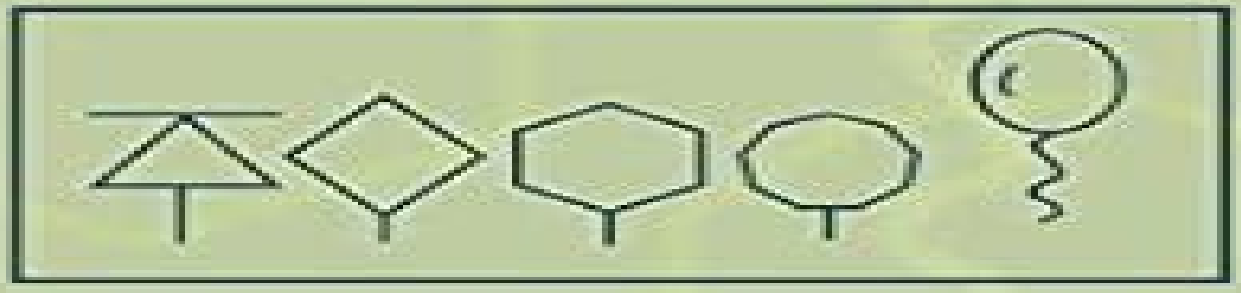
Piecewise Linear Modeling and Analysis

Domine M.W. Leenaerts and Wim M.G. van Bokhoven



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Piecewise Linear Modeling And Analysis

Vincent Acary,Olivier Bonnefon,Bernard Brogliato

Piecewise Linear Modeling And Analysis:

Piecewise Linear Modeling and Analysis Domine Leenaerts,Wim M.G. van Bokhoven,2013-03-09 Piecewise Linear PL approximation of non linear behaviour is a well known technique in synthesis and analysis of electrical networks However the PL description should be efficient in data storage and the description should allow simple retrieval of the stored information Furthermore it would be useful if the model description could handle a large class of piecewise linear mappings Piecewise Linear Modeling and Analysis explains in detail all possible model descriptions for efficiently storing piecewise linear functions starting with the Chua descriptions Detailed explanation on how the model parameter can be obtained for a given mapping is provided and demonstrated by examples The models are ranked to compare them and to show which model can handle the largest class of PL mappings All model descriptions are implicitly related to the Linear Complementarity Problem and most solution techniques for this problem like Katzenelson and Lemke are discussed according to examples that are explained in detail To analyse PL electrical networks a simulator is mandatory Piecewise Linear Modeling and Analysis provides a detailed outline of a possible PL simulator including pseudo programming code Several simulation domains like transient AC and distortion are discussed The book explains the attractive features of PL simulators with respect to mixed level and mixed signal simulation while paying due regard also to hierarchical simulation Piecewise Linear Modeling and Analysis shows in detail how many existing components in electrical networks can be modeled These range from digital logic and analog basic elements such as transistors to complex systems like Phase Locked Loops and detection systems Simulation results are also provided The book concludes with a discussion on how to find multiple solutions for PL functions or networks Again the most common techniques areoutlined using clear examples Piecewise Linear Modeling and Analysis is an indispensable guide for researchers and designers interested in network theory network synthesis and network analysis

Piecewise-linear Modelling and Analysis Wilhelmus Maria Gezinus van Bokhoven,1981 Piecewise Linear Control Systems Mikael K.-J. Johansson,2003-07-01 2 Piecewise Linear Modeling 9 2 1 Model Representation 9 2 2 Solution Concepts 2 3 Uncertainty Models 2 4 Modularity and Interconnections 26 2 5 Piecewise Linear Function Representations 28 2 6 Comments and References 30 3 Structural Analysis 32 3 1 Equilibrium Points and the Steady State Characteristic 32 3 2 Constraint Verification and Invariance 35 3 3 Detecting Attractive Sliding Modes on Cell Boundaries 37 3 4 Comments and References 39 4 Lyapunov Stability 41 4 1 Exponential Stability 41 4 2 Quadratic Stability 42 4 3 Conservatism of Quadratic Stability 46 4 4 From Quadratic to Piecewise Quadratic 48 4 5 Interlude Describing Partition Properties 51 4 6 Piecewise Quadratic Lyapunov Functions 55 4 7 Analysis of Piecewise Linear Differential Inclusions 61 4 8 Analysis of Systems with Attractive Sliding Modes 63 4 9 Improving Computational Efficiency 66 4 10 Piecewise Linear Lyapunov Functions 72 4 11 A Unifying View 77 4 12 Comments and References 82 5 Dissipativity Analysis 85 5 1 Dissipativity Analysis via Convex Optimization 86 21 14 Contents Contents 5 2 Computation of 2 induced Gain 88 5 3 Estimation of Transient Energy 89 5 4

