

CONTENTS

List of Boxes	<i>page</i> ix
List of Symbols	x
Preface	xv
Acknowledgements	xviii

PART I

1: Scope of Structural Geology	3
1.1 Deformation of Earth's Lithosphere and Asthenosphere	4
1.2 Styles of Deformation	9
1.3 Geologic Structures	10
1.4 Methodology of Structural Geology	13
1.5 Applications and Careers	19
Recapitulation	20
Review Questions	20
MATLAB Exercises for Chapter 1: A Tutorial	21
Further Reading	21

PART II

2: Mathematical Tools	25
2.1 Characteristics of Scalar, Vector, and Tensor Quantities	25
2.2 Algebraic Representation of Vectors	30
2.3 Mapping Geologic Structures with Vectors	34
2.4 Geologic Structures Represented by Vector Functions	40
2.5 Vector Quantities	43
2.6 Tensor Quantities	53
2.7 Coordinate Rotation for Points, Vectors, and Tensors	62
Recapitulation	65
Review Questions	66
MATLAB Exercises for Chapter 2: Mathematical Tools	67
Further Reading	67
3: Physical Concepts	70
3.1 Units of Measure	70
3.2 Accuracy, Precision, and Significant Figures	73
3.3 Dimensional Analysis	74
3.4 Material Continuum	79
3.5 Conservation of Mass	85
3.6 Conservation of Linear Momentum	89
3.7 Conservation of Angular Momentum	93
3.8 Conservation of Energy	95
Recapitulation	97
Review Questions	98

MATLAB Exercises for Chapter 3: Physical Concepts	99
Further Reading	99

PART III

4: Elastic–Brittle Deformation	105
4.1 Hookean Elastic Solid	105
4.2 Elastic Deformation of Earth’s Lithosphere	107
4.3 Brittle Deformation at the Outcrop and Grain Scales	107
4.4 Elastic–Brittle Deformation in the Laboratory	109
4.5 Field Estimates of Rock Stiffness at the Kilometer Scale	114
4.6 Three-Dimensional Stress States	116
4.7 Elastic–Brittle Deformation under Axisymmetric Loading	118
4.8 The State of Stress During Opening and Shear Fracture	124
4.9 Displacement and Strain Fields During Brittle Deformation	128
4.10 Constitutive Equations for the Linear Elastic Solid	134
4.11 Equations of Motion for the Elastic Solid	135
Recapitulation	139
Review Questions	140
MATLAB Exercises for Chapter 4: Elastic Brittle Deformation	142
Further Reading	142
5: Elastic–Ductile Deformation	144
5.1 Idealized Plastic Solids	144
5.2 Elastic–Ductile Deformation at the Outcrop Scale	146
5.3 Elastic–Ductile Deformation at the Crustal Scale	146
5.4 Elastic–Ductile Deformation in the Laboratory	148
5.5 Deformation and Strain for the Ductile Solid	154
5.6 Mechanisms of Ductile Deformation	163
5.7 Constitutive Equations for Elastic–Ductile Deformation	172
5.8 Equations of Motion for Rigid Plastic Deformation	175
Recapitulation	179
Review Questions	180
MATLAB Exercises for Chapter 5: Elastic Ductile Deformation	181
Further Reading	181
6: Elastic–Viscous Deformation	184
6.1 Viscous and Viscoelastic Liquids	184
6.2 Viscous Deformation at the Outcrop Scale	187
6.3 Viscous Deformation at the Crustal Scale	188
6.4 Viscous Deformation in the Laboratory	190
6.5 Field Estimates of Lava Viscosity	197
6.6 Kinematics of Flow	198
6.7 Constitutive Equations for Linear Viscous Materials	203
6.8 Equations of Motion for Linear Viscous Materials	206
Recapitulation	214
Review Questions	215
MATLAB Exercises for Chapter 6: Elastic Viscous Deformation	217
Further Reading	217

PART IV

7: Fractures	223
7.1 Descriptions of Joints, Veins, and Dikes	223
7.2 A Canonical Model for Opening Fractures	230
7.3 Fracture Modes and the Near-tip Fields	243
7.4 Fracture Initiation and Propagation	249
Recapitulation	253
Review Questions	254
MATLAB Exercises for Chapter 7: Fractures	256
Further Reading	256
8: Faults	258
8.1 Fault Terminology	258
8.2 Descriptions of Faults at the Outcrop Scale	260
8.3 Descriptions of Faults at the Crustal Scale	269
8.4 A Canonical Model for Faulting	279
8.5 Kinematics of Faulting and Associated Deformation	287
8.6 Fossil Earthquakes	292
Recapitulation	296
Review Questions	297
MATLAB Exercises for Chapter 8: Faults	298
Further Reading	299
9: Folds	301
9.1 Fold Terminology	301
9.2 Descriptions of Folds at the Outcrop Scale	304
9.3 Quantifying Fold Profiles using Curvature	307
9.4 Descriptions of Folds in Three Dimensions at the Crustal Scale	310
9.5 Quantifying Folds in Three Dimensions using Curvature	313
9.6 A Canonical Model for Bending	322
9.7 A Canonical Model for Buckling	331
9.8 Fault-Cored Anticlines	339
Recapitulation	341
Review Questions	342
MATLAB Exercises for Chapter 9: Folds	344
Further Reading	344
10: Fabrics	346
10.1 Descriptions of Rock Fabrics from Outcrop to Thin Section	346
10.2 Descriptions of Rock Fabrics in Sedimentary and Igneous Rock	349
10.3 Kinematics of Ductile Deformation	361
10.4 A Canonical Model for a Viscous Shear Zone	365
10.5 Relating Fabric to Plastic Deformation at Fault Steps	367
Recapitulation	373
Review Questions	375
MATLAB Exercises for Chapter 10: Fabrics	376
Further Reading	376

11: Intrusions	379
11.1 Dikes	379
11.2 Sills	394
11.3 Laccoliths	400
11.4 Stocks	403
11.5 Salt Diapirs	408
11.6 A Canonical Model for a Rising Diapir	410
Recapitulation	415
Review Questions	417
MATLAB Exercises for Chapter 11: Intrusions	418
Further Reading	418
References	421
Index	428