 Molecular modeling	191
16.3 Open problems	195
16.4 References	197

17 Finite set statistics with applications to data fusion	198
17.1 Random sets	198
17.2 Single-sensor, single-target estimation	200
17.3 Multi-sensor, multi-target estimation	202
17.4 An example	203
17.5 References	205
18 Electromigration modeling for smart power applications	207
18.1 Universal Power Output Driver (UPOD)	207
18.2 Previous work	210
18.3 Electromigration	210
18.4 References	217
19 Maxwell's equations and the analysis of electromagnetic devices	218
19.1 Electromagnetic actuators	218
19.2 The Maxwell equations	221
19.3 The numerical scheme	225
19.4 References	227
20 Engineering modeling of batteries	229
20.1 Description of the battery cell	229
20.2 Mathematical modeling	234
20.3 Numerical results and open problems	237
20.4 References	239
21 Solutions to problems from previous parts	241
21.1 Part 6	241
21.2 Part 5	241
21.3 Part 3	242
21.4 Part 1	243
21.5 References	244
Index	245