620.1 HUD

CONTENTS

PART 1. MECHANICS OF A PARTICLE

CHAPTER 1. INTRODUCTION

1.1 Nature of mechanics 1
1.2 Methods of mechanics 1
1.3 Basic concepts 4
1.4 Units 7
1.5 Brief history of mechanics 7

CHAPTER 2. ELEMENTARY VECTOR ALGEBRA

2.1 Introduction 9
2.2 Equality of vectors 10
2.3 Addition of vectors 11
2.4 Multiplication of a vector by a scalar 13
2.5 Subtraction of vectors 14
2.6 Null vector 14
2.7 Unit vector 15
2.8 Components of a vector 15
2.9 Vectors in rectangular coordinate systems 19
2.10 The position vector of a particle 24
2.11 Discussion 24

CHAPTER 3. CONCURRENT FORCE SYSTEMS

3.1 Introduction 28
3.2 Resultant of a group of forces 28
3.3 Concurrent forces in a plane 29
3.4 Concurrent forces in space 34

CHAPTER 4. EQUILIBRIUM OF A PARTICLE

4.1 Introduction 40
4.2 Newton's First Law 40
4.3 Equilibrium in a plane 42
4.4 Equilibrium in space 45
4.5 Static friction 48
4.6 Impending motion 52

CHAPTER 5. KINEMATICS OF A PARTICLE

5.1 Introduction to vector calculus 58
5.2 Velocity and acceleration 64
5.3 Rectilinear motion 67
5.4 Curvilinear motion in a plane 74
5.5 Curvilinear motion in space 78
5.6 Cylindrical coordinates 78

CHAPTER 6. KINETICS OF A PARTICLE

6.1 Introduction 90
6.2 Newton's Second Law 90
6.3 Rectilinear motion 94
6.4 Kinetic friction 96
6.5 Curvilinear motion in a plane 98
6.6 Curvilinear motion in space 100
6.7 Cylindrical coordinates 101
6.8 Gravitation 103

PART 2. MECHANICS OF RIGID BODIES

CHAPTER 7. PRODUCTS OF VECTORS

7.1 Multiplication of two vectors 115
7.2 Scalar product of two vectors 115
7.3 Vector product of two vectors 120
7.4 Scalar triple product 123
7.5 Differentiation of products 124

CHAPTER 8. NONCONCURRENT FORCE SYSTEMS

8.1 Moment of a force 127
5.2 Moments of several forces 132
8.3 Couples 134
8.4 Mechanical equivalence 137
8.5 The resultant of a nonconcurrent force system . 141

CHAPTER 9. CENTER OF MASS, CENTER OF GRAVITY, AND CENTROID

9.1 Systems of particles 146
9.2 Centroids of geometrical shapes 149
9.3 Centroid of an area 151
9.4 Centroid of a volume 158
9.5 Continuous bodies 163
9.6 Distributed forces 170

CHAPTER 10. SECOND MOMENTS OF MASSES AND AREAS

10.1 Systems of particles 178
10.2 Second moments of areas 179
10.3 Rotation of axes 187
10.4 Pressure on submerged areas 192
10.5 Continuous bodies 193

CHAPTER 11. EQUILIBRIUM OF RIGID BODIES

11.1 Introduction 207
11.2 Newton's Third Law 207
11.3 Equations of equilibrium 210
11.4 Equilibrium of rigid bodies in a plane 213

11.5 Classification of rigid bodies 220
11.6 Equilibrium of rigid bodies in space 223
11.7 Sufficiency of equations of equilibrium 227

CHAPTER **12.** KINEMATICS OF RIGID BODIES

12.1 Introduction 236
12.2 Relative motion of two particles 236
12.3 Motion of a rigid body parallel to a plane 239
12.4 Rolling without slipping 251

CHAPTER **13.** KINETICS OF RIGID BODIES

13.1 Motion of a system of particles 258
13.2 Equations of motion for a rigid body in plane motion . . . 260
13.3 Translation 264
13.4 Rotation 266
13.5 General plane motion 269

PART **3.** MECHANICS OF DEFORMABLE BODIES

CHAPTER **14.** STRESS AND STRAIN

14.1 Introduction 283
14.2 Internal forces in a body 284
14.3 Stress 287
14.4 Strain 290
14.5 Stress-strain relations 291
14.6 Plane stress 301

CHAPTER **15.** AXIAL FORCES

15.1 Analysis and design 306
15.2 Bars and cables 307
15.3 Simple trusses 313

CHAPTER 16. FLEXURE

16.1 Introduction 324
16.2 Normal force, shear, and bending moment 325
16.3 Normal stresses in beams 335
16.4 Shear stresses in beams 341
16.5 Analysis and design of beams 345
16.6 Deflection of beams 352
16.7 Moment-area theorems 356

CHAPTER **17.** TORSION

17.1 Introduction 367
17.2 Circular torsion bars 367
17.3 Combined torsion and flexure 371
17.4 Rectangular torsion bars 373

CHAPTER 18. STATICALLY INDETERMINATE SYSTEMS

18.1 Applied axial forces **377**
18.2 Temperature changes **380**
18.3 Combined applied forces and temperature changes **383**
18.1 Flexure **384**

PART 4. THE CONCEPTS OF MOMENTUM AND ENERGY

CHAPTER 19. IMPULSE AND MOMENTUM

19.1 Introduction **391**
19.2 Single particle **391**
19.3 System of particles **396**
19.4 Rigid bodies in plane motion **399**
19.5 Impact **404**

CHAPTER 20. WORK AND ENERGY

20.1 Introduction **412**
20.2 Work **412**
20.3 Kinetic energy **418**
20.4 Principle of kinetic energy **419**
20.5 Potential energy in two dimensions **423**
20.6 Principle of conservation of mechanical energy . **426**

CHAPTER 21. ENERGY METHODS FOR EQUILIBRIUM

21.1 Particles and rigid bodies **432**
21.2 Deformable bodies **437**

APPENDIX. ELEMENTS OF SCALAR CALCULUS

A.1 The concept of function 447
A.2 The derivative 449
A.3 Formulas for the derivative 451
A.4 The differential 455
A.5 The indefinite integral 456
A.6 The definite integral 459
A.7 Double and triple integrals 465
A.8 Partial derivatives 471

SUGGESTED READING 475

INDEX 479

INDEX TO USEFUL TABLES AND FIGURES 493