CONTENTS

I. INTRODUCTION 1
1. Definition of the subject 1
2. Historical outline 2
3. Physical background 4
4. The stress-strain curve 8

II. FOUNDATIONS OF THE THEORY 14
1. The ideal plastic body 14
2. The criterion of yielding 15
3. Strain-hardening 23
4. The complete stress-strain relations 33
5. The Lévy–Mises and Reuss equations 38
6. The Hencky stress-strain equations 45
7. Other theories 48

III. GENERAL THEOREMS 50
1. The plastic potential 50
2. Uniqueness of a stress distribution under given boundary conditions 53
3. Extremum and variational principles 60

IV. THE SOLUTION OF PLASTIC-ELASTIC PROBLEMS. I . 70
1. Introduction 70
2. Theory of Hohenemser's experiment 71
3. Combined torsion and tension of a thin-walled tube . . 74
4. Combined torsion and tension of a cylindrical bar . . . 75
5. Compression under conditions of plane strain . . . 77
6. Bending under conditions of plane strain 79
7. Bending of a prismatic beam 81
8. Torsion of a prismatic bar 84
9. Torsion of a bar of non-uniform section 94

V. THE SOLUTION OF PLASTIC-ELASTIC PROBLEMS. II . 97
1. The expansion of a spherical shell 97
2. The expansion of a cylindrical tube 106
3. Theory of the autofrettage process 114
4. Expansion of a cylindrical cavity in an infinite medium . . 125

VI. PLANE PLASTIC STRAIN AND THE THEORY OF THE SLIP-LINE FIELD 128
1. Assumption of a plastic-rigid material 128
2. The plane strain equations referred to Cartesian coordinates . 129

3. The plane strain equations referred to the slip-lines . . 132
4. Geometry of the slip-line field 136
5. The numerical calculation of slip-line fields 140
6. The numerical calculation of the velocity distribution . . 149
7. Analytic integration of the plane strain equations . . . 151
8. Discontinuities in the stress 157

VII. TWO-DIMENSIONAL PROBLEMS OF STEADY MOTION . 161
1. Formulation of the problem 161
2. Sheet-drawing 163
3. Ironing of a thin-walled cup 178
4. Sheet-extrusion 181
5. Piercing 186
6. Strip-rolling 188
7. Machining 206
8. Flow through a converging channel 209

VIII. NON-STEADY MOTION PROBLEMS IN TWO DIMENSIONS. I 213
1. Geometric similarity and the unit diagram 213
2. Wedge-indentation 215
3. Compression of a wedge by a flat die 221
4. Expansion of a semi-cylindrical cavity in a surface . . . 223
5. Compression of a block between rough plates . . . 226

IX. NON-STEADY MOTION PROBLEMS IN TWO DIMENSIONS. II 237
1. Introduction 237
2. Formulation of the problem 238
3. Yielding of notched bars under tension 245
4. Plastic yielding round a cavity 252
5. Indentation and the theory of hardness tests . . . 254

X. AXIAL SYMMETRY 262
1. Fundamental equations 262
2. Extrusion from a contracting cylindrical container . . . 263
3. Compression of a cylinder under certain distributed loads . . 265
4. Cylindrical tube under axial tension and internal pressure . . 267
5. Tube-sinking 269
6. Stress distribution in the neck of a tension specimen . . 272
7. Compression of a cylinder between rough plates . . . 277
8. Relations along slip-lines and flow-lines 278

XI. MISCELLANEOUS TOPICS 282
1. Deep-drawing 282
2. General theory of sheet-bending 287

3. Plane strain of a general plastic material 294
4. The theory of plane plastic stress, with applications . . 300
5. Completely plastic states of stress in a prismatic bar . . 313

XII. PLASTIC ANISOTROPY 317
1. The yield criterion 318
2. Relations between stress and strain-increment . . . 320
3. Plastic anisotropy of rolled sheet 321
4. Length changes in a twisted tube 325
5. The earing of deep-drawn cups 328
6. Variation of the anisotropic parameters during cold-work . . 332
7. Theory of plane strain for anisotropic metals . . . 334

APPENDIXES 341

ADDENDUM 351

AUTHOR INDEX 352

SUBJECT INDEX 355