

CONTENTS

PART ONE
THEORETICAL MECHANICS

Introduction	13
1. Mechanical Motion	13
2. The State of Rest As a Relative Phenomenon	13
3. Fundamental Elements of Mechanics	14
4. Basic Units of Measure Used in Mechanics	14
5. A Material Point and a Solid Body	15
6. The Science of Mechanics	15
7. Chief Stages in the Historical Development of Mechanics	16

STATICS

Chapter I. Fundamentals of Force, and an Introduction to Statics

8. Forces	21
9. Statics	21
10. Elements Which Determine a Force	22
11. Graphic Method of Representing Forces	24
12. A System of Forces and Its Resultant	25
13. Two Equal Forces Acting in Opposite Directions Along a Straight Line Connecting Their Points of Application Are in Equilibrium	25
14. The Point of Application May Be Altered Along the Line of Action of a Force	26
15. Equilibrant of a Force	26
16. Composition of Collinear Forces	27
17. Constraints and the Reactions of Constraints	28
18. Questions for Review	29
19. Exercises	29

Chapter II. Coplanar System of Concurrent Forces

20. Finding the Resultant of Two Forces Acting at an Angle	30
21. Resolving a Force into Two Components Applied at One Point and Acting at an Angle	33

22. The Composition of Several Forces Lying in One Plane and Intersecting at One Point	35
23. Equilibrium of a System of Coplanar Forces Intersecting at One Point	38
24. Lines of Action of Three Non-Parallel Balanced Coplanar Forces that Intersect at One Point	40
25. Questions for Review	40
26. Exercises	41

Chapter III. Coplanar Parallel Forces, and the Moment of a Force

27. Composition of Parallel Forces Acting in One Direction	42
28. Composition of Parallel Forces Acting in Opposite Directions ...	44
29. Resolution of a Force into Parallel Components	46
30. The Centre of Coplanar Parallel Forces	47
31. Moment of a Force in Respect to a Point	48
32. Moment of a Resultant	50
33. The Couple	51
34. Equilibrium of a Coplanar System of Parallel Forces	53
35. The Moment of a Force in Respect to an Axis	57
36. Questions for Review	58
37. Exercises	58

Chapter IV. Centre of Gravity, and Stability of Bodies

38. Centre of Gravity, and Centre of Parallel Forces	59
39. Centre of Gravity of Certain Bodies of Simple Form	60
40. Centre of Gravity of Plane Figures	62
41. Practical Method of Determining the Centre of a Plate	64
42. The Stability of a Body Having a Point or an Axis as Support ..	65
43. The Stability of a Body on a Horizontal Surface	68
44. Questions for Review	70
45. Exercises	71

Chapter V. Friction

46. Harmful Frictional Resistance	72
47. Sliding and Rolling Friction	73
48. Basic Laws of Sliding Friction, and the Coefficient of Sliding Friction	74
49. Dry and Fluid Friction	77
50. Coefficient of Rolling Friction	78
51. Function of Friction in Nature and in Engineering	80
52. Questions for Review	81
53. Exercises	81

KINEMATICS

Chapter VI. The Trajectory of a Particle. Displacement and Time

54. Fundamentals of Kinematics	83
55. Trajectories and Their Influence on Principal Types of Motion ..	83

56. Determining the Distance Traversed by a Point According to Its Positions on the Trajectory	85
57. Plotting a Trajectory According to Given Coordinates	86
58. The Displacement-Time Graph	87
59. Questions for Review	89
60. Exercises	89

Chapter VII. Rectilinear Motion of a Particle

61. Uniform Motion	90
62. Velocity and Displacement When Motion Is Uniform	91
63. The Graph Illustrating Displacement and Velocity for Uniform Motion	92
64. Variable (or Non-Uniform) Motion, and Averages of Velocity and Acceleration	95
65. Uniformly-Variable Motion. Velocity and Acceleration	97
66. Displacement When Motion Is Uniformly Accelerated	97
67. Vertical Motion Under the Force of Gravity	101
68. Questions for Review	103
69. Exercises	104

Chapter VIII. The Composition of Simple Motions of a Particle

70. Compound Motion, and Absolute and Relative Motion	104
71. The Composition of Uniform Collinear Motions	106
72. The Composition of Rectilinear Uniform Motions Which Are at an Angle to One Another	108
73. Resolving a Velocity into Its Components	110
74. Questions for Review	111
75. Exercises	111

