
CONTENTS

Preface v*List of Symbols* x**1 KINEMATICS OF PARTICLES 1**

- 1.1 Introduction 2
- 1.2 Rectilinear Kinematics: Position, Velocity, and Acceleration 2
- 1.3 Analysis of Rectilinear Motion from Known Velocity or Acceleration 9
- 1.4 Rectilinear Motion: Procedure for Analysis 15
- 1.5 Curvilinear Kinematics: Position, Velocity, and Acceleration 22
- 1.6 Curvilinear Motion: Rectangular Coordinates 25
- 1.7 Curvilinear Motion: Tangential and Normal Coordinates 30
- 1.8 Curvilinear Motion: Cylindrical Coordinates 35
- 1.9 Relative Motion 41
- 1.10 Dependent Motion 45
- 1.11 Summary 48
 - Key Terms 49
 - Problems 49

2 KINETICS OF PARTICLES: NEWTON'S SECOND LAW OF MOTION 69

- 2.1 Introduction 70
- 2.2 Newton's Second Law of Motion 70
- 2.3 Equation of Motion: Procedure for Analysis 73
- 2.4 Rectangular Coordinates 75
- 2.5 Tangential and Normal Coordinates 80
- 2.6 Cylindrical Coordinates 83
- 2.7 Summary 86
 - Key Terms 87
 - Problems 87

3 KINETICS OF PARTICLES: WORK AND ENERGY 98

- 3.1 Introduction 99
- 3.2 Work 99
- 3.3 Kinetic Energy of a Particle 106
- 3.4 Equation of Work and Kinetic Energy 106
- 3.5 Applications of the Work–Kinetic Energy Relationship 107
- 3.6 Conservative Force Fields: Potential Energy 113
- 3.7 The Equation of Work and Potential Energy: Conservation of Mechanical Energy 118

- 3.8 Power and Efficiency 123
- 3.9 Summary 128
- Key Terms 129
- Problems 129
- 4 KINETICS OF PARTICLES: IMPULSE AND MOMENTUM 144**
- 4.1 Introduction 145
- 4.2 Linear Momentum and Impulse 145
- 4.3 Conservation of Linear Momentum 150
- 4.4 Impulsive Motion 150
- 4.5 Impact 155
- 4.6 Angular Momentum and Impulse 161
- 4.7 Conservation of Angular Momentum 164
- *4.8 Central Force Field 167
- 4.9 Summary 177
- Key Terms 179
- Problems 179
- 5 KINETICS OF SYSTEMS OF PARTICLES 191**
- 5.1 Introduction 192
- 5.2 Equation of Motion for a System of Particles 192
- 5.3 Equation of Work and Kinetic Energy for a System of Particles 196
- 5.4 Equation of Linear Impulse and Momentum for a System of Particles 202
- 5.5 Equation of Angular Impulse and Momentum for a System of Particles 207
- *5.6 Systems with Steady Mass Flow 212
- *5.7 Systems with Variable Mass Flow 217
- 5.8 Summary 222
- Key Terms 224
- Problems 224
- 6 KINEMATICS OF RIGID BODIES 238**
- 6.1 Introduction 239
- 6.2 Translation of a Rigid Body 241
- 6.3 Rotation of a Rigid Body About a Fixed Axis 241
- 6.4 General Planar Motion Relative to a Translating Frame of Reference 247
- 6.5 Absolute and Relative Velocities 249
- 6.6 Instantaneous Center of Zero Velocity 252
- 6.7 Absolute and Relative Accelerations 256
- 6.8 General Planar Motion Relative to a Rotating Frame of Reference 260
- *6.9 Rotation of a Rigid Body about a Fixed Point 268
- *6.10 General Spatial Motion Relative to a Translating Frame of Reference 270
- *6.11 General Spatial Motion Relative to a Rotating Frame of Reference 271
- 6.12 Summary 278
- Key Terms 280
- Problems 281
- 7 KINETICS OF RIGID BODIES IN PLANAR MOTION: FORCE, MASS, AND ACCELERATION 302**
- 7.1 Introduction 303
- 7.2 General Equations of Planar Motion 303
- 7.3 Special Cases: Frictional Rolling and Planar Motion of Connected Bodies 306
- 7.4 Pure Translational Motion 308
- 7.5 Pure Rotational Motion 309
- 7.6 Summary 323
- Key Terms 324
- Problems 324
- 8 KINETICS OF RIGID BODIES IN PLANAR MOTION: WORK-ENERGY AND IMPULSE-MOMENTUM METHODS 340**
- 8.1 Introduction 341
- 8.2 Work-Kinetic Energy Relationship for a Rigid Body in Planar Motion 341
- 8.3 Conservation of Mechanical Energy 353
- 8.4 Power 354
- 8.5 Impulse-Momentum Relationships for a Rigid Body in Planar Motion 359
- 8.6 Conservation of Momentum 367
- 8.7 Eccentric Impact 371
- 8.8 Summary 377
- Key Terms 379
- Problems 379
- 9 SPATIAL DYNAMICS 399**
- *9.1 Introduction 400
- *9.2 Linear and Angular Momenta of a Three-Dimensional Rigid Body 400

*9.3	Kinetic Energy of a Three-Dimensional Rigid Body	411
*9.4	Fundamental Equations of Motion of a Three-Dimensional Rigid Body	417
*9.5	Gyroscopic Motion	425
*9.6	Summary	434
	Key Terms	437
	Problems	438
10	INTRODUCTION TO VIBRATION	455
*10.1	Introduction	456
*10.2	Undamped Free Vibration	456
*10.3	Rotational Vibration	463
*10.4	Energy Method	466
*10.5	Undamped Forced Vibration	470
*10.6	Damped Free Vibration	475
*10.7	Damped Forced Vibration	479
*10.8	Electrical Analogue	482
*10.9	Summary	482
	Key Terms	484
	Problems	484
	Appendix	494
A	SI Prefixes	494
B	Conversion Factors	495
C	Specific Weight of Common Materials	496
D	Mathematical Expressions	497
E	Properties of Areas and Homogeneous Bodies	500
	Answers to Selected Problems	506
	Index	513