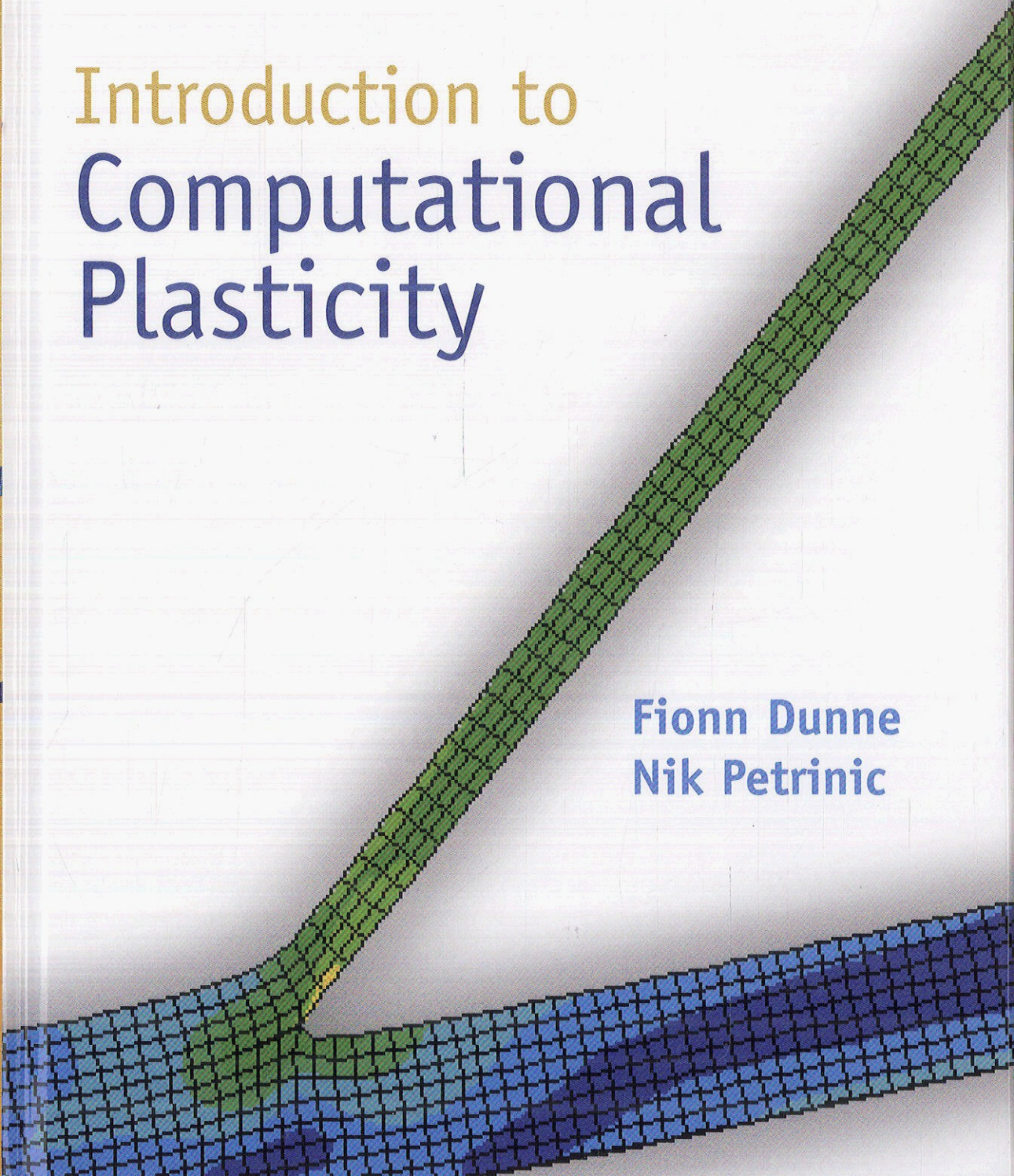


OXFORD

Introduction to Computational Plasticity

Fionn Dunne
Nik Petrinic



Contents

Acknowledgements	xii
-------------------------	------------

Notation	xiii
-----------------	-------------

Part I. Microplasticity and continuum plasticity

1. Microplasticity	3
1.1 Introduction	3
1.2 Crystal slip	5
1.3 Critical resolved shear stress	7
1.4 Dislocations	8
Further reading	10
2. Continuum plasticity	11
2.1 Introduction	11
2.2 Some preliminaries	11
2.3 Yield criterion	17
2.4 Isotropic hardening	23
2.5 Kinematic hardening	27
2.6 Combined isotropic and kinematic hardening	36
2.7 Viscoplasticity and creep	38
Further reading	45
3. Kinematics of large deformations and continuum mechanics	47
3.1 Introduction	47
3.2 The deformation gradient	48
3.3 Measures of strain	49
3.4 Interpretation of strain measures	52
3.5 Polar decomposition	57

3.6	Velocity gradient, rate of deformation, and continuum spin	60
3.7	Elastic–plastic coupling	66
3.8	Objective stress rates	69
3.9	Summary	81
	Further reading	82
4.	The finite element method for static and dynamic plasticity	83
4.1	Introduction	83
4.2	Hamilton’s principle	84
4.3	Introduction to the finite element method	96
4.4	Finite element equilibrium equations	100
4.5	Integration of momentum balance and equilibrium equations	136
	Further reading	142
5.	Implicit and explicit integration of von Mises plasticity	143
5.1	Introduction	143
5.2	Implicit and explicit integration of constitutive equations	143
5.3	Material Jacobian	150
5.4	Kinematic hardening	154
5.5	Implicit integration in viscoplasticity	161
5.6	Incrementally objective integration for large deformations	167
	Further reading	168
6.	Implementation of plasticity models into finite element code	169
6.1	Introduction	169
6.2	Elasticity implementation	170
6.3	Verification of implementations	171
6.4	Isotropic hardening plasticity implementation	172
6.5	Large deformation implementations	176
6.6	Elasto-viscoplasticity implementation	180

Part II. Plasticity models

7.	Superplasticity	185
7.1	Introduction	185
7.2	Some properties of superplastic alloys	185

7.3	Constitutive equations for superplasticity	189
7.4	Multiaxial constitutive equations and applications	192
	References	197
8.	Porous plasticity	199
8.1	Introduction	199
8.2	Finite element implementation of the porous material constitutive equations	201
8.3	Application to consolidation of Ti–MMCs	205
	References	207
9.	Creep in an aero-engine combustor material	209
9.1	Introduction	209
9.2	Physically based constitutive equations	209
9.3	Multiaxial implementation into ABAQUS	212
	References	217
	Appendix 9.1	218
10.	Cyclic plasticity, creep, and TMF	219
10.1	Introduction	219
10.2	Constitutive equations for cyclic plasticity	219
10.3	Constitutive equations for C263 undergoing TMF	222
	References	227
	Appendix A: Elements of tensor algebra	229
	Differentiation	231
	The chain rule	232
	Rotation	233
	Appendix B: Fortran coding available via the OUP website	235
	Index	239