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Finite Element Methods are used for numerous engineering applications where numerical solutions of partial differential equations are needed. As computers can now deal with the millions of parameters used in these methods, automatic error estimation and automatic adaptation of the utilised method (according to this error estimation), has become a hot research topic. This text offers comprehensive coverage of this new field of automatic adaptation and error estimation, bringing together the work of eight outstanding researchers in this field who have completed a six year national research project within the German Science Foundation. The result is a state-of-the-art work in true reference style. Each chapter is self-contained and covers theoretical, algorithmic and software presentations as well as solved problems. A main feature consists of several carefully elaborated benchmarks of 2D- and 3D- applications. First book to go beyond the Finite Element Method in itself Covers material from a new research area Presents benchmarks of 2D- and 3D- applications Fills with the new trend for genetic strategies in engineering

These proceedings collect the major part of the lectures given at ENU MATH2003, the European Conference on Numerical Mathematics and Advanced Applications, held in Prague, Czech Republic, from 18 August to 22 August, 2003. The importance of numerical and computational mathematics and scientific computing is permanently growing. There is an increasing number of different research areas, where numerical simulation is necessary. Let us mention fluid dynamics, continuum mechanics, electromagnetism, phase transition, cosmology, medicine, economics, finance, etc. The success of applications of numerical methods is conditioned by changing its basic instruments and looking for new appropriate techniques adapted to new problems as well as new computer architectures. The ENUMATH conferences were established in order to provide a forum for discussion of current topics of numerical mathematics. They seek to convene leading experts and young scientists with special emphasis on con tributions from Europe. Recent results and new trends are discussed in the analysis of numerical algorithms as well as in their applications to challenging scientific and industrial problems. The first ENUMATH conference was organized in Paris in 1995, then the series continued by the conferences in Heidelberg 1997, Jyvaskyla 1999 and Ischia Porto 2001. It was a great pleasure and honour for the Czech numerical community that it was decided at Ischia Porto to organize the ENUMATH2003 in Prague. It was the first time when this conference crossed the former Iron Curtain and was organized in a post-socialist country.

This book is the standard text book of elastoplasticity in which the elastoplasticity theory is comprehensively described from the conventional theory for the monotonic loading to the unconventional theory for the cyclic loading behavior. Explanations of vector-tensor analysis and continuum mechanics are provided first as a foundation for elastoplasticity theory, covering various strain and stress measures and their rates with their objectivities. Elastoplasticity has been highly developed by the creation and formulation of the subloading surface model which is the unified fundamental law for irreversible mechanical phenomena in solids. The assumption that the interior of the yield surface is an elastic domain is excluded in order to describe the plastic strain rate due to the rate of stress inside the yield surface in this model aiming at the prediction of cyclic loading behavior, although the yield surface enclosing the elastic domain is assumed in all the elastoplastic models other than the subloading surface model. Then, the plastic strain rate develops continuously as the stress approaches the yield surface, providing the advantages: 1) The tangent modulus changes continuously, 2) The yield judgment whether the stress reaches the yield surface is not required, 3) The stress is automatically attracted to the yield surface even when it goes out from the yield surface by large loading increments in numerical calculation and 4) The finite strain theory based on the multiplicative decomposition of deformation gradient tensor is formulated exactly. Consequently, the monotonic, the cyclic, the non-proportional loading behaviors for wide classes of materials including soils, rocks and concretes in addition to metals can be described rigorously by the subloading surface model. Further, the viscoplastic constitutive equations in a general rate from the quasi-static to the impact loadings are described, and constitutive equations of friction behavior and its application to the prediction of stick-slip phenomena, etc. are also described in detail. In addition, the return-mapping algorithm, the consistent tangent modulus, etc. are explained for the numerical analyses. Further, the damage, the phase-transformation and the crystal plasticity models are also described in brief. All of them are based on the subloading surface model. The elastoplasticity analysis will be advanced steadily based on the subloading surface model. This volume demonstrates the use of FORTRAN for numerical computing in the context of the finite element method. FORTRAN is still an important programming language for computational mechanics and all classical finite element codes are written in this language, some of them even offer an interface to link user-code to the main program. This feature is especially important for the development and investigation of new engineering structures or materials. Thus, this volume gives a simple introduction to programming of elasto-plastic material behavior, which is, for example, the prerequisite for implementing new constitutive laws into a commercial finite element program.

