CAMBRIDGE

Cambridge University Press
0521817668 - Statics and Dynamics with Background Mathematics
A. P. Roberts
Table of Contents
More information

Contents

Preface *page* xiii

Part I Statics 1

1 Forces 3
- 1.1 Force 3
- 1.2 Forces of contact 4
- 1.3 Mysterious forces 5
- 1.4 Quantitative definition of force 6
- 1.5 Point of application 7
- 1.6 Line of action 7
- 1.7 Equilibrium of two forces 8
- 1.8 Parallelogram of forces (vector addition) 9
- 1.9 Resultant of three coplanar forces acting at a point 12
- 1.10 Generalizations for forces acting at a point 13
- 1.11 More exercises 15
- 1.12 Answers to exercises 16

2 Moments 25
- 2.1 Moment of force 25
- 2.2 Three or more non-parallel non-concurrent coplanar forces 27
- 2.3 Parallel forces 28
- 2.4 Couples 31
- 2.5 Equations of equilibrium of coplanar forces 33
- 2.6 Applications 35
- 2.7 Answers to exercises 37

3 Centre of gravity 45
- 3.1 Coplanar parallel forces 45
- 3.2 Non-coplanar parallel forces 47
- 3.3 Finding c.g. positions of uniform plane laminas without using calculus 49
- 3.4 Using calculus to find c.g. positions of uniform plane laminas 51

© Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
0521817668 - Statics and Dynamics with Background Mathematics
A. P. Roberts
Table of Contents
More information

3.5 Centre of gravity positions of uniform solid bodies of revolution 53
3.6 Answers to exercises 55

4 Distributed forces 59
4.1 Distributed loads 59
4.2 Hydrostatics 61
4.3 Buoyancy 63
4.4 Centre of pressure on a plane surface 64
4.5 Answers to exercises 65

5 Trusses 70
5.1 Method of sections 70
5.2 Method of joints 72
5.3 Bow's notation 76
5.4 Answers to exercises 81

6 Beams 85
6.1 Shearing force and bending moment 85
6.2 Uniformly distributed beam loading 87
6.3 Using calculus 90
6.4 Answers to exercises 92

7 Friction 98
7.1 Force of friction 98
7.2 Sliding or toppling? 99
7.3 Direction of minimum pull 101
7.4 Ladder leaning against a wall 102
7.5 Motor vehicle clutch 103
7.6 Capstan 104
7.7 Answers to exercises 105

8 Non-coplanar forces and couples 109
8.1 Coplanar force and couple 109
8.2 Effect of two non-coplanar couples 111
8.3 The wrench 114
8.4 Resultant of a system of forces and couples 116
8.5 Equations of equilibrium 117
8.6 Answers to exercises 119

9 Virtual work 123
9.1 Work done by a force 123
9.2 Work done by a couple 123
9.3 Virtual work for a single body 124
9.4 Virtual work for a system of bodies 125
9.5 Stability of equilibrium 130
9.6 Answers to exercises 134

© Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
0521817668 - Statics and Dynamics with Background Mathematics
A. P. Roberts
Table of Contents
More information

Part II Dynamics 139

10 Kinematics of a point 141
10.1 Rectilinear motion 141
10.2 Simple harmonic motion 142
10.3 Circular motion 144
10.4 Velocity vectors 145
10.5 Relative velocity 146
10.6 Motion along a curved path 147
10.7 Answers to exercises 150

11 Kinetics of a particle 154
11.1 Newton's laws of motion 154
11.2 Sliding down a plane 155
11.3 Traction and braking 157
11.4 Simple harmonic motion 158
11.5 Uniform circular motion 160
11.6 Non-uniform circular motion 161
11.7 Projectiles 162
11.8 Motion of connected weights 165
11.9 Answers to exercises 167

12 Plane motion of a rigid body 173
12.1 Introduction 173
12.2 Moment 173
12.3 Instantaneous centre of rotation 174
12.4 Angular velocity 176
12.5 Centre of gravity 178
12.6 Acceleration of the centre of gravity 179
12.7 General dynamic equations 180
12.8 Moments of inertia 182
12.9 Perpendicular axis theorem 184
12.10 Rotation about a fixed axis 185
12.11 General plane motion 188
12.12 More exercises 191
12.13 Answers to exercises 194

13 Impulse and momentum 207
13.1 Definition of impulse and simple applications 207
13.2 Pressure of a water jet 209
13.3 Elastic collisions 210
13.4 Moments of impulse and momentum 211
13.5 Centre of percussion 214
13.6 Conservation of moment of momentum 215
13.7 Impacts 216
13.8 Answers to exercises 217

© Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
0521817668 - Statics and Dynamics with Background Mathematics
A. P. Roberts
Table of Contents
More information

14 Work, power and energy 221
14.1 Work done by force on a particle 221
14.2 Conservation of energy 223
14.3 Spring energy 224
14.4 Power 225
14.5 Kinetic energy of translation and rotation 225
14.6 Energy conservation with both translation and rotation 226
14.7 Energy and moment of momentum 227
14.8 Answers to exercises 229

Part III Problems 233

15 Statics 235

16 Dynamics 263

Part IV Background mathematics 281

17 Algebra 283
17.1 Indices 283
17.2 Logarithm 283
17.3 Polynomials 284
17.4 Partial fractions 285
17.5 Sequences and series 287
17.6 Binomial theorem 290

18 Trigonometry 292
18.1 Introduction 292
18.2 Trigonometrical ratios to remember 294
18.3 Radian measure 295
18.4 Compound angles 296
18.5 Solution of trigonometrical equations: inverse trigonometrical functions 298
18.6 Sine and cosine rules 300

19 Calculus 301
19.1 Differential calculus 301
19.2 Differentiation from first principles 302
19.3 More derivative formulae 304
19.4 Complex numbers 308
19.5 Integral calculus 310
19.6 The definite integral 311

© Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
0521817668 - Statics and Dynamics with Background Mathematics
A. P. Roberts
Table of Contents
More information

19.7 Methods of integration 315
19.8 Numerical integration 320
19.9 Exponential function e^x and natural logarithm $\ln x$ 323
19.10 Some more integrals using partial fractions and integration by parts 326
19.11 Taylor, Maclaurin and exponential series 327

20 Coordinate geometry 329
20.1 Introduction 329
20.2 Straight line 331
20.3 Circle 332
20.4 Conic sections 335
20.5 Parabola 335
20.6 Ellipse 338
20.7 Hyperbola 339
20.8 Three-dimensional coordinate geometry 341
20.9 Equations for a straight line 343
20.10 The plane 344
20.11 Cylindrical and spherical coordinates 346

21 Vector algebra 349
21.1 Vectors 349
21.2 Straight line and plane 351
21.3 Scalar product 354
21.4 Vector product 356

22 Two more topics 359
22.1 A simple differential equation 359
22.2 Hyperbolic sines and cosines 360

Appendix: answers to problems in Part III 361
Index 365

© Cambridge University Press www.cambridge.org