

# Contents

---

Preface .....	vii
To the Reader .....	xi
Chapter 1 Introduction .....	1
1.1 Brief Historical Background .....	2
1.2 Mechanical Models .....	6
1.3 The Laws of Motion .....	13
1.4 Mass Center .....	18
1.5 Methodology .....	19
1.6 Notation .....	21
Exercise Series #1 .....	24
Chapter 2 Vectors and Moments .....	27
2.1 Free, Sliding, and Bound Vectors .....	28
2.2 Moments .....	30
2.3 Vector Systems .....	35
2.4 Equivalent Systems .....	43
2.5 Central Axis .....	49
2.6 Forces and Torques .....	60
2.7 Friction .....	66
Exercise Series #2 .....	76
Chapter 3 Kinematics .....	90
3.1 Differentiation of Vectors and Reference Frames .....	92

---

3.2	Angular Velocity of a Rigid Body .....	99
3.3	Use of Different Reference Frames .....	106
3.4	Angular Acceleration .....	114
3.5	Position, Velocity, and Acceleration .....	118
3.6	Kinematic Theorems .....	125
3.7	Motion of Particles .....	133
3.8	Rigid Body Motion .....	149
3.9	Rolling .....	161
3.10	Mechanical Systems .....	167
	Exercise Series #3 .....	183
	Exercise Series #4 .....	194
	Exercise Series #5 .....	197
Chapter 4	Dynamics of Particles .....	213
4.1	Dynamic Properties .....	214
4.2	Newton's Second Law .....	221
4.3	Plane Motion .....	237
4.4	Angular Momentum .....	242
4.5	Work and Potentials .....	247
4.6	Work and Energy .....	257
4.7	Impulse and Impact .....	264
4.8	Conservation Principles .....	276
	Exercise Series #6 .....	287
Chapter 5	Dynamics of Systems .....	297
5.1	Dynamic Properties .....	298
5.2	Force Systems .....	317
5.3	Equations of Motion .....	328
5.4	Continuous Systems .....	342
5.5	Work and Potentials .....	350
5.6	Work and Energy .....	361
5.7	Conservation Principles .....	367
5.8	Fluids .....	379
	Exercise Series #7 .....	387
Chapter 6	Inertia .....	400
6.1	Mass and Mass Center .....	401
6.2	Inertia Properties of a Particle .....	410
6.3	Inertia Properties of Systems and Bodies .....	418

---

6.4	Cartesian Coordinates	429
6.5	Transfer of Axes	439
6.6	Principal Directions of Inertia	447
	Exercise Series #8	461
	Exercise Series #9	470
Chapter 7	Dynamics of the Rigid Body	484
7.1	Dynamic Properties	485
7.2	Equations of Motion	498
7.3	Work on a Rigid Body	510
7.4	Work and Energy	520
7.5	Plane Motion	527
	Exercise Series #10	542
	Exercise Series #11	552
Chapter 8	Advanced Topics	563
8.1	Motion with a Fixed Point	564
8.2	Gyroscopic Motion	574
8.3	General Motion	601
8.4	Impulse and Impact	619
	Exercise Series #12	626
Appendix A	Linear Algebra	635
A.1	Scalars	636
A.2	Vectors	637
A.3	Tensors	648
A.4	Eigenvalues and Eigenvectors	656
	Exercise Series #13	661
Appendix B	Linkages	663
Appendix C	Properties of Inertia	668
C.1	Lines	672
C.2	Sections	673
C.3	Surfaces	682
C.4	Solids	684
Appendix D	Answers to the Exercises	691
Index		707