

Contents

- 1 Introduction** 1
- 2 Tensor Notation** 9
 - 2.1 Cartesian Tensors 9
 - 2.2 General Bases 16
- 3 Some Basic Equations of Continuum Mechanics** 31
 - 3.1 Analysis of Deformation and Strain 31
 - 3.2 Analysis of Stress 40
- 4 Creep Behavior of Isotropic and Anisotropic Materials;
Constitutive Equations** 49
 - 4.1 Primary Creep 52
 - 4.1.1 Primary Creep for Austenitic Steel 53
 - 4.1.2 Strain-Hardening-Theory 54
 - 4.1.3 Time-Hardening-Theory 55
 - 4.1.4 Comparison of Strain- and Time-Hardening 57
 - 4.2 Secondary Creep 61
 - 4.2.1 Creep Potential Hypothesis 62
 - 4.2.2 Isochoric Creep Behavior 65
 - 4.2.3 Creep Parameters 67
 - 4.2.4 Second-Order Effects 68
 - 4.3 Tertiary Creep 77
 - 4.3.1 Uniaxial Tertiary Creep 77
 - 4.3.2 Multiaxial Tertiary Creep 80
- 5 Creep Behavior of Thick-Walled Tubes** 85
 - 5.1 Method to describe the Kinematics 85
 - 5.2 Isochoric Creep Behavior 90
 - 5.3 Stress Field 93

5.4	Expansion and Failure Time	97
5.5	Numerical Computation and Examples	100
6	The Creep Potential Hypothesis in Comparison with the Tensor Function Theory	109
6.1	Isotropy	109
6.2	Oriented Solids	111
6.3	Modification of the Normality Rule	115
6.4	Anisotropy expressed through a Fourth-Rank Tensor	118
6.4.1	Irreducible Sets of Tensor Generators and Invariants ..	119
6.4.2	Special Formulations of Constitutive Equations and Creep Criteria	121
6.4.3	Incompressibility and Volume Change	123
6.4.4	Characteristic Polynomial for a Fourth Order Tensor ..	127
6.4.5	LAGRANGE Multiplier Method	131
6.4.6	Combinatorial Method	132
6.4.7	Simplified Representations	135
7	Damage Mechanics	139
7.1	Damage Tensors and Tensors of Continuity	139
7.2	Stresses in a Damaged Continuum	148
7.3	Damage Effective Stress Concepts	155
8	Tensorial Generalization of Uniaxial Creep Laws to Multiaxial States of Stress	159
8.1	Polynomial Representation of Tensor Functions	159
8.2	Interpolation Methods for Tensor Functions	160
8.3	Tensorial Generalization of NORTON-BAILEY's Creep Law ..	162
8.4	Tensorial Generalization of a Creep Law including Damage ..	165
9	Viscous Fluids	171
9.1	Linear Viscous Fluids	171
9.2	Nonlinear Viscous Fluids	179
10	Memory Fluids	189
10.1	MAXWELL Fluid	189
10.2	General Principle	190
10.3	Effects of Normal Stresses	193

11	Viscoelastic Materials	195
11.1	Linear Theory of Viscoelasticity	195
11.2	Nonlinear Theory of Viscoelasticity	201
11.3	Special Viscoelastic Models	202
11.3.1	Creep Spectra and Creep Functions for the Generalized KELVIN Model	202
11.3.2	Creep Behavior due to the $\sqrt{t}$ - Law	215
11.3.3	Creep as a Diffusion Process	218
11.3.4	Relaxation Spectra and Relaxation Functions for the Generalized MAXWELL Model	225
11.3.5	Relaxation Behavior due to the $\sqrt{t}$ -Law	229
11.3.6	Mechanical Hysteresis of Rheological Models	231
11.3.7	Complex Parameters of Rheological Models	234
11.3.8	BURGERS Model	237
12	Viscoplastic Materials	245
12.1	Linear Theory of Viscoplasticity	246
12.2	Nonlinear Theory of Viscoplasticity	249
12.3	Viscoplastic Behavior of Metals	250
13	Creep and Damage Experiments	253
14	Creep Curve	279
Appendices		
A	The HEAVISIDE and DIRAC Functions	285
B	The LAPLACE Transformation	295
B.1	Linearity	298
B.2	Inverse LAPLACE Transforms	299
B.3	Similarity Rule	299
B.4	Shift Rule	299
B.5	Damping Rule	300
B.6	LAPLACE Transforms of Derivatives	300
B.7	Differentiation of LAPLACE Transforms	301
B.8	LAPLACE Transform of an Integral	302
B.9	Convolution Theorem	303
B.10	LAPLACE Transforms of the HEAVISIDE and DIRAC Functions	308
B.11	LAPLACE Transformation for Integral Equations	314

B.12 Periodic Functions	326
B.13 Application to Partial Differential Equations	329
References	345
Index	361