The present thesis investigates the usage of higher order accurate time integrators together with appropriate error estimators for small and finite dynamic (visco)plasticity. Therefore, a general (visco)plastic problem is defined which serves as a basis to create closed-form solution strategies. A classical access towards small and finite (visco)plasticity is integrated into this concept. This approach is based on the idea, that the balance of linear momentum is formulated in a weak sense and the material laws are included indirectly. Thus, separate time discretizations are implemented and an appropriate coupling between them is necessary. Limitations for the usage of time integrators are the consequence. In contrast, an alternative multifield formulation is derived, adapting the principle of Jourdain. The idea is to assume that the balance of energy - taking into account a pseudopotential representing dissipative effects – resembles a rate-type functional, whose stationarity condition leads to the equations describing small or finite dynamic (visco)plasticity. Accordingly, the material laws and the balance of linear momentum can be solved on the same level and only one single time discretization has to be performed. A greater freedom in the choice of time integrators is obtained and the application of higher order accurate schemes - such as Newmark’s method, fully implicit as well as diagonally implicit Runge-Kutta schemes, and continuous as well as discontinuous Galerkin methods - is facilitated. An analysis and a comparison of the classical and the multifield formulation is accomplished by means of distinct examples. In this context, a dynamic benchmark problem is developed, which allows to focus on the effect of different time integrators. For this investigation, a variety of time discretization error estimators are formulated, evaluated, and compared. The papers in this volume were presented at the 4th International Conference on Large-Scale Scientific Computations ICLSSC 2003. It was held in Sozopol, Bulgaria, June 4-8, 2003. The conference was organized and sponsored by the Central Laboratory for Parallel Processing at the Bulgarian Academy of Sciences. Support was also provided from the Center of Excellence “BIS 21” (funded by the European Commission), SIAM and GAMM. A co-organizer of this traditional scientific meeting was the Division of Numerical Analysis and Statistics of the University of Rousse. The success of the conference and the present volume in particular are the outcome of the joint efforts of many colleagues from various institutions and organizations. First thanks to all the members of the Scientific Committee for their valuable contribution to forming the scientific face of the conference, as well as for their help in reviewing contributed papers. We would like to specially thank the organizers of the special sessions: R. Blaheta, N. Dimitrova, A. Ebel, K. Georgiev, O. Iliev, A. Karaivanova, H. Kosina, M. Krastanov, U. Langer, P. Minev, M. Neytcheva, M. Sch ?afer, V. Veliov, and Z. Zlatev. We are also grateful to the staff involved in the local organization. Special Events - The conference was devoted to the 60th anniversary of Raytcho Lazarov. - During the conference, the nomination for the World Level of the Hall of Fame for Engineering,
Science and Technology, HOFEST, was officially awarded to Owe Axelsson.

This research monograph represents an outcome of the cross-fertilization between nonlinear functional analysis and mathematical modelling, and demonstrates its application to solid and contact mechanics. Based on authors’ original results, it introduces a general fixed point principle and its application to various nonlinear problems in analysis and mechanics. The classes of history-dependent operators and almost history-dependent operators are exposed in a large generality. A systematic and unified presentation contains a carefully-selected collection of new results on variational-hemivariational inequalities with or without unilateral constraints. A wide spectrum of static, quasistatic, dynamic contact problems for elastic, viscoelastic and viscoplastic materials illustrates the applicability of these theoretical results. Written for mathematicians, applied mathematicians, engineers and scientists, it is also a valuable tool for graduate students and researchers in nonlinear analysis, mathematical modelling, mechanics of solids, and contact mechanics.

This book thoroughly describes a theory concerning the yield and failure of materials under multi-axial stresses – the Unified Strength Theory, which was first proposed by the author and has been frequently quoted since. It provides a system of yield and failure criteria adopted for most materials, from metals to rocks, concretes, soils, and polymers. This new edition includes six additional chapters: General behavior of strength theory function; Visualization of the Unified Strength Theory; Equivalent Stress of the UST and Comparisons with other criteria; Economic Signification of the UST; General form of failure criterion; Beauty of Strength Theories. It is intended for researchers and graduate students in various fields, including engineering mechanics, material mechanics, plasticity, soil mechanics, rock mechanics, mechanics of metallic materials and civil engineering, hydraulic engineering, geotechnical engineering, mechanical engineering and military engineering.

