

CONTENTS

Preface to the Third Edition	xv
Preface to the Second Edition	xix
Preface to the First Edition	xxi
Nomenclature	xxv
List of Acronyms	xxvii

Chapter 1 Overview	1
1.1 Virtual Engineering	2
1.2 Modeling of Flight Dynamics	5
1.3 Simulation of Aerospace Vehicles	10
References	15

PART 1 MODELING OF FLIGHT DYNAMICS

Chapter 2 Mathematical Concepts in Modeling	17
2.1 Classical Mechanics	17
2.2 Tensor Elements	24
2.3 Modeling of Geometry	42
2.4 Summary	54
References	55
Problems	55
Chapter 3 Frames and Coordinate Systems	61
3.1 Frames	61
3.2 Coordinate Systems	68
References	92
Problems	93

Chapter 4	Kinematics of Translation and Rotation	97
4.1	Rotation Tensor	97
4.2	Kinematics of Changing Times	115
4.3	Attitude Determination	132
References		144
Problems		144
Chapter 5	Translational Dynamics	155
5.1	Linear Momentum	155
5.2	Newtonian Dynamics	159
5.3	Transformations	169
5.4	Simulation Implementation	173
References		181
Problems		181
Chapter 6	Attitude Dynamics	187
6.1	Inertia Tensor	188
6.2	Angular Momentum	196
6.3	Euler's Law	205
6.4	Gyrodynamics	224
6.5	Summary	236
References		236
Problems		237
Chapter 7	Perturbation Equations	247
7.1	Perturbation Techniques	248
7.2	Linear and Angular Momentum Equations	250
7.3	Aerodynamic Forces and Moments	257
7.4	Perturbation Equations of Steady Flight	268
7.5	Perturbation Equations of Unsteady Flight	274
References		289
Problems		289
 PART 2 SIMULATION OF AEROSPACE VEHICLES		
Chapter 8	Three-Degrees-of-Freedom Simulation	291
8.1	Equations of Motion	292
8.2	Subsystem Models	298

8.3 Simulations	311
References	321
Problems	321
Chapter 9 Five-Degrees-of-Freedom Simulation	325
9.1 Pseudo-Five-DoF Equations of Motion	327
9.2 Subsystem Models	338
9.3 Simulations	384
References	405
Problems	406
Chapter 10 Six-Degrees-of-Freedom Simulation	411
10.1 Six-DoF Equations of Motion	412
10.2 Subsystem Models	448
10.3 Monte Carlo Analysis	512
10.4 Simulations	532
References	538
Problems	539
Chapter 11 Real-Time Applications	545
11.1 Flight Simulator	545
11.2 Hardware-in-the-Loop Facility	564
11.3 Wargaming	567
References	573
Appendix A Matrices	575
A.1 Matrix Definitions	575
A.2 Matrix Operations	576
A.3 Matrix Eigenvalues	578
Problems	578
Appendix B CADAC_FTN Primer	581
Appendix C Aerospace Simulations in C++	599
C.1 Introduction	599
C.2 C++ Architecture and Three-DoF Cruise Missile Simulation	599
C.3 High-Fidelity Missile and Aircraft Simulations	601
C.4 Advanced Components of Ascent Vehicles	603
References	605

Appendix D	Foundation of Tensor Flight Dynamics	607
D.1	Introduction	607
D.2	Derivation of the Rotational Time Derivative	608
D.3	Tensor Property of the Rotational Time Derivative	611
D.4	Euler Transformation	618
D.5	Conclusions	621
	References	622
Appendix E	CADAC++ Architecture	623
E.1	Introduction	623
E.2	Requirements	624
E.3	Architecture	626
E.4	Constructive Simulations	640
E.5	CADAC4	642
E.6	Conclusions	643
Index		645
Supporting Materials		663