

CONTENTS



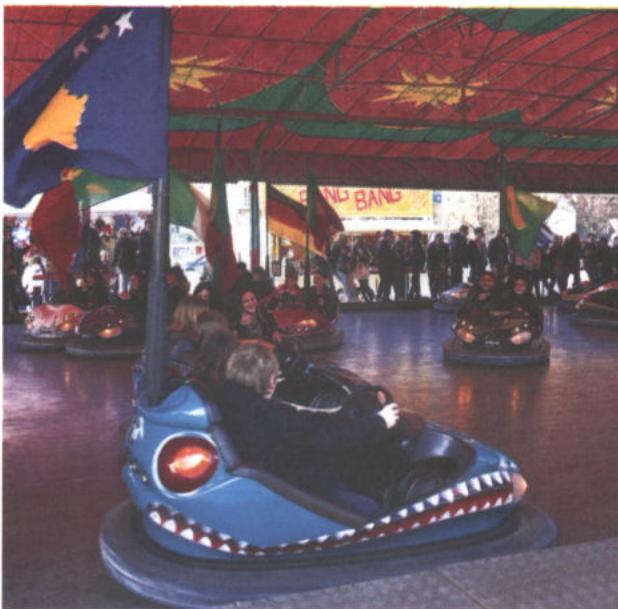
12 Kinematics of a Particle 3

Chapter Objectives 3
12.1 Introduction 3
12.2 Rectilinear Kinematics: Continuous Motion 5
12.3 Rectilinear Kinematics: Erratic Motion 19
12.4 General Curvilinear Motion 32
12.5 Curvilinear Motion: Rectangular Components 34
12.6 Motion of a Projectile 39
12.7 Curvilinear Motion: Normal and Tangential Components 53
12.8 Curvilinear Motion: Cylindrical Components 67
12.9 Absolute Dependent Motion Analysis of Two Particles 81
12.10 Relative-Motion of Two Particles Using Translating Axes 87



13 Kinetics of a Particle: Force and Acceleration 107

Chapter Objectives 107
13.1 Newton's Second Law of Motion 107
13.2 The Equation of Motion 110
13.3 Equation of Motion for a System of Particles 112
13.4 Equations of Motion: Rectangular Coordinates 114
13.5 Equations of Motion: Normal and Tangential Coordinates 131
13.6 Equations of Motion: Cylindrical Coordinates 144
***13.7** Central-Force Motion and Space Mechanics 155



14

Kinetics of a Particle: Work and Energy 169

- Chapter Objectives 169
- 14.1 The Work of a Force 169
- 14.2 Principle of Work and Energy 174
- 14.3 Principle of Work and Energy for a System of Particles 176
- 14.4 Power and Efficiency 192
- 14.5 Conservative Forces and Potential Energy 201
- 14.6 Conservation of Energy 205

15

Kinetics of a Particle: Impulse and Momentum 221

- Chapter Objectives 221
- 15.1 Principle of Linear Impulse and Momentum 221
- 15.2 Principle of Linear Impulse and Momentum for a System of Particles 228
- 15.3 Conservation of Linear Momentum for a System of Particles 236
- 15.4 Impact 248
- 15.5 Angular Momentum 262
- 15.6 Relation Between Moment of a Force and Angular Momentum 263
- 15.7 Principle of Angular Impulse and Momentum 266
- 15.8 Steady Flow of a Fluid Stream 277
- *15.9 Propulsion with Variable Mass 282

Review

1. Kinematics and Kinetics of a Particle 298



16 Planar Kinematics of a Rigid Body 311

Chapter Objectives 311
16.1 Planar Rigid-Body Motion 311
16.2 Translation 313
16.3 Rotation about a Fixed Axis 314
16.4 Absolute Motion Analysis 329
16.5 Relative-Motion Analysis: Velocity 337
16.6 Instantaneous Center of Zero Velocity 351
16.7 Relative-Motion Analysis: Acceleration 363
16.8 Relative-Motion Analysis using Rotating Axes 377



17 Planar Kinetics of a Rigid Body: Force and Acceleration 395

Chapter Objectives 395
17.1 Mass Moment of Inertia 395
17.2 Planar Kinetic Equations of Motion 409
17.3 Equations of Motion: Translation 412
17.4 Equations of Motion: Rotation about a Fixed Axis 425
17.5 Equations of Motion: General Plane Motion 440



18

Planar Kinetics of a Rigid Body: Work and Energy 455

- Chapter Objectives 455
- 18.1 Kinetic Energy 455
- 18.2 The Work of a Force 458
- 18.3 The Work of a Couple Moment 460
- 18.4 Principle of Work and Energy 462
- 18.5 Conservation of Energy 477



19

Planar Kinetics of a Rigid Body: Impulse and Momentum 495

- Chapter Objectives 495
- 19.1 Linear and Angular Momentum 495
- 19.2 Principle of Impulse and Momentum 501
- 19.3 Conservation of Momentum 517
- *19.4 Eccentric Impact 521

Review

2. Planar Kinematics and Kinetics of a Rigid Body 534



20 Three-Dimensional Kinematics of a Rigid Body 549

Chapter Objectives 549
20.1 Rotation About a Fixed Point 549
*20.2 The Time Derivative of a Vector Measured from Either a Fixed or Translating-Rotating System 552
20.3 General Motion 557
*20.4 Relative-Motion Analysis Using Translating and Rotating Axes 566



21 Three-Dimensional Kinetics of a Rigid Body 579

Chapter Objectives 579
*21.1 Moments and Products of Inertia 579
21.2 Angular Momentum 589
21.3 Kinetic Energy 592
*21.4 Equations of Motion 600
*21.5 Gyroscopic Motion 614
21.6 Torque-Free Motion 620



22 Vibrations 631

Chapter Objectives 631
*22.1 Undamped Free Vibration 631
*22.2 Energy Methods 645
*22.3 Undamped Forced Vibration 651
*22.4 Viscous Damped Free Vibration 655
*22.5 Viscous Damped Forced Vibration 658
*22.6 Electrical Circuit Analogs 661

Appendix

A. Mathematical Expressions 670
B. Vector Analysis 672
C. The Chain Rule 677

Fundamental Problems Partial Solutions and Answers 680

Answers to Selected Problems 701

Index 721