

Contents

Chapter 1	Simple Modes of Elastic Deformation	1
§1	Simple Stretching and Compression of Springs	1
	1.1 Deformation mode	1
	1.2 Variational principles and equilibrium equation	4
§2	Stretching and Compression of Uniform Rods	5
	2.1 Deformation modes	5
	2.2 Variational principles and equilibrium equations	10
	2.3 Piecewise uniform rods	16
	2.4 Systems of rods in plane tension	22
§3	Stretching and Compression of Nonuniform Rods	38
	3.1 Deformation modes	38
	3.2 Variational principles	40
	3.3 Boundary value problems	48
	3.4 Equilibrium equations	54
	3.5 Strainless states	57
§4	Stretching and Compression in Various Directions	60
	4.1 Hooke's law and strain energy	60
	4.2 Changes of volume	62
§5	Shear Deformations	64
	5.1 Shearing stresses	64
	5.2 Shear strains	65
	5.3 Hooke's law and the strain energy of shear deformations	68
§6	Torsion of Circular Rods	69
	6.1 Deformation modes	69
	6.2 Variational principles and equilibrium equations	71
	6.3 Torsion of circular tubes	73

§7	Bending of Beams	74
	7.1 Deformation modes	74
	7.2 Variational principles and equilibrium equations	77
	7.3 Boundary conditions and interface conditions	81
	7.4 Strainless states	86
Chapter 2	Static Elasticity	89
§1	Displacements and Strains	89
	1.1 Strains	89
	1.2 Rotations	91
	1.3 Strainless states and infinitesimal rigid displacements ...	93
§2	Transformation of Principal Axes and Principal Strains	95
	2.1 Rotation of coordinate axes	95
	2.2 Strain tensors in the transformed and original systems of coordinates	96
	2.3 Principal axes and principal strains	97
§3	Stresses	99
	3.1 Components of stress	99
	3.2 Equilibrium equations	101
	3.3 Principal stresses	103
§4	Hooke's Law and Strain Energy	104
	4.1 Hooke's law	104
	4.2 Strain energy	106
§5	Variational Principles and Elastic Equilibrium	108
	5.1 Variational principles	108
	5.2 Equilibrium equations	111
	5.3 Boundary conditions and interface conditions	112
	5.4 Strainless states	116
	5.5 On variational principles and finite element methods	117
§6	Geometrical Compatibility	118
	6.1 Integrability conditions of vector fields and topological properties of domain	118
	6.2 Equations of geometric compatibility and conditions for intergrability	126

§7	Thermal Effects	132
	7.1 Hooke's law and strain energy	132
	7.2 Variational principles and equilibrium equations	135
Chapter 3	Typical Problems of Elastic Equilibrium	139
§1	Plane Elastic Problems	139
	1.1 Plane strain problems	141
	1.2 Plane stress problems	143
	1.3 Comparisons	144
	1.4 One dimensional problems	146
§2	Plane Geometrical Compatibility and Stress Function	148
	2.1 Plane geometric compatibility	148
	2.2 Stress function	149
	2.3 Boundary conditions	152
	2.4 Multiply-connected domains	155
§3	Torsion of Cylinders	158
	3.1 Deformation modes	158
	3.2 Torsion function	160
	3.3 Stress function	163
	3.4 Torsion formulas of several specified cross sections	166
§4	Bending of Thin Plates	169
	4.1 Deformation modes	169
	4.2 Variational principles	172
	4.3 Equilibrium equations	175
	4.4 Boundary conditions and interface conditions	183
	4.5 Strainless states	191
	4.6 Thermal effects	193
§5	Bending of Spatial Beams	197
	5.1 Deformation modes	197
	5.2 Variational principles	200
	5.3 Equilibrium equations	203
	5.4 Boundary conditions and interface conditions	207
	5.5 Strainless states	208
	5.6 Thermal effects	210

Chapter 4 Composite Elastic Structures	212
§1 Introduction	212
§2 Plane Composite Structures	215
2.1 Geometric description	215
2.2 Fundamental members	220
2.3 The rigid connection	226
2.4 Boundary conditions	231
2.5 The pinned connection	233
2.6 Variational principles	234
2.7 Equilibrium equations	236
2.8 Strainless states	239
§3 Space Composite Structures	243
3.1 Geometric description	243
3.2 Fundamental members	249
3.3 The rigid connection	262
3.4 Boundary conditions	264
3.5 The pinned connection	268
3.6 Variational principles	270
3.7 Equilibrium equations	272
3.8 Strainless states	280
3.9 Treatment of the offset distance	284
Chapter 5 Finite Element Methods	289
§1 Introduction	289
§2 Stretching and Torsion of Rods	290
2.1 Variational problems	290
2.2 Subdivision and interpolation	292
2.3 Analysis of elements (linear elements	294
2.4 Assembly	297
2.5 Treatment of essential conditions	300
2.6 Applications of the quadratic element	301
§3 Bending of Beams	304
3.1 Variational problems	304
3.2 The cubic hermite element	305

§4	Poisson Equation	309
	4.1 Variational problems	309
	4.2 Subdivision and interpolation	311
	4.3 Analysis of elements (linear elements and quadratic elements	322
	4.4 Assembly and the others	328
§5	Problems of Plane Elasticity	332
	5.1 Variational problems	332
	5.2 Bilinear rectangular elements	334
	5.3 Essential boundary conditions	340
§6	Bending Thin Plates	343
	6.1 Variational principles	343
	6.2 Incomplete bicubic rectangular elements (addini-clough-melosh elements	344
	6.3 Incomplete cubic triangular elements (zienkiewicz elements	351
	6.4 Complete quadratic triangular elements (morley elements	356
	6.5 On nonconforming elements	361
§7	Composite Structures	362
	7.1 Plane composite structures	362
	7.2 Space composite structures	370
	7.3 Nonstandard connections and the treatment of the offset distance	381
	References	386
	Index	390