Numerical Methods For Nonsmooth Dynamical Systems Applications In Mechanics And Electronics Lecture Notes In Applied And Computational Mechanics

The aim of this International Symposium on Dynamics of Vibro-Impact Systems is to provide a forum for the discussion of recent developments in the theory and industrial applications of vibro-impact ocean systems. A special effort has been made to invite active researchers from engineering, science, and applied mathematics communities. This symposium has indeed updated engineers with recent analytical developments of vibro-impact dynamics and at the same time allowed engineers and industrial practitioners to alert mathematicians with their unresolved issues. The symposium was held in Troy, Michigan, during the period October 1-3, 2008. It included 28 presentations grouped as follows: The first group comprises of nine papers dealing with the interaction of ocean systems with slamming waves and floating ice. It also covers related topics such as sloshing-slamming dynamics, and non-smooth dynamics associated with offshore structures. Moreover, it includes control issues pertaining to marine surface vessels. The second group consists of fifteen papers treats the interaction of impact systems with friction and their control, Hertzian contact dynamics, parameter variation in vibro-impact oscillators, random excitation of vibro-impact systems, vibro-impact dampers, oscillators with a bouncing ball, limiting phase trajectory corresponding to energy exchange between the oscillator and external source, frequency-energy distribution in oscillators with impacts, and discontinuity mapping. The third group is covered in four papers and addresses some industrial applications such as hand-held percussion machines, rub-impact dynamics of rotating machinery, impact fatigue in joint structures.

It is our pleasure to present these proceedings for “ The Aerodynamics of Heavy Vehicles II: Trucks, Buses and Trains ” International Conference held in Lake - hoe, California, August 26-31, 2007 by Engineering Conferences International (ECI). Brought together were the world ’ s leading scientists and engineers from industry, universities, and research laboratories, including truck and high-speed train manufacturers and operators. All were gathered to discuss computer simu- tion and experimental techniques to be applied for the design of the more efficient trucks, buses and high-speed trains required in future years. This was the second conference in the series. The focus of the first conference in 2002 was the interplay between computations and experiment in minimizing ae- dynamic drag. The present proceedings, from the 2007 conference, address the development and application of advanced aerodynamic simulation and experim- tal methods for state-of-the-art analysis and design, as well as the development of new ideas and trends holding promise for the coming 10-year time span. Also - cluded, are studies of heavy vehicle aerodynamic tractor and trailer add-on - vices, studies of schemes to delay undesirable flow separation, and studies of - derhood thermal management.

This book analyzes several compliant contact force models within the context of multibody dynamics, while also revisiting the main issues associated with fundamental contact mechanics. In particular, it presents various contact force models, from linear to nonlinear, from purely elastic to dissipative, and describes their

parameters. Addressing the different numerical methods and algorithms for contact problems in multibody systems, the book describes the gross motion of multibody systems by using a two-dimensional formulation based on the absolute coordinates and employs different contact models to represent contact-impact events. Results for selected planar multibody mechanical systems are presented and utilized to discuss the main assumptions and procedures adopted throughout this work. The material provided here indicates that the prediction of the dynamic behavior of mechanical systems involving contact-impact strongly depends on the choice of contact force model. In short, the book provides a comprehensive resource for the multibody dynamics community and beyond on modeling contact forces and the dynamics of mechanical systems undergoing contact-impact events.

Many historically and artistically important masonry buildings of the world ' s architecturalheritageareindireneedofmaintenanceandrestoration.Inorder tooptimizesuchoperationsintermsofcost-e?ectiveness,architecturalimpact andstatice?ectiveness,accuratemodelsofthestructuralbehaviorofmasonry constructions are invaluable. The ultimate aim of such modeling is to obtain important information, such as the stress ?eld, and to estimate the extent of cracking and its evolution when the structure is subjected to variations in both boundary and loading conditions. Although masonry has been used in building for centuries, it is only - centlythatconstitutivemodelsandcalculationtechniqueshavebeenavailable that enable realistic description of the static behavior of structures made of this heterogeneous material whose response to tension is fundamentally d- ferent from that to compression. Important insights on the mechanical behavior of masonry arches and vaults come from as far back as Leonardo [10], Hooke [58], Poleni [92] and many other authors (see [47], [9] and [10] for detailed references). Castigliano, in his famous paper on the Mosca bridge [23], and Signorini, in his studies on masonry beams [97], [98], showed both the possibility and necessity of taking into account the weak tensile strength of masonry material.

Kansei Engineering and Soft Computing: Theory and Practice offers readers a comprehensive review of kansei engineering, soft computing techniques, and the fusion of these two fields from a variety of viewpoints. It explores traditional technologies, as well as solutions to real-world problems through the concept of kansei and the effective utilization of soft computing techniques. This publication is an essential read for professionals, researchers, and students in the field of kansei information processing and soft computing providing both theoretical and practical viewpoints of research in humanized technology.

The papers in this edited volume aim to provide a better understanding of the dynamics and control of a large class of hybrid dynamical systems that are described by different models in different state space domains. They not only cover important aspects and tools for hybrid systems analysis and control, but also a number of experimental realizations. Special attention is given to synchronization a universal phenomenon in nonlinear science that gained tremendous significance since its discovery by Huygens in the 17th century. Possible applications of the results introduced in the book include control of mobile robots, control of CD/DVD players, flexible manufacturing lines, and complex networks of interacting agents. The book is based on the material presented at a similarly entitled minisymposium at the 6th

European Nonlinear Dynamics Conference held in St Petersburg in 2008. It is unique in that it contains results of several international and interdisciplinary collaborations in the field, and reflects state-of-the-art technological development in the area of hybrid mechanical systems at the forefront of the 21st century.

Studies of vibro-impact dynamics falls into three main categories: modeling, mapping and applications. This text covers the latest in those studies plus selected deterministic and stochastic applications. It includes a bibliography exceeding 1,100 references.

Now in its third edition, this standard reference is a comprehensive treatment of nonsmooth mechanical systems refocused to give more prominence to issues connected with control and modelling. It covers Lagrangian and Newton–Euler systems, detailing mathematical tools such as convex analysis and complementarity theory. The ways in which nonsmooth mechanics influence and are influenced by well-posedness analysis, numerical analysis and simulation, modelling and control are explained. Contact/impact laws, stability theory and trajectory-tracking control are given detailed exposition connected by a mathematical framework formed from complementarity systems and measure-differential inclusions. Links are established with electrical circuits with set-valued nonsmooth elements as well as with other nonsmooth dynamical systems like impulsive and piecewise linear systems. Nonsmooth Mechanics (third edition) retains the topical structure familiar from its predecessors but has been substantially rewritten, edited and updated to account for the significant body of results that have emerged in the twenty-first century—including developments in: the existence and uniqueness of solutions; impact models; extension of the Lagrange–Dirichlet theorem and trajectory tracking; and well-posedness of contact complementarity problems with and without friction. Many figures (both new and redrawn to improve the clarity of the presentation) and examples are used to illustrate the theoretical developments. Material introducing the mathematics of nonsmooth mechanics has been improved to reflect the broad range of applications interest that has developed since publication of the second edition. The detail of some mathematical essentials is provided in four appendices. With its improved bibliography of over 1,300 references and wide-ranging coverage, Nonsmooth Mechanics (third edition) is sure to be an invaluable resource for researchers and postgraduates studying the control of mechanical systems, robotics, granular matter and relevant fields of applied mathematics. “ The book ’ s two best features, in my view are its detailed survey of the literature... and its detailed presentation of many examples illustrating both the techniques and their limitations... For readers interested in the field, this book will serve as an excellent introductory survey. ” Andrew Lewis in Automatica “ It is written with clarity, contains the latest research results in the area of impact problems for rigid bodies and is recommended for both applied mathematicians and engineers. ” Panagiotis D. Panagiotopoulos in Mathematical Reviews “ The presentation is excellent in combining rigorous mathematics with a great number of examples... allowing the reader to understand the basic concepts. ” Hans Troger in Mathematical Abstracts “ /i>

Information Computing and Applications, Part II

Masonry Constructions: Mechanical Models and Numerical Applications

This book discusses emerging topics in the area of nonsmooth dynamics research, such as numerical methods for nonsmooth systems, impact laws for multi-collisions, nonlinear vibrations and control of nonsmooth systems. It documents original work of researchers at the European Network for NonSmooth Dynamics (ENNSD), which provides a cooperation platform for researchers in the field and promotes research focused on nonsmooth dynamics and its applications. Since the establishment of the network in 2012, six ENNSD symposia have been organized at different European locations. The network brings together 40 specialists from 9 different countries in and outside Europe and a wealth of scientific knowledge has been gathered and developed by this group of experts in recent years. The book is of interest to both new and experienced researchers in the field of nonsmooth dynamics. Each chapter is written in such a way as to provide an introduction to the topic for researchers from other fields.

Qualitative Analysis of Nonsmooth Dynamics: A Simple Discrete System with Unilateral Contact and Coulomb Friction explores the effects of small and large deformations to understand how shocks, sliding, and stick phases affect the trajectories of mechanical systems. By analyzing these non-regularities successively this work explores the set of equilibria and properties of periodic solutions of elementary mechanical systems, where no classical results issued from the theory of ordinary differential equations are readily available, such as stability, continuation or approximation of solutions. The authors focus on unilateral contact in presence of Coulomb friction and show, in particular, how any regularization would greatly simplify the mathematics but lead to unacceptable physical responses. Explores the effects of small and large deformations to understand how shocks, sliding, and stick phases affect the trajectories of mechanical systems Includes theoretical results concerning the full investigation of the behavior under constant or oscillating loadings, even in the case of the simplest mechanical systems Provides a focus on unilateral contact in presence of Coulomb friction Helps you gain an accurate understanding of how the transition occurs to ensure the safe use of any machine involving rotating or sliding mechanisms

The book combines vehicle systems dynamics with the latest theoretical developments in dynamics of non-smooth systems and numerical analysis of differential-algebraic dynamical systems with discontinuities. These two fields are fundamental for the modelling and analysis of vehicle

dynamical sytems. The results are also applicable to other non-smooth dynamical systems.

This volume provides the international multibody dynamics community with an up-to-date view on the state of the art in this rapidly growing field of research which now plays a central role in the modeling, analysis, simulation and optimization of mechanical systems in a variety of fields and for a wide range of industrial applications. This book contains selected contributions delivered at the ECCOMAS Thematic Conference on Multibody Dynamics, which was held in Brussels, Belgium and organized by the Université catholique de Louvain, from 4th to 7th July 2011. Each paper reflects the State-of-Art in the application of Multibody Dynamics to different areas of engineering. They are enlarged and revised versions of the communications, which were enhanced in terms of self-containment and tutorial quality by the authors. The result is a comprehensive text that constitutes a valuable reference for researchers and design engineers which helps to appraise the potential for the application of multibody dynamics methodologies to a wide range of areas of scientific and engineering relevance.

This second edition of Dissipative Systems Analysis and Control has been substantially reorganized to accommodate new material and enhance its pedagogical features. It examines linear and nonlinear systems with examples of both in each chapter. Also included are some infinite-dimensional and nonsmooth examples. Throughout, emphasis is placed on the use of the dissipative properties of a system for the design of stable feedback control laws.

Nonlinear Dynamics represents a wide interdisciplinary area of research dealing with a variety of “unusual” physical phenomena by means of nonlinear differential equations, discrete mappings, and related mathematical algorithms. However, with no real substitute for the linear superposition principle, the methods of Nonlinear Dynamics appeared to be very diverse, individual and technically complicated. This book makes an attempt to find a common ground for nonlinear dynamic analyses based on the existence of strongly nonlinear but quite simple counterparts to the linear models and tools. It is shown that, since the subgroup of rotations, harmonic oscillators, and the conventional complex analysis generate linear and weakly nonlinear approaches, then translations and reflections, impact oscillators, and hyperbolic (Clifford’s) algebras must give rise to some “quasi impact” methodology. Such strongly nonlinear methods are developed in several chapters of this book based on the idea of non-smooth time substitutions. Although most of the illustrations are based on mechanical oscillators, the area of applications may include also electric, electro-mechanical, electrochemical and other physical models generating strongly anharmonic temporal signals or spatial distributions. Possible applications to periodic elastic structures with non-smooth or discontinuous characteristics are outlined in the final chapter of the book.

While the stability theory for systems with bilateral constraints is a well-established field, this monograph represents a systematic study of mechanical systems with unilateral constraints, such as unilateral

contact, impact and friction. Such unilateral constraints give rise to non-smooth dynamical models for which stability theory is developed in this work. The book will be of interest to those working in the field of non-smooth mechanics and dynamics.

This is the proceedings of IFToMM CK 2017, the 7th International Workshop on Computational Kinematics that was held in Futuroscope-Poitiers, France in May 2017. Topics treated include: kinematic design and synthesis, computational geometry in kinematics, motion analysis and synthesis, theory of mechanisms, mechanism design, kinematical analysis of serial and parallel robots, kinematical issues in biomechanics, molecular kinematics, kinematical motion analysis and simulation, geometric constraint solvers, deployable and tensegrity structures, robot motion planning, applications of computational kinematics, education in computational kinematics, and theoretical foundations of kinematics. Kinematics is an exciting area of computational mechanics and plays a central role in a great variety of fields and industrial applications nowadays. Apart from research in pure kinematics, the field deals with problems of practical relevance that need to be solved in an interdisciplinary manner in order for new technologies to develop. The results presented in this book should be of interest for practicing and research engineers as well as Ph.D. students from the fields of mechanical and electrical engineering, computer science, and computer graphics.

Bifurcation and Chaos in Nonsmooth Mechanical Systems
Complementarity and Variational Inequalities in Electronics
Robotics and Mechatronics
Convective Heat and Mass Transfer in Rotating Disk Systems
Computational Methods and Applications
High Performance Computing in Science and Engineering
Nonsmooth Optimization
Advanced Topics in Nonsmooth Dynamics
Theory and Applications
Numerical Methods for Fluid Dynamics V
Models, Dynamics and Control
Applications in Unilateral Mechanics and Electronics

This monograph combines the knowledge of both the field of nonlinear dynamics and non-smooth mechanics, presenting a framework for a class of non-smooth mechanical systems using techniques from both fields. The book reviews recent developments, and opens the field to the nonlinear dynamics community. This book addresses researchers and graduate students in engineering and mathematics interested in the modelling, simulation and dynamics of non-smooth systems and nonlinear dynamics.

This brief examines mathematical models in nonsmooth mechanics and nonregular electrical circuits, including evolution variational inequalities, complementarity systems, differential inclusions, second-order dynamics, Lur'e systems and Moreau's sweeping process. The field of nonsmooth dynamics is of great interest to mathematicians, mechanicians, automatic controllers and engineers. The present volume acknowledges this transversality and provides a

multidisciplinary view as it outlines fundamental results in nonsmooth dynamics and explains how to use them to study various problems in engineering. In particular, the author explores the question of how to redefine the notion of dynamical systems in light of modern variational and nonsmooth analysis. With the aim of bridging between the communities of applied mathematicians, engineers and researchers in control theory and nonlinear systems, this brief outlines both relevant mathematical proofs and models in unilateral mechanics and electronics.

This book concerns the numerical simulation of dynamical systems whose trajec- ries may not be differentiable everywhere. They are named nonsmooth dynamical systems. They make an important class of systems, rst because of the many app- cations in which nonsmooth models are useful, secondly because they give rise to new problems in various elds of science. Usually nonsmooth dynamical systems are represented as differential inclusions, complementarity systems, evolution va- ational inequalities, each of these classes itself being split into several subclasses. The book is divided into four parts, the rst three parts being sketched in Fig. 0. 1. The aim of the rst part is to present the main tools from mechanics and applied mathematics which are necessary to understand how nonsmooth dynamical systems may be numerically simulated in a reliable way. Many examples illustrate the th- retical results, and an emphasis is put on mechanical systems, as well as on electrical circuits (the so-called Filippov ' s systems are also examined in some detail, due to their importance in control applications). The second and third parts are dedicated to a detailed presentation of the numerical schemes. A fourth part is devoted to the presentation of the software platform Siconos. This book is not a textbook on - merical analysis of nonsmooth systems, in the sense that despite the main results of numerical analysis (convergence, order of consistency, etc.) being presented, their proofs are not provided.

"This book concerns matter that is intrinsically difficult: convex optimization, complementarity and duality, nonsmooth analysis, linear and nonlinear programming, etc. The author has skillfully introduced these and many more concepts, and woven them into a seamless whole by retaining an easy and consistent style throughout. The book is not all theory: There are many real-life applications in structural engineering, cable networks, frictional contact problems, and plasticity... I recommend it to any reader who desires a modern, authoritative account of nonsmooth mechanics and convex optimization." – Prof. Graham M.L. Gladwell, Distinguished Professor Emeritus, University of Waterloo, Fellow of the Royal Society of Canada "... reads very well–the structure is good, the language and style are clear and fluent, and the material is rendered accessible by a careful presentation that contains many concrete examples. The range of applications, particularly to problems in mechanics, is admirable and a valuable complement to theoretical and computational investigations that are at the forefront of the areas concerned." – Prof. B. Daya Reddy, Department of

Mathematics and Applied Mathematics, Director of Centre for Research in Computational and Applied Mechanics, University of Cape Town, South Africa "Many materials and structures (e.g., cable networks, membrane) involved in practical engineering applications have complex responses that cannot be described by smooth constitutive relations. ... The author shows how these difficult problems can be tackled in the framework of convex analysis by arranging the carefully chosen materials in an elegant way. Most of the contents of the book are from the original contributions of the author. They are both mathematically rigorous and readable. This book is a must-read for anyone who intends to get an authoritative and state-of-art description for the analysis of nonsmooth mechanics problems with theory and tools from convex analysis." – Prof. Xu Guo, State Key Laboratory of Structural Analysis for Industrial Equipment, Department of Engineering Mechanics, Dalian University of Technology

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.

Nonsmooth Modeling and Simulation for Switched Circuits concerns the modeling and the numerical simulation of switched circuits with the nonsmooth dynamical systems (NSDS) approach, using piecewise-linear and multivalued models of electronic devices like diodes, transistors, switches. Numerous examples (ranging from introductory academic circuits to various types of power converters) are analyzed and many simulation results obtained with the INRIA open-source SICONOS software package are presented. Comparisons with SPICE and hybrid methods demonstrate the power of the NSDS approach. Nonsmooth Modeling and Simulation for Switched Circuits is intended to researchers and engineers in the field of circuits simulation and design, but may also attract applied mathematicians interested by the numerical analysis for nonsmooth dynamical systems, as well as researchers from Systems and

Control.

This book constitutes the thoroughly refereed post-conference proceedings of the Second International Conference on High Performance Computing in Science and Engineering, HPCSE 2015, held in Sol á ň , Czech Republic, in May 2015. The 14 papers presented in this volume were carefully reviewed and selected from 21 submissions. The conference provides an international forum for exchanging ideas among researchers involved in scientific and parallel computing, including theory and applications, as well as applied and computational mathematics. The focus of HPCSE 2015 was on models, algorithms, and software tools which facilitate efficient and convenient utilization of modern parallel and distributed computing architectures, as well as on large-scale applications.

This book is a self-contained elementary study for nonsmooth analysis and optimization, and their use in solution of nonsmooth optimal control problems. The first part of the book is concerned with nonsmooth differential calculus containing necessary tools for nonsmooth optimization. The second part is devoted to the methods of nonsmooth optimization and their development. A proximal bundle method for nonsmooth nonconvex optimization subject to nonsmooth constraints is constructed. In the last part nonsmooth optimization is applied to problems arising from optimal control of systems covered by partial differential equations. Several practical problems, like process control and optimal shape design problems are considered. Contents: Part I: Nonsmooth Analysis:IntroductionConvex AnalysisNonsmooth Differential TheoryNonsmooth GeometryNonsmooth Optimization TheoryPart II: Nonsmooth Optimization:IntroductionA Survey of Bundle MethodsProximal Bundle Method for Nonconvex Constrained OptimizationNumerical ExperimentsPart III: Nonsmooth Optimal Control:IntroductionPreliminariesDistributed Parameter Control Problems Optimal Shape Design Boundary Control for Stefan Type Problems Readership: Applied mathematicians, mathematicians, operations researchers, engineers, economists and mathematical physicists. keywords:Nonsmooth Optimization;Nondifferentiable Programming;Bundle Methods;Convex Analysis;Nonconvexity;Subgradients;Tangent and Normal Cones;Optimal Control;Optimal Shape Design;Continuous Casting

Applications in Mechanics and Electronics

Transactions of the European Network for Nonsmooth Dynamics

A Simple Discrete System with Unilateral Contact and Coulomb Friction

Modeling, Analysis and Numerical Methods

Dynamics and Control of Switched Electronic Systems

Between Linear and Impact Limits

Numerics of Unilateral Contacts and Friction

Nonsmooth/Nonconvex Mechanics

Lectures given at the 3rd 1983 Session of the Centro Internationale Matematico Estivo (CIME) held at Como, Italy, July 7-15, 1983

International Conference, ICICA 2010, Tangshan, China, October 15-18, 2010.

Proceedings

Second International Conference, HPCSE 2015, Sol á ň , Czech Republic, May 25-28, 2015, Revised Selected Papers

Dynamics and Bifurcations of Non-Smooth Mechanical Systems

The book is devoted to investigation of a series of problems of convective heat and mass transfer in rotating-disk systems. Such systems are widespread in scienti?c and engineering applications. As examples from the practical area, one can mention gas turbine and computer engineering, disk brakes of automobiles, rotating-disk air cleaners, systems of microclimate, extractors, dispensers of liquids, evaporators, c- cular saws, medical equipment, food process engineering, etc. Among the scienti?c applications, it is necessary to point out rotating-disk electrodes used for experim- tal determination of the diffusion coef?cient in electrolytes. The system consisting of a ?xed disk and a rotating cone that touches the disk by its vertex is widely used for measurement of the viscosity coef?cient of liquids. For time being, large volume of experimental and computational data on par- eters of ?uid ?ow, heat and mass transfer in different types of rotating-disk systems have been accumulated, and different theoretical approaches to their simulation have been developed. This obviously causes a need of systematization and generalization of these data in a book form.

This volume contains the proceedings of the International Conference on Inf- mation Computing and Applications (ICICA 2010), which was held in Tangshan, China, October 15-18, 2010. As future-generation information technology, information computing and applications become specialized, information computing and applications - cluding hardware, software, communications and networks are growing with ever-increasing scale and heterogeneity and becoming overly complex. The c- plexity is getting more critical along with the growing applications. To cope with the growing and computing complexity, information computing and applications focus on intelligent, selfmanageable, scalable computing systems and applications to the maximum extent possible without human intervention or guidance. With the rapid development of information science and technology, infor- tion computing has become the third approach of science research. Information computing and applications is the ?eld of study concerned with constructing - telligent computing, mathematical models, numerical solution techniques and using computers to analyze and solve natural scienti?c, social scienti?c and engineering problems. In practical use, it is typically the application of c- puter simulation, intelligent computing, internet computing, pervasive comp- ing, scalable

computing, trusted computing, autonomy-oriented computing, evolutionary computing, mobile computing, computational statistics, engine- ing computing, multimedia networking and computing, applications and other forms of computation problems in various scienti?c disciplines and engine- ing. Information computing and applications is an important underpinning for techniques used in information and computational science and there are many unresolved problems that address worth studying.

This book presents the theoretical frame for studying lumped nonsmooth dynamical systems: the mathematical methods are recalled, and adapted numerical methods are introduced (differential inclusions, maximal monotone operators, Filippov theory, Aizerman theory, etc.). Tools available for the analysis of classical smooth nonlinear dynamics (stability analysis, the Melnikov method, bifurcation scenarios, numerical integrators, solvers, etc.) are extended to the nonsmooth frame. Many models and applications arising from mechanical engineering, electrical circuits, material behavior and civil engineering are investigated to illustrate theoretical and computational developments.

Complementarity and Variational Inequalities in Electronics evaluates the main mathematical models relevant to the study of electrical network problems involving devices. The book focuses on complementarity problems, variational inequalities and non-regular dynamical systems which are well-known for their applications in mechanics and economics, but rarely target electrical applications. The book uses these tools to review the qualitative properties of devices, including slicers, amplitude selectors, sampling gates, operational amplifiers, and four-diode bridge full-wave rectifiers. Users will find demonstrations on how to compute optimized output signal relevant to potentially superior applications. In addition, the book describes how to determine the stationary points of dynamical circuits and to determine the corresponding Lyapunov stability and attractivity properties, topics of major importance for further dynamical analysis and control. Hemivariational inequalities are also covered in some depth relevant to application in thyristor devices. Reviews the main mathematical models applicable to the study of electrical networks involving diodes and transistors Focuses on theoretical existence and uniqueness of a solution, stability of stationary solutions, and invariance properties Provides realistic complementarity and variational problems to illustrate theoretical results Evaluates applications of the theory across many devices, including slicers, amplitude selectors, sampling gates, operational amplifiers, and four-diode bridge full-wave

rectifiers Details both fully developed mathematical proofs and common models used in electronics Provides a comprehensive literature review, including thousands of relevant references This book provides a summary of recent research on the computational aspects of fluid dynamics. It includes contributions from many distinguished mathematicians and engineers. The main themes of the book are algorithms and algorithmic needs arising from applications, Navier-Stokes on flexible grids, and environmental computational fluid dynamics. This book contains theoretical and application-oriented methods to treat models of dynamical systems involving non-smooth nonlinearities. The theoretical approach that has been retained and underlined in this work is associated with differential inclusions of mainly finite dimensional dynamical systems and the introduction of maximal monotone operators (graphs) in order to describe models of impact or friction. The authors of this book master the mathematical, numerical and modeling tools in a particular way so that they can propose all aspects of the approach, in both a deterministic and stochastic context, in order to describe real stresses exerted on physical systems. Such tools are very powerful for providing reference numerical approximations of the models. Such an approach is still not very popular nevertheless, even though it could be very useful for many models of numerous fields (e.g. mechanics, vibrations, etc.). This book is especially suited for people both in research and industry interested in the modeling and numerical simulation of discrete mechanical systems with friction or impact phenomena occurring in the presence of classical (linear elastic) or non-classical constitutive laws (delay, memory effects, etc.). It aims to close the gap between highly specialized mathematical literature and engineering applications, as well as to also give tools in the framework of non-smooth stochastic differential systems: thus, applications involving stochastic excitations (earthquakes, road surfaces, wind models etc.) are considered. Contents 1. Some Simple Examples. 2. Theoretical Deterministic Context. 3. Stochastic Theoretical Context. 4. Riemannian Theoretical Context. 5. Systems with Friction. 6. Impact Systems. 7. Applications–Extensions. About the Authors Jérôme Bastien is Assistant Professor at the University Lyon 1 (Centre de recherche et d'Innovation sur le sport) in France. Frédéric Bernardin is a Research Engineer at Département Laboratoire de Clermont-Ferrand (DLCF), Centre d'Etudes Techniques de l'Equipement (CETE), Lyon, France. Claude-Henri Lamarque is Head of Laboratoire Géomatériaux et Génie Civil (LGCB) and Professor at Ecole des Travaux Publics de l'Etat (ENTPE), Vaulx-en-Velin,

France.

The increased efficiency and quality constraints imposed on electrical energy systems have inspired a renewed research interest in the study of formal approaches to the analysis and control of power electronics converters. Switched systems represent a useful framework for modeling these converters and the peculiarities of their operating conditions and control goals justify the specific classification of “switched electronic systems”. Indeed, idealized switched models of power converters introduce problems not commonly encountered when analyzing generic switched models or non-switched electrical networks. In that sense the analysis of switched electronic systems represents a source for new ideas and benchmarks for switched and hybrid systems generally. Dynamics and Control of Switched Electronic Systems draws on the expertise of an international group of expert contributors to give an overview of recent advances in the modeling, simulation and control of switched electronic systems. The reader is provided with a well-organized source of references and a mathematically-based report of the state of the art in analysis and design techniques for switched power converters. Intuitive language, realistic illustrative examples and numerical simulations help the reader to come to grips with the rigorous presentation of many promising directions of research such as: converter topologies and modulation techniques; continuous-time, discrete-time and hybrid models; modern control strategies for power converters; and challenges in numerical simulation. The guidance and information imparted in this text will be appreciated by engineers, and applied mathematicians working on system and circuit theory, control systems development, and electronic and energy conversion systems design.

This volume constitutes an advanced introduction to the field of analysis, modeling and numerical simulation of rigid body mechanical systems with unilateral constraints. The topics include Moreau's sweeping process, the numerical analysis of nonsmooth multibody systems with friction, the study of energetical restitution coefficients for elasto-plastic models, the study of stability and bifurcation in systems with impacts, and the development of a multiple impact rule for Newton's cradle and the simple rocking model. Combining pedagogical aspects with innovative approaches, this book will not only be of interest to researchers working actively in the field, but also to graduate students wishing to get acquainted with this field of research through lectures written at a level also accessible to nonspecialists.

