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This is the first book to provide a complete and rigorous presentation of the quasidifferentiability approach to nonconvex, possibly nonsmooth, energy functions,

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Nonsmooth energy functions govern phenomena which occur frequently in nature and in all areas of life. They constitute a fascinating subject in mathematics and permit the rational understanding of yet unsolved or partially solved questions in mechanics, engineering and economics. This is the first book to provide a complete and rigorous presentation of the quasidifferentiability approach to nonconvex, possibly nonsmooth, energy functions, of the derivation and study of the corresponding variational expressions in mechanics, engineering and economics, and of their numerical treatment. The new variational formulations derived are illustrated by many interesting numerical problems. The techniques presented will permit the reader to check any solution obtained by other heuristic techniques for nonconvex, nonsmooth energy problems. A civil, mechanical or aeronautical engineer can find in the book the only existing mathematically sound technique for the formulation and study of nonconvex, nonsmooth energy problems. Audience: The book will be of interest to pure and applied mathematicians, physicists, researchers in mechanics, civil,

mechanical and aeronautical engineers, structural analysts and software developers. It is also suitable for graduate courses in nonlinear mechanics, nonsmooth analysis, applied optimization, control, calculus of variations and computational mechanics.

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The aim of the book is to cover the three fundamental aspects of research in equilibrium problems: the statement problem and its formulation using mainly variational methods, its theoretical solution by means of classical and new variational tools, the calculus of solutions and applications in concrete cases. The book shows how many equilibrium problems follow a general law (the so-called user equilibrium condition). Such law allows us to express the problem in terms of variational inequalities. Variational inequalities provide a powerful methodology, by which existence and calculation of the solution can be obtained.

Nonsmooth mechanics is a relatively complex field and requires a good knowledge of mechanics as well as a good background in some parts of modern mathematics. The present volume of lecture notes follows a very successful advanced school, with the aim to cover as much as possible all these aspects. It includes contributions that cover mechanical aspects as well as the mathematical and numerical treatment.

Based on practical problems in mechanical engineering, here the author develops the fundamental concepts of non-smooth mechanics and introduces the necessary background material needed to deal with mechanics involving discontinuities and non-smooth constraints.

Nonsmooth and nonconvex models arise in several important applications of mechanics and engineering. The interest in this field is growing from both mathematicians and engineers. The study of numerous industrial applications, including contact phenomena in statics and dynamics or delamination effects in composites, require the consideration of nonsmoothness and nonconvexity. The mathematical topics discussed in this book include variational and hemivariational inequalities, duality, complementarity, variational principles, sensitivity analysis, eigenvalue and resonance problems, and minimax problems. Applications are considered in the following areas among others: nonsmooth statics and dynamics, stability of quasi- static evolution processes, friction problems, adhesive contact and debonding, inverse problems, pseudoelastic modeling of phase transitions, chaotic behavior in nonlinear beams, and nonholonomic mechanical systems. This volume contains 22 chapters written by various leading researchers and presents a cohesive and authoritative overview of recent results and applications in the area of nonsmooth and nonconvex mechanics. Audience: Faculty, graduate students, and researchers in applied mathematics, optimization, control and engineering.

Many questions dealing with solvability, stability and solution methods for va- ational inequalities or equilibrium, optimization and complementarity problems lead to the analysis of certain (perturbed) equations. This often requires a - formulation of the initial model being under consideration. Due to the specific of the original problem, the resulting equation is usually either not differ- tiable (even if the data of the original model are smooth), or it does not satisfy the assumptions of the classical implicit function theorem. This phenomenon is the main reason why a considerable analytical inst- ment dealing with generalized equations (i.e., with finding zeros of multivalued mappings) and nonsmooth equations (i.e., the defining functions are not c- tinuously differentiable) has been developed during the last 20 years, and that under very different viewpoints and assumptions. In this theory, the classical hypotheses of convex analysis, in particular, monotonicity and convexity, have been weakened or dropped, and the scope of possible applications seems to be quite large. Briefly, this discipline is often called nonsmooth analysis, sometimes also variational analysis. Our book fits into this discipline, however, our main intention is to develop the analytical theory in close connection with the needs of applications in optimization and related subjects. Main Topics of the Book 1. Extended analysis of Lipschitz functions and their generalized derivatives, including ”Newton maps” and regularity of multivalued mappings. 2. Principle of successive approximation under metric regularity and its - plication to implicit functions.

This volume contains a collection of papers based on lectures and presentations delivered at the International Conference on Constructive Nonsmooth Analysis (CNSA) held in St. Petersburg (Russia) from June 18-23, 2012. This conference was organized to mark the 50th anniversary of the birth of nonsmooth analysis and nondifferentiable optimization and was dedicated to J.-J. Moreau and the late B.N. Pshenichnyi, A.M. Rubinov, and N.Z. Shor, whose contributions to NSA and NDO remain invaluable. The first four chapters of the book are devoted to the theory of nonsmooth analysis. Chapters 5-8 contain new results in nonsmooth mechanics and calculus of variations. Chapters 9-13 are related to nondifferentiable optimization, and the volume concludes with four chapters containing interesting and important historical chapters, including tributes to three giants of nonsmooth analysis, convexity, and optimization: Alexandr Alexandrov, Leonid Kantorovich, and Alex Rubinov. The last chapter provides an overview and important snapshots of the 50-year history of convex analysis and optimization.