“Computational Plasticity with Emphasis on the Application of the Unified Strength Theory” explores a new and important branch of computational mechanics and is the third book in a plasticity series published by Springer. The other two are: Generalized Plasticity, Springer: Berlin, 2006; and Structural Plasticity, Springer and Zhejiang University Press: Hangzhou, 2009. This monograph describes the unified strength theory and associated flow rule, the implementation of these basic theories in computational programs, and shows how a series of results can be obtained by using them. The unified strength theory has been implemented in several special nonlinear finite-element programs and commercial Finite Element Codes by individual users and corporations. Many new and interesting findings for beams, plates, underground caves, excavations, strip foundations, circular foundations, slop, underground structures of hydraulic power stations, pumped-storage power stations, underground mining, high-velocity penetration of concrete structures, ancient structures, and rocket components, along with relevant computational results, are presented. This book is intended for graduate students, researchers and engineers working in solid mechanics, engineering and materials science. The theories and methods provided in this book can also be used for other computer codes and different structures. More results can be obtained, which put the potential strength of the material to better use, thus offering material-saving and energy-saving solutions. Mao-Hong Yu is a professor at the Department of Civil Engineering at Xi’an Jiaotong University, Xi’an, China.

This careful and detailed introduction to non-linear continuum mechanics and to elasticity and plasticity, with a unique mathematical foundation, starts right from the basics. The general theory of mechanical behaviour is particularized for the broad and important classes of elasticity and plasticity. Brings the reader to the forefront of today's knowledge. A list of notations and an index help the reader finding specific topics. These proceedings collect lectures given at ENUMATH 2005, the 6th European Conference on Numerical Mathematics and Advanced Applications held in Santiago de Compostela, Spain in July, 2005. Topics include applications such as fluid dynamics, electromagnetism, structural mechanics, interface problems, waves, finance, heat transfer, unbounded domains, numerical linear algebra, convection-diffusion, as well as methodologies such as a posteriori error estimates, discontinuous Galerkin methods, multiscale methods, optimization, and more. The Mechanics and Thermodynamics of Continua presents a unified treatment of continuum mechanics and thermodynamics that emphasises the universal status of the basic equations and the entropy imbalance. These laws are viewed as fundamental building blocks on which to frame theories of material behaviour. As a valuable reference source, this book presents a detailed and complete treatment of continuum mechanics and thermodynamics for graduates and advanced undergraduates in engineering, physics and mathematics. The chapters on plasticity discuss the standard isotropic theories and, in addition, crystal plasticity and gradient plasticity. The subject of computational plasticity encapsulates the numerical methods used for the finite element simulation of the behaviour of a wide range of engineering materials considered to be plastic – i.e. those that undergo a permanent change of shape in response to an applied force. Computational Methods for Plasticity: Theory and Applications describes the theory of the associated numerical methods for the simulation of a wide range of plastic engineering materials; from the simplest infinitesimal plasticity theory to more complex damage mechanics and finite strain crystal plasticity models. It is split into three parts - basic concepts, small strains and large strains. Beginning with elementary theory and progressing to advanced, complex theory and computer implementation, it is suitable for use at both introductory and advanced levels. The book: Offers a self-contained text that allows the reader to learn computational plasticity theory and its implementation from one volume. Includes many numerical examples that illustrate the application of the methodologies described. Provides introductory material on related disciplines and procedures such as tensor analysis, continuum mechanics and finite elements for non-linear solid mechanics. Is accompanied by purpose-developed finite element software that illustrates many of the techniques discussed in the text, downloadable from the book’s companion website. This comprehensive text will appeal to postgraduate and graduate students of civil, mechanical, aerospace and materials engineering as well as applied mathematics and courses with computational mechanics components. It will also be of interest to research engineers, scientists and software developers working in the field of computational solid mechanics.

This book focuses on mathematical theory and numerical simulation related to various aspects of continuum mechanics, such as fracture mechanics, elasticity, plasticity, pattern dynamics, inverse problems, optimal shape design, material design, and disaster estimation related to earthquakes. Because these problems have become more important in engineering and industry, further development of mathematical study of them is required for future applications. Leading researchers with profound knowledge of mathematical analysis from the fields of applied mathematics, physics, seismology, engineering, and industry provide the contents of this book. They help readers to understand that mathematical theory can be applied not only to different types of industry, but also to a broad range of industrial problems including materials, processes, and products.

This book introduces the reader the theory of nonlinear inclusions and hemivariational inequalities with emphasis on the study of contact mechanics. The work covers both abstract results in
the area of nonlinear inclusions, hemivariational inequalities as well as the study of specific contact problems, including their modelling and their variational analysis. Provided results are based on original research on the existence, uniqueness, regularity and behavior of the solution for various classes of nonlinear stationary and evolutionary inclusions. In carrying out the variational analysis of various contact models, one systematically uses results of hemivariational inequalities and, in this way, illustrates the applications of nonlinear analysis in contact mechanics. New mathematical methods are introduced and applied in the study of nonlinear problems, which describe the contact between a deformable body and a foundation. Contact problems arise in industry, engineering and geophysics. Their variational analysis presented in this book lies the background for their numerical analysis. This volume will interest mathematicians, applied mathematicians, engineers, and scientists as well as advanced graduate students.

A description of the theoretical foundations of inelasticity, its numerical formulation and implementation, constituting a representative sample of state-of-the-art methodology currently used in inelastic calculations. Among the numerous topics covered are small deformation plasticity and viscoplasticity, convex optimisation theory, integration algorithms for the constitutive equation of plasticity and viscoplasticity, the variational setting of boundary value problems and discretization by finite element methods. Also addressed are the generalisation of the theory to non-smooth yield surface, mathematical numerical analysis issues of general return mapping algorithms, the generalisation to finite-strain inelasticity theory, objective integration algorithms for rate constitutive equations, the theory of hyperelastic-based plasticity models and small and large deformation viscoelasticity. Of great interest to researchers and graduate students in various branches of engineering, especially civil, aeronautical and mechanical, and applied mathematics.

This volume comprises selected, revised papers from the Joint CIM-WIAS Workshop, TAAO 2017, held in Lisbon, Portugal, in December 2017. The workshop brought together experts from research groups at the Weierstrass Institute in Berlin and mathematics centres in Portugal to present and discuss current scientific topics and to promote existing and future collaborations. The papers include the following topics: PDEs with applications to material sciences, thermodynamics and laser dynamics, scientific computing, nonlinear optimization and stochastic analysis. Presents a new physical and mathematical theory of irreversible deformations and ductile fracture of metals that acknowledges the continuous change in the structure of materials during deformation and the accumulation of deformation damage. Plastic deformation, viscous destruction, evolution of structure, creep processes, and long-term strength of metals and stress relaxation are described in the framework of a unified approach and model. The author then expands this into a mathematical model for determining the mechanical characteristics of quasi-samples of standard mechanical properties in deformed semi-finished products.

This book focuses on the theoretical aspects of small strain theory of elastoplasticity with hardening assumptions. It provides a comprehensive and unified treatment of the mathematical theory and numerical analysis. It is divided into three parts, with the first part providing a detailed introduction to plasticity, the second part covering the mathematical analysis of the elasticity problem, and the third part devoted to error analysis of various semi-discrete and fully discrete approximations for variational formulations of the elastoplasticity. This revised and expanded edition includes material on single-crystal and strain-gradient plasticity. In addition, the entire book has been revised to make it more accessible to readers who are actively involved in computations but less in numerical analysis. Reviews of earlier edition: "The authors have written an excellent book which can be recommended for specialists in plasticity who wish to know more about the mathematical theory, as well as those with a background in the mathematical sciences who seek a self-contained account of the mechanics and mathematics of plasticity theory." (ZAMM, 2002) "In summary, the book represents an impressive comprehensive overview of the mathematical approach to the theory and numerics of plasticity. Scientists as well as lecturers and graduate students will find the book very useful as a reference for research or for preparing courses in this field." (Technische Mechanik) "The book is professionally written and will be a useful reference to researchers and students interested in mathematical and numerical problems of plasticity. It represents a major contribution in the area of continuum mechanics and numerical analysis." (Math Reviews)

The approach to plasticity theory developed here is firmly rooted in thermodynamics. Emphasis is placed on the use of potentials and the derivation of incremental response, necessary for numerical analysis. The derivation of constitutive models for irreversible behaviour entirely from two scalar potentials is shown. The use of potentials allows models to be very simply defined, classified and, if necessary, developed and it permits dependent and independent variables to be interchanged, making possible different forms of a model for different applications. The theory is extended to include treatment of rate-dependent materials and a powerful concept, in which a single plastic strain is replaced by a plastic strain function, allowing smooth transitions between elastic and plastic behaviour is introduced. This monograph will benefit academic researchers in mechanics, civil engineering and geomechanics and practising geotechnical engineers; it will also interest numerical analysts in engineering mechanics.

The contributions in this volume have been written by eminent scientists from the international mathematical community and present significant advances in several theories, methods and problems of Mathematical Analysis, Discrete Mathematics, Geometry and their Applications. The chapters focus on both old and recent developments in Functional Analysis, Harmonic Analysis, Complex Analysis, Operator Theory, Combinatorics, Functional Equations, Differential Equations as well as a variety of Applications. The book also contains some review works, which could prove particularly useful for a broader audience of readers in Mathematical Sciences, and especially to graduate students looking for the latest information. Understanding the elastoplastic deformation of metals and geomaterials, including the constitutive description of the materials and analysis of structure undergoing plastic deformation, is an essential part of the background required by mechanical, civil, and geotechnical engineers as well as materials scientists. However, most books address the subject at a introductory level and within the infinitesimal strain context. Elastoplasticity Theory takes a different approach in an advanced treatment presented entirely within the framework of finite deformation. This comprehensive, self-contained text includes an introduction to nonlinear continuum mechanics and nonlinear elasticity. In addition to in-depth analysis of the mathematical and physical theories of plasticity, it furnishes an up-to-date look at contemporary topics, such as plastic stability and localization, monocristalline plasticity, micro-to-macro transition, and polycrysalline plasticity models. Elastoplasticity Theory reflects recent trends and advances made in the theory of plasticity over the last four decades. It will not only help stimulate further research in the field, but will enable its readers to confidently select the appropriate constitutive models for the materials or structural members relevant to their own applications.
This book is addressed primarily to civil engineers familiar with such traditional topics as strength of materials, soil mechanics, and theory of elasticity and structures, but less familiar with the modern development of the mathematical theory of soil plasticity necessary to any engineer working under the general heading of nonlinear analysis of soil-structure system. This book will satisfy his needs in the case of the soil medium. It introduces the reader to the theory of soil plasticity and its numerical implementation into computer programs. The theory and method of computer implementation presented here are appropriate for solving nonlinear static dynamic problems in soil mechanics and are applicable for finite difference and finite element computer codes. A sample computer model subroutine is developed and this is used to study some typical soil mechanics problems. With its comprehensive coverage and simple, concise presentation, the book will undoubtedly prove to be very useful for consulting engineers, research and graduate students in geotechnical engineering.

This book concentrates upon the mathematical theory of plasticity and fracture as opposed to the physical theory of these fields, presented in the thermomechanical framework. The mathematical theory of contact mechanics is a growing field in engineering and scientific computing. This book is intended as a unified and readily accessible source for mathematicians, applied mechanicians, engineers, and scientists, as well as advanced students. The first part describes models of the processes involved like friction, heat generation and thermal effects, wear, adhesion and damage. The second part presents many mathematical models of practical interest and demonstrates the close interaction and cross-fertilization between contact mechanics and the theory of variational inequalities. The last part reviews further results, gives many references to current research and discusses open problems and future developments. The book can be read by mechanical engineers interested in applications. In addition, some theorems and their proofs are given as examples for the mathematical tools used in the models. Mechanics of Solids and Materials intends to provide a modern and integrated treatment of the foundations of solid mechanics as applied to the mathematical description of material behavior. The 2006 book blends both innovative (large strain, strain rate, temperature dependent deformation and localized plastic deformation in crystalline solids, deformation of biological networks) and traditional (elastic theory of torsion, elastic beam and plate theories, contact mechanics) topics in a coherent theoretical framework. The extensive use of transform methods to generate solutions makes the book also of interest to structural, mechanical, and aerospace engineers. Plasticity theories, micromechanics, crystal plasticity, energetics of elastic systems, as well as an overall review of math and thermodynamics are also covered in the book.

This book provides a representative selection of the most relevant, innovative, and useful mathematical methods and models applied to the analysis and characterization of composites and their behaviour on micro-, meso-, and macroscale. It establishes the fundamentals for meaningful and accurate theoretical and computer modelling of these materials in the future. Although the book is primarily concerned with fibre-reinforced composites, which have ever-increasing applications in fields such as aerospace, many of the results presented can be applied to other kinds of composites. The topics covered include: scaling and homogenization procedures in composite structures, thin plate and wave solutions in anisotropic materials, laminated structures, instabilities, fracture and damage analysis of composites, and highly efficient methods for simulation of composites manufacturing. The results presented are useful in the design, fabrication, testing, and industrial applications of composite components and structures. The book is written by well-known experts in different areas of applied mathematics, physics, and composite engineering and is an essential source of reference for graduate and doctoral students, as well as researchers.

This book gives a comprehensive account of the formulation and computational treatment of basic geometrically linear models in 1D. To set the stage, it assembles some preliminaries regarding necessary modelling, computational and mathematical tools. Thereafter, the remaining parts are concerned with the actual catalogue of computational material models. To this end, after starting out with elasticity as a reference, further 15 different basic variants of material models (5 x each of (visco-)elasticity, plasticity, visco-plasticity, respectively) are systematically explored. The presentation for each of these basic material models is a stand-alone account and follows in each case the same structure. On the one hand, this allows, in the true sense of a catalogue, to consult each of the basic material models separately without the need to refer to other basic material models. On the other hand, even though this somewhat repetitious concept may seem tedious, it allows to compare the formulation and resulting algorithmic setting of the various basic material models and thereby to uncover, in detail, similarities and differences. In particular, the response of each basic material model is analysed for the identical histories (Zig-Zag, Sine, Ramp) of prescribed strain and stress so as to clearly showcase and to contrast to each other the characteristics of the various modelling options.

This book is devoted to the deformation and failure in metallic materials, summarizing the results of a research programme financed by the "Deutsche Forschungsgemeinschaft". It presents the recent engineering as well as mathematical key aspects of this field for a broad community. Its main focus is on the constitutive behaviour as well as the damage and fracture of metallic materials, covering their mathematical foundation, modelling and numerics, but also relevant experiments and their verification.

Foundations of Elasticity, Plasticity and Viscoelasticity presents the fundamental skills and approaches for carrying out research in the field of modern problems in the mechanics of deformed solids, which involves the theories of elasticity, plasticity, and viscoelasticity. The book includes all modern methods of research as well as the results of the authors' recent work and is presented with sufficient mathematical strictness and proof. The first six chapters are devoted to the foundations of the theory of elasticity. Theory of stress-strain state, physical relations and problem statements, variation principles, contact and 2D problems, and the theory of plates are presented, and the theories are accompanied by examples of solving typical problems. The last six chapters will be useful to postgraduates and scientists engaged in nonlinear mechanics of deformed inhomogeneous bodies. The foundations of the modern theory of plasticity (general, small elastoplastic deformations and the theory of flow), linear, and nonlinear viscoelasticity are set forth. Corresponding research of three-layered circular plates of various materials is included to illustrate methods of problem solving. Analytical solutions and numerical results for elastic, elastoplastic, linear viscoelastic and viscoelastic-plastic plates are also given. Thermoviscoelastic characteristics of certain materials needed for numerical account are presented in the eleventh chapter. The informative book is intended for scientists, postgraduates and higher-level students of engineering spheres and will provide important practical skills and approaches.

Focussing on theoretical aspects of the small-strain theory of hardening elasto-plasticity, this monograph provides a comprehensive and unified treatment of the mathematical theory and numerical analysis, exploiting in particular the great advantages gained by placing the theory in a convex analytic context. Divided into three parts, the first part of the text provides a detailed introduction to plasticity, in which the mechanics of elastoplastic behaviour is emphasised, while the second part is taken up with mathematical analysis of the elastoplasticity problem. The third part is devoted to error analysis of various semi-discrete and fully discrete approximations for variational formulations of the elastoplasticity. Comprehensive introduction to finite elastoplasticity addressing various analytical and numerical analyses (including state-of-the-art theories Introduction to Finite Elastoplasticity presents introductory explanations that can be readily understood by readers with only a basic knowledge of elastoplasticity, showing physical backgrounds of concepts in detail and derivation processes of almost all equations. The
authors address various analytical and numerical finite strain analyses, including new theories developed in recent years, and explain fundamentals including the push-forward and pull-back operations and the Lie derivatives of tensors. As a foundation to finite strain theory, the authors begin by addressing the advanced mathematical and physical properties of continuum mechanics. They progress to explain a finite elastoplastic constitutive model, discuss numerical issues on stress computation, implement the numerical algorithms for stress computation into large-deformation finite element analysis and illustrate several numerical examples of boundary-value problems. Programs for the stress computation of finite elastoplastic models explained in this book are included in an appendix, and the code can be downloaded from an accompanying website.

Plasticity: Mathematical Theory and Numerical Analysis
Springer Science & Business Media

The aim of Plasticity Theory is to provide a comprehensive introduction to the contemporary state of knowledge in basic plasticity theory and to its applications. It treats several areas not commonly found between the covers of a single book: the physics of plasticity, constitutive theory, dynamic plasticity, large-deformation plasticity, and numerical methods, in addition to a representative survey of problems treated by classical methods, such as elastic-plastic problems, plane plastic flow, and limit analysis; the problem discussed come from areas of interest to mechanical, structural, and geotechnical engineers, metallurgists and others. The necessary mathematics and basic mechanics and thermodynamics are covered in an introductory chapter, making the book a self-contained text suitable for advanced undergraduates and graduate students, as well as a reference for practitioners of solid mechanics. The articles that comprise this distinguished annual volume for the Advances in Mechanics and Mathematics series have been written in honor of Gilbert Strang, a world-renowned mathematician and exceptional person. Written by leading experts in complementarity, duality, global optimization, and quantum computations, this collection reveals the beauty of these mathematical disciplines and investigates recent developments in global optimization, nonconvex and nonsmooth analysis, nonlinear programming, theoretical and engineering mechanics, large scale computation, quantum algorithms and computation, and information theory.

This text provides a complete introduction to the theory of variational inequalities with emphasis on contact mechanics. It covers existence, uniqueness and convergence results for variational inequalities, including the modelling and variational analysis of specific frictional contact problems with elastic, viscoelastic and viscoplastic materials. New models of contact are presented, including contact of piezoelectric materials. Particular attention is paid to the study of history-dependent quasivariational inequalities and to their applications in the study of contact problems with unilateral constraints. The book fully illustrates the cross-fertilisation between modelling and applications on the one hand and nonlinear mathematical analysis on the other. Indeed, the reader will gain an understanding of how new and nonstandard models in contact mechanics lead to new types of variational inequalities and, conversely, how abstract results concerning variational inequalities can be applied to prove the unique solvability of the corresponding contact problems.

This book presents new research results in multidisciplinary fields of mathematical and numerical modelling in mechanics. The chapters treat the topics: mathematical modelling in solid, fluid and contact mechanics nonconvex variational analysis with emphasis to nonlinear solid and structural mechanics numerical modelling of problems with non-smooth constitutive laws, approximation of variational and hemivariational inequalities, numerical analysis of discrete schemes, numerical methods and the corresponding algorithms, applications to mechanical engineering numerical aspects of non-smooth mechanics, with emphasis on developing accurate and reliable computational tools mechanics of fibre-reinforced materials behaviour of elastoplastic materials accounting for the microstructural defects definition of structural defects based on the differential geometry concepts or on the atomistic basis interaction between phase transformation and dislocations at nano-scale energetic arguments bifurcation and post-buckling analysis of elasto-plastic structures engineering optimization and design, global optimization and related algorithms. The book presents selected papers presented at ETAMM 2016. It includes new and original results written by internationally recognized specialists.