Stability and Convergence of Mechanical Systems with Unilateral

Mechanics provides the link between mathematics and practical engineering app- cations. It is one of the oldest sciences, and many famous scientists have left and will leave their mark in this fascinating ?eld of research. Perhaps one of the most prominentscientists in mechanics was Sir Isaac Newton, who with his "laws of - tion" initiated the description of mechanical systems by differential equations. And still today, more than 300 years after Newton, this mathematical concept is more actual than ever. The rising computer power and the development of numerical solvers for diff- ential equations allowed engineersall over the world to predict the behavior of their physical systems fast and easy in an numerical way. And the trend to computational simulation methods is still further increasing, not only in mechanics, but practically in all branches of science. Numerical simulation will probablynot solve the world's engineering problems, but it will help for a better understanding of the mechanisms of our models.

Presents an aspect of activity in integral equations methods for the solution of Volterra equations for those who need to solve real-world problems. Since there are few known analytical methods leading to closed-form solutions, the emphasis is on numerical techniques. The major points of the analytical methods used to study the properties of the solution are presented in the first part of the book. These techniques are important for gaining insight into the qualitative behavior of the solutions and for designing effective numerical methods. The second part of the book is devoted entirely to numerical methods. The author has chosen the simplest possible setting for the discussion, the space of real functions of real variables. The text is supplemented by examples and exercises.

This book gathers the latest advances, innovations and applications in the field of robotics and mechatronics, as presented by leading international researchers and engineers at the 6th IFToMM International Symposium on Robotics and Mechatronics (ISRM), held in Taipei, Taiwan, on October 28–30, 2019. It covers highly diverse topics, including mechanism synthesis, analysis, and design, kinematics and dynamics of multibody systems, modelling and simulation, sensors and actuators, novel robotic systems, industrial-

and service-related robotics and mechatronics, medical robotics, and historical developments in robotics and mechatronics. The contributions, which were selected through a rigorous international peer-review process, share exciting ideas that spur novel research directions and foster new, multidisciplinary collaborations.

Phenomena occurring during a contact of two bodies are encountered in everyday life. In reality almost every type of motion is related to frictional contact between a moving body and a ground. Moreover, modeling of simple and more complex processes as nailing, cutting, vacuum pressing, movement of machines and their elements, rolling or, finally, a numerical simulation of car crash tests, requires taking contact into account. Therefore, its analysis has been a subject of many research efforts for a long time now. However, it is author's opinion that there are relatively few efforts related to contact between structural elements, like beams, plates or shells. The purpose of this work is to fill this gap. It concerns the beam-to-beam contact as a specific case of the 3D solids contact. A numerical formulation of frictional contact for beams with two shapes of cross-section is derived. Further, a couple of effective methods for modeling of smooth curves representing beam axes are presented. A part of the book is also devoted to analyze some aspects of thermo-electro-mechanical coupling in contact of thermal and electric conductors. Analyses in every chapter are illustrated with numerical examples showing the performance of derived contact finite elements.

Contents Recent advancements in the performance of industrial products and structures are quite intense. Consequently, mechanical design of high accuracy is necessary to enhance their mechanical performance, strength and durability. The basis for their mechanical design can be provided through elastoplastic deformation analyses. For that reason, industrial engineers in the fields of mechanical, civil, architec- ral, aerospace engineering, etc. must learn pertinent knowledge relevant to elas- plasticity. Numerous books about elastoplasticity have been published since "Mathema- cal Theory of Plasticity", the notable book of R. Hill (1950), was written in the middle of the last century. That and similar books mainly address conventional plasticity models on the premise that the interior of a yield surface is an elastic domain. However, conventional plasticity models are applicable to the prediction of monotonic loading behavior, but are inapplicable to prediction of deformation behavior of machinery subjected to cyclic loading and civil or architectural str- tures subjected to earthquakes. Elastoplasticity has developed to predict defor- tion behavior under cyclic loading and non-proportional loading and to describe nonlocal, finite and rate-dependent deformation behavior.

Qualitative Analysis of Nonsmooth Dynamics
Applications to Models with Friction or Impact
Computational Kinematics
Nonlinear Dynamics
Nonsmooth Modeling and Simulation for Switched Circuits
Modeling and Numerical Time Integration in Non-Smooth Dynamics

Nonsmooth Mechanics
Proceedings of the 7th International Workshop on Computational Kinematics that was held at Futuroscope-Poitiers, France, in May 2017
Impacts in Mechanical Systems
Kansei Engineering and Soft Computing: Theory and Practice
The Aerodynamics of Heavy Vehicles II: Trucks, Buses, and Trains
Analysis and Algorithms with Applications to Optimal Control