Dissipative Systems with Quadratic Supply Rates 91 5 5 Comments and References 95 Controller Design 96 6 1 Quadratic Stabilization of Piecewise Linear Systems 97 6 2 Controller Synthesis based on Piecewise Quadratics 98 6 3 Comments and References 105 7 Selected Topics 107 7 1 Estimation of Regions of Attraction **Analysis, Modelling, Optimization, and Numerical Techniques** Gerard Olivar Tost,Olga Vasilieva,2015-03-18 This book highlights recent compelling research results and trends in various aspects of contemporary mathematics emphasizing applicabilitions to real world situations The chapters present exciting new findings and developments in situations where mathematical rigor is combined with common sense A multi disciplinary approach both within each chapter and in the volume as a whole leads to practical insights that may result in a more synthetic understanding of specific global issues as well as their possible solutions The volume will be of interest not only to experts in mathematics but also to graduate students scientists and practitioners from other fields including physics biology geology management and medicine **The Circuits and Filters Handbook (Five Volume Slipcase Set)** Wai-Kai Chen,2018-12-14 Standard setting groundbreaking authoritative comprehensive these often overused words perfectly describe The Circuits and Filters Handbook Third Edition This standard setting resource has documented the momentous changes that have occurred in the field of electrical engineering providing the most comprehensive coverage available More than 150 contributing experts offer in depth insights and enlightened perspectives into standard practices and effective techniques that will make this set the first and most likely the only tool you select to help you with problem solving In its third edition this groundbreaking bestseller surveys accomplishments in the field providing researchers and designers with the comprehensive detail they need to optimize research and design All five volumes include valuable information on the emerging fields of circuits and filters both analog and digital Coverage includes key mathematical formulas concepts definitions and derivatives that must be mastered to perform cutting edge research and design The handbook avoids extensively detailed theory and instead concentrates on professional applications with numerous examples provided throughout The set includes more than 2500 illustrations and hundreds of references Available as a comprehensive five volume set each of the subject specific volumes can also be purchased separately *The Circuits and Filters Handbook* Wai-Kai Chen,2002-12-23 A bestseller in its first edition The Circuits and Filters Handbook has been thoroughly updated to provide the most current most comprehensive information available in both the classical and emerging fields of circuits and filters both analog and digital This edition contains 29 new chapters with significant additions in the areas of computer

Nonsmooth Modeling and Simulation for Switched Circuits Vincent Acary,Olivier Bonnefon,Bernard Brogliato,2010-10-19 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 Nonlinear and Distributed Circuits Wai-Kai Chen,2018-10-08 Culled from the pages of CRC s highly successful best selling The Circuits and Filters Handbook Second Edition Nonlinear and Distributed Circuits presents a sharply focused comprehensive review of the fundamental theory behind professional applications of these complex circuits It supplies a concise convenient reference to the key concepts models and equations necessary to analyze design and predict the behavior of nonlinear and distributed circuits illustrated by frequent examples Edited by a distinguished authority this book emphasizes the theoretical concepts underlying the processes behavior and operation of these devices More than 225 figures and tables illustrate the concepts and where necessary the theories principles and mathematics of some subjects are reviewed Expert contributors discuss the analysis synthesis and design of nonlinear circuits their representation approximation identification and simulation cellular neