BRIEF TABLE OF CONTENTS

PREFACE		xii
FEATURES	xvi	
ACKNOWLED	ХХ	
ABOUT THE A	xxi	
REVIEWERS		xxii
Chapter 1	Biomechanics and Related Movement Disciplines	1
Chapter 2	Describing the System and Its Motion	21
Chapter 3	Paradigms for Studying Motion of the System	60
Chapter 4	Interaction of Forces and the System	102
Chapter 5	Linear Motion of the System	144
Chapter 6	Angular Motion of the System	181
Chapter 7	System Balance and Stability	222
Chapter 8	The System as a Machine	248
Chapter 9	System Motion in a Fluid Medium	273
Chapter 10	The System as a Projectile	308
Chapter 11	Biomechanics of the Musculoskeletal System	343
Chapter 12	Connection by Application	397
APPENDIX A KEY EQUATIONS		423
APPENDIX B CONVERSION FACTORS		434
APPENDIX C ANSWERS TO ODD-NUMBERED PRACTICE PROBLEMS		437
GLOSSARY	439	
INDEX		451
WORKBOOK		473

TABLE OF CONTENTS

PREFACE		xii
FEATURES		xvi
ACKNOWLED	GMENTS	хх
ABOUT THE A	UTHORS	ххі
REVIEWERS		ххіі
Chapter 1	 Biomechanics and Related Movement Disciplines 1.1 Benefits of A Comprehensive Understanding of Biomechanics 1 1.2 Understanding the Discipline of Biomechanics 2 1.3 Relationship of Biomechanics to Other Movement Disciplines 6 Exercise Physiology 7 Motor Behavior 9 Ergonomics 13 Injury Science 13 Pedagogy 16 Adapted Motion 17 	1
Chapter 2	Describing the System and Its Motion	21
	Concepts	22
	 2.1 Introduction to the System 22 Anthropometry 23 2.2 Anatomical Terminology 27 Anatomical Position 27 Directional Terms 28 2.3 System Orientation 28 Planes of System Motion 28 Axes of System Motion 29 Planes, Axes, and the Center of Gravity 29 Spatial Frames of Reference 30 Degrees of Freedom 33 2.4 Motion at Segmental Links 34 Motions in Sagittal Planes 36 Motions in Frontal Planes 36 Motions in Transverse Planes 39 Motions in Oblique and Multiple Planes 40 	
	Use of Terminology 40 2.5 The Movement Environment 42 Closed Skills 42 Open Skills 42 2.6 Types of Movement 43 Linear and Angular Motion 43 Discrete, Continuous, and Serial Skills 45	

	Coni 2.7 2.8 2.9	Gross and Fine Motor 47 Kinetic Chain 49 Compensatory Motion 51 nections Exercise Physiology 53 Motor Behavior 55 Motor Control 55 Motor Development 55 Motor Learning 56 Pedagogy 56 Adapted Motion 57	53
Chapter 3	Para	digms for Studying Motion of the System	60
	Con	cepts	61
	3.1	Qualitative Motion Analysis 61 Composite Approach 62 Component Approach 64 Quantitative Motion Analysis 64	
		Scalars, Vectors, and Force 66 Special Properties of Vectors 72 Graphical Methods of Vector Analysis 74 Trigonometric Methods of Vector Analysis 83	
		nections	88
	3.4 3.5 3.6	Functional Anatomy 88 Injury Science 91 Motor Behavior 93 Motor Control 93 Motor Development 93 Motor Learning 94 Pedagogy 94 Adapted Motion 97	
Chapter 4	Inte	raction of Forces and the System	102
		cepts	103
		Properties of Force 103 Introduction to Newtonian Laws 104 Newton's First Law: Law of Inertia 104 Newton's Second Law: Fundamental Law of Dynamics or Law of Acceleratio Newton's Third Law: Law of Reciprocal Actions or Law of Action–Reaction Newton's Law of Universal Gravitation: Law of Gravitation, or Law of Attraction Types of Forces Affecting System Motion 106 Noncontact (Field) Forces 107 Contact Forces 108 External and Internal Forces 108	105
	4.4	Action and Reaction Forces 109 Force, Force Application, and Material Properties 109 Gravity 110 Friction 111 Pressure Versus Force 117 Stress, Strain, and Elasticity 120 Fluid Forces 128	

	4.5	Resultant Force 130		
		Motive and Resistive Forces 130		
		Centripetal and Centrifugal Forces 131		
	Connections			
	4.6	Human Performance and Injury Science 132		
		Exercise Physiology 132		
		Functional Anatomy 133		
		Sport Science 134		
	4.7	Motor Behavior 135		
		Motor Development 135		
	4.8	Pedagogy 136		
		Teaching 136		
		Coaching 137		
	4.9	Adapted Motion 138		
		Adapted Physical Education 138		
		Prosthetics 138		
Chapter 5	Lin	opr Mation of the System	144	
Chapter 5		ear Motion of the System		
	Cor	ncepts	145	
	5.1	Linear Kinematics 145		
		Linear Distance and Displacement 145		
		Linear Speed and Velocity 146		
		Linear Acceleration 147		
	5.2	Linear Kinetics and Newtonian Laws 148		
		Application of the Newtonian Laws 148		
		Linear Momentum and Linear Impulse 153		
	5.3			
		Work 161		
		Power 162		
		Potential Energy 163		
		Kinetic Energy 165		
	_	Conservation of Mechanical Energy 168		
	Cor	nnections	169	
	5.4	Human Performance and Injury Science 169		
		Sport Science 169		
		Injury Science 171		
	5.5	Motor Behavior 172		
		Motor Development 172		
		Motor Learning 172		
	5.6	Pedagogy 174		
		Teaching 174		
		Coaching 175		
	5.7	Adapted Motion 175		
		Adapted Physical Education 175		
		Prosthetics 176		
Chapter 6	Ang	gular Motion of the System	181	
		ncepts	182	
	6.1			
	6.1 6.2	Torque and Angular Motion 182 Torque and the Center of Gravity 186		
	0.2	Indue and the Denter of Gravity 100		

	 6.3 Angular Kinematics 188 Angular Distance and Displacement 188 Angular Speed and Velocity 190 Angular Acceleration 192 Centripetal Acceleration 193 6.4 Angular Kinetics and Newtonian Laws 194 Application of the Newtonian Laws 194 Angular Momentum and Angular Impulse 202 6.5 Angular Kinetics and Energy Transfer 207 Work 207 Power 208 Kinetic Energy 209 Conservation of Mechanical Energy 209 		
		211	
	6.6 Human Performance and Injury Science 211 Functional Anatomy 211 Sport Science 211 Injury Science 214		
	6.7 Motor Behavior 216 Motor Development 216 Motor Learning 216		
	6.8 Adapted Motion 217		
Chapter 7	System Balance and Stability	222	
		223	
		223	
	 7.1 Equilibrium, Stability, and Balance 223 Static Equilibrium 224 Dynamic Equilibrium 226 Stable Equilibrium 228 Unstable Equilibrium 228 Neutral Equilibrium 229 		
	7.2 Linear Stability 229		
	Linear Stability and External Forces 230		
	 7.3 Rotational Stability 231 Rotational Stability and the Center of Gravity 231 Rotational Stability and the Base of Support 234 Rotational Stability and Mass 238 		
	7.4 Stability and Energy Transfer 238		
	Connections 23		
	7.5 Injury Science 239		
	Physical and Occupational Therapy 239 7.6 Motor Behavior 241 Motor Development 241 Motor Control 243		
	7.7 Pedagogy 243		
	7.8 Adapted Motion 244 Adapted Physical Education 244 Pregnancy 245		