Chapter IX. Curvilinear Motions of a Particle

76. Uniform and Non-Uniform Curvilinear Motion of a Particle ...	112
77. The Velocity of a Particle Possessing Curvilinear Motion	112
78. Acceleration of a Particle Possessing Curvilinear Motion	113
79. Tangential and Normal Acceleration	114
80. Normal Acceleration of a Particle Possessing Uniform Circular Motion	116
81. Total Acceleration of a Particle Moving in a Circle	117
82. Questions for Review	118
83. Exercises	118

Chapter X. Simple Motions of a Hard Body

84. The Difference Between the Motion of a Hard Body and That of a Particle	119
85. Linear Translation	119
86. Rotation of a Body Around a Fixed Axis, and Angular Displacement	121
87. Angular Velocity and Angular Acceleration	122
88. Linear Velocity of the Points of a Rotating Body	123

89. Uniform Rotation of a Body Around a Fixed Axis	123
90. Diagrams Showing the Relationship Between Peripheral Velocity, Diameter, and Number of Revolutions	126
91. Uniformly-Accelerated Rotation of a Body Around a Fixed Axis	127
92. Questions for Review	129
93. Exercises	129

DYNAMICS

Chapter Xf. Fundamentals of Dynamics

94. Definition of Dynamics	130
95. The First Law of Mechanics (Newton's First Law).....	130
96. The Basic Equation of Dynamics (Newton's Second Law) ...	131
97. Law of the Independent Action of Forces	133
98. Propositions Deduced From the Laws of Mechanics	135
99. Units of Measure in Engineering and Physics	136
100. Relationship Between Mass and Weight of a Body	137
101. Law of Action and Reaction (Newton's Third Law)	138
102. Questions for Review	139
103. Exercises	140

Chapter XII. Introduction to Dynamics of a Material Point

104. Dynamics of a Material Point	140
105. The Action of the Force of Gravity on the Motion of a Vertically-Projected Body	141
106. The Motion of a Body Thrown Upwards at an Angle to the Horizon	141
107. Tangential and Normal Forces When a Particle Moves in a Circular Trajectory	144
108. Inertial Forces	145
109. Inertial Forces in Rectilinear Motion of a Particle	146
110. Inertial Forces Acting Upon a Particle Moving in a Circular Trajectory	147
111. Forces of Inertia as Applied in Engineering	150
112. Questions for Review	151
113. Exercises	152

Chapter XIII. Work and Power

114. Definition of Work	153
115. Measurement of Work	153
116. Work Done by a Resultant Force	155
117. Graphic Representation of Work	156
118. Indicator-Diagram for Heat-Propelled Engines	159
119. Work Done by a Rotating Force of Constant Magnitude	160
120. Power and Its Units of Measurement	162
121. Power and Uniform Motion of Translation	163
122. Power in Uniform Rotation of a Body	163

123. Relationship Between Turning Moment, Power Transmitted, and Number of Revolutions	165
124. Questions for Review	167
125. Exercises	167

Chapter XZV. Mechanical Energy

126. Kinetic Energy	168
127. Kinetic Energy of a Body Possessing Motion of Translation ...	169
128. The Energy of a Body Moving Under the Force of Gravity. Potential Energy	172
129. Kinetic Energy of a Body Rotating Around a Fixed Axis	174
130. Governing an Engine. The Function of the Flywheel	176
131. Mechanical Efficiency	177
132. „Perpetual Motion” as an Impossibility	178
133. Impact	179
134. Impact of a Freely Falling Hammer	180
135. Questions for Review	182
136. Exercises	182

PART TWO

THE THEORY OF MACHINES AND FUNDAMENTAL CONCEPTS OF STRAIN

THE THEORY OF MACHINES

Introduction	185
137. Machines and Mechanism	185
138. Historical Survey of Machine Engineering in Russia	186

Chapter XV. The Inclined Plane, the Pulley, and the Windlass

139. The Inclined Plane	190
140. The Wedge	193
141. The Lever	194
142. A System of Levers. The Differential Lever	197
143. Fixed and Movable Pulleys	199
144. Systems of Pulleys and the Differential Pulley Block	201
145. Simple and Differential Windlasses	203
146. Questions for Review	205
147. Exercises	205

Chapter XVI. Transmission of Power Between Parallel Shafts

148. General Principles of Transmission	206
149. Transmission Through Pliant Connectors	207
150. The Speed Ratio and Transmission Number in Transmission Through Pliant Connectors	208
151. Kinematics of Transmission with One Pair of Sheaves	209
152. Kinematics of Transmission with More than One Pair of Sheaves	210

