

## Contents

<i>Preface</i>	page ix
<i>Acknowledgements</i>	xii
<b>1 Some mathematical essentials</b>	1
1.1 Scalars, vectors, and Cartesian tensors	1
1.2 Matrices and determinants	7
1.3 Transformations of Cartesian tensors	9
1.4 Eigenvalues and eigenvectors	12
1.5 Simplified approach to rotation	16
1.6 Curvature, torsion, and kinematics	18
Exercises	23
<b>2 Stress principles</b>	27
2.1 Body and surface forces	27
2.2 Cauchy stress principle	29
2.3 Stress tensor	31
2.4 Symmetry and transformation laws	33
2.5 Principal stresses and directions	34
2.6 Solving the cubic eigenvalue equation problem	37
2.7 Maximum and minimum stress values	39
2.8 Mohr's circles	42
2.9 Plane, deviator, spherical, and octahedral stress	44
Exercises	46
<b>3 Deformation and motion</b>	49
3.1 Coordinates and deformation	49
3.2 Strain tensor	53
3.3 Linearized deformation theory	54
3.4 Stretch ratios	58
3.5 Velocity gradient	59
3.6 Vorticity and material derivative	61
Exercises	64

viii	<i>Contents</i>	
<b>4</b>	<b>Fundamental laws and equations</b>	67
4.1	Terminology and material derivatives	67
4.2	Conservation of mass and the continuity equation	71
4.3	Linear momentum and the equations of motion	73
4.4	Piola–Kirchhoff stress tensor	74
4.5	Angular momentum principle	75
4.6	Conservation of energy and the energy equation	76
4.7	Constitutive equations	79
4.8	Thermodynamic considerations	82
	Exercises	86
<b>5</b>	<b>Linear elastic solids</b>	89
5.1	Elasticity, Hooke’s law, and free energy	89
5.2	Homogeneous deformations	94
5.3	Role of temperature	97
5.4	Elastic waves for isotropic bodies	100
5.5	Helmholtz’s decomposition theorem	102
5.6	Statics for isotropic bodies	104
5.7	Microscopic structure and dislocations	106
	Exercises	109
<b>6</b>	<b>Classical fluids</b>	112
6.1	Stokesian and Newtonian fluids: Navier–Stokes equations	113
6.2	Some special fluids and flows	117
	Exercises	129
<b>7</b>	<b>Geophysical fluid dynamics</b>	134
7.1	Dimensional analysis and dimensionless form	134
7.2	Dimensionless numbers	138
	Exercises	143
<b>8</b>	<b>Computation in continuum mechanics</b>	147
8.1	Review of partial differential equations	148
8.2	Survey of numerical methods	153
<b>9</b>	<b>Nonlinearity in the Earth</b>	159
9.1	Friction	163
9.2	Fracture	165
9.3	Percolation and self-organized criticality	168
9.4	Fractals	171
	<i>References</i>	175
	<i>Index</i>	180