Chapter 8	The	System as a Machine	248
	Con	cepts	249
	8.1 8.2	Musculoskeletal Analogy of Machines 249 Lever Systems 250 First-Class Lever Systems 251 Second-Class Lever Systems 255 Third-Class Lever Systems 256	
	8.3	Pulley Systems 260	
	8.4	Wheel-and-Axle Systems 262	
	Con	nections	265
	8.5	Human Performance 265 Sport Science 265	
	8.6	Ergonomics 269	
	8.7	Spinal Loading 269 Adapted Motion 270 Adapted Sport Science 270	
Chapter 9	Syst	em Motion in a Fluid Medium	273
	Con	cepts	274
	9.1	Buoyant Fluid Force 274 Density 276 Specific Gravity 277 Floating Position 279	
	9.2	Dynamic Fluid Force 282 Relative Motion 282 Viscosity 283 Drag 283 Lift 291	
	Con	nections	296
	9.3	Human Performance 296 Exercise Physiology 296 Sport Science 297	
	9.4	Veterinary Medicine 304	
Chapter 10	The	System as a Projectile	308
Stub ter 10	_	cepts	309
	10.1		
	10.2	Projectile Trajectory 314 Projection Angle 315 Projection Velocity 317 Projection Height 319	
	10.3	Laws of Uniformly Accelerated Motion 320	
		Projection for Vertical Distance 322 Projection for Horizontal Distance 324	
		Projection for Accuracy 328	

	Connections	331
	10.7 Human Performance 331 Sport Science 331 Dance 335	
	10.8 Motor Behavior 337 Motor Development 337	
Chapter 11	Biomechanics of the Musculoskeletal System	343
	Concepts	344
	 11.1 Review of Muscle Physiology 344 Muscle Structure and Function 344 Muscle Structure 344 The Neuromuscular Junction and Excitation-Contraction Coupling 352 Muscle Contraction 352 Muscle Relaxation 356 Types of Muscle Actions 359 Factors Related to Contractile Force 359 The Motor Unit 359 Neural Stimulation Frequency 360 Length-Tension Relationship 362 Force-Velocity Relationship 364 The Compromise for Power 365 The Stretch-Shorten Cycle 365 	
	 11.2 Biomechanics of Muscle Location, Origin, and Insertion 366 Uniarticular Versus Multiarticular Muscles 367 Active and Passive Insufficiency 367 Degrees of Freedom 368 Agonists Versus Antagonists 368 Angle of Muscle Pull 371 Rotary and Stabilizing Components 371 Moment Arm Length 377 Anatomical Force Couples 378 11.2 Biomechanica of Muncle Arabitecture 270 	
	11.3 Biomechanics of Muscle Architecture 379Muscle Fiber Arrangement and Length 37911.4 The System as a Human 385	
	Human Skeletal Link System 385 Human Skeletal and Muscular System Interaction 387 Human Limb Shape 388 Limb Mass 388 Limb Mass Distribution 389	
	Connections	391
	11.5 Exercise Science 39111.6 Physical Education 39111.7 Physical Therapy 392	

Chapter 12	Connection by Application	397
	The Final Connections 398	
	Golf	398
	 12.1 Chapter 1: Biomechanics and Related Movement Disciplines 398 12.2 Chapter 2: Describing the System and Its Motion 399 12.3 Chapter 3: Paradigms for Studying Motion of the System 402 12.4 Chapter 4: Interaction of Forces and the System 403 12.5 Chapter 5: Linear Motion of the System 406 12.6 Chapter 6: Angular Motion of the System 409 12.7 Chapter 7: System Balance and Stability 412 12.8 Chapter 8: The System as a Machine 414 12.9 Chapter 9: System Motion in a Fluid Medium 415 12.10 Chapter 10: The System as a Projectile 417 12.11 Chapter 11: Biomechanics of the Musculoskeletal System 418 	
	Soccer	418
	Skills 419 Equipment And Injury 420	
APPENDIX A	KEY EQUATIONS	423
APPENDIX B	CONVERSION FACTORS	434
APPENDIX C	ANSWERS TO ODD-NUMBERED PRACTICE PROBLEMS	437
GLOSSARY		439
INDEX		451
WORKBOOK		473