153. Statics of Sheave Transmission	210
154. Belt Transmission with Variable Speed Ratios	212
155. Transmission with a Belt Tightener	215
156. Flat and V-Shaped Belts	215
157. Chain Transmission	217
158. Friction Transmission Between Parallel Shafts	217
159. Friction Transmission with a Variable Speed Ratio	220
160. Spur Gears	222
161. Speed Ratio and the Transmission Number of Toothed Gears ..	222
162. Kinematics of Drives Possessing More than One Pair of Gears	224
163. Statics of Toothed-Gear Transmission	227
164. Idler Gears	228
165. Spur-Gear Differential Mechanisms	231
166. The Geometry of Toothed Gearing	232
167. Chief Forms of Spur-Gear Teeth	235
168. Intermittent Transmission of Rotation	236
169. Questions for Review	237
170. Exercises	238

Chapter XVII. Transmission Between Non-Parallel Shafts

171. Transmission of Rotation Between Non-Parallel Shafts Through Pliant connectors	241
172. Friction Transmission Between Non-Parallel Shafts	241
173. Bevel-Gear Transmission	245
174. The Screw	247
175. Helical-Gear and Worm-Gear Transmission	250
176. The Universal Joint	253
177. Questions for Review	254
178. Exercises	255

Chapter XVIII. Conversion of Rotation into Linear Translation and Vice Versa

179. Conversion of Rotation into Linear Translation	256
180. Friction Mechanisms for Obtaining Linear Translation	256
181. The Rack-and-Pinion	257
182. Kinematics of the Screw-and-Nut Drive	259
183. Statics of the Screw-and-Nut Drive	262
184. Thread Profiles of Principal Types of Transmission Screws ...	263
185. Slider-Crank Mechanism	265
186. Kinematics of the Slider-Crank Mechanism	266
187. The Eccentric Mechanism	270
188. The Rocker-Arm Mechanism	271
189. Kinematics of the Rocker-Arm Mechanism	272
190. The Cam Mechanism	274
191. Determining the Working Surface of a Disc Cam	376
192. Questions for Review	278
193. Exercises	280

Chapter XIX. Auxiliary Parts Employed in Transmitting Rotation

194. Axles and Shafts and Their Components	281
195. Main Types of Sliding Bearings	283
196. Antifriction Bearings	283
197. Couplings	285
198. Questions for Review	285

Demountable Connections

199. Threaded Connections	285
200. Threads for Connections	285
201. Tapered-Pin Connections	287

STRENGTH OF MATERIALS

Chapter XXI. Basic Principles

202. Stress and Strain in a Body Under the Action of External Forces	290
203. External and Internal Forces, and the Cross-Section Method ..	291
204. Internal Forces of Elasticity	293
205. Stress in Strained Bodies	293
206. Ultimate Strength and Safe Stresses	294
207. Static and Dynamic Loads	295
208. Chief Types of Strain	296
209. Questions for Review	296

Chapter XXII. Tension and Compression

210. Tension. Absolute and Unit Elongation	296
211. Transverse Strain of a Body Under the Action of a Tensile Force	297
212. The Tensile-Stress Diagram	298
213. Relationship Between Stress and Unit Elongation. The Modulus of Elasticity ,.....	300
214. Compression	302
215. Design Formulae for Allowable Tensile and Compressive Stresses	302
216. Compression end Buckling	304
217. Questions for Review ,.....	305
218. Exercises	305

Chapter XXIII. Shear and Torsion

219. Shear (Strain in Lateral Displacement)	306
220. Determining the Amount of Shear Strain, and the Modulus of Elasticity for Shear	307
221. Allowable Shear	308
222. Punching of Metals and Cutting Them with Steel Blades	309
223. Torque	310
224. Torque As a Form of Shear	311
225. Distribution of Torsional Stress in a Plane Circular Section ...	311
226. The Fundamental Equation for Torque	313

227. Computing the Dimensions of Shafts for a Given Torsion	316
228. Questions for Review	317
229. Exercises	317

Chapter XXIV. Bending

230. The Nature of Bending Strain	318
231. Distribution of Normal Stresses During Bending. The Neutral Plane	320
232. The Fundamental Equation for Bending	322
233. The Bending Moment	324
234. Questions for Review	327

Chapter XXV. General Principles of Combined Strain

235. Simple and Combined Strain	327
236. Combined Tension, Compression, and Bending Strains	328
237. Combined Torsion and Bending Strains	329
Supplements	331
Answers to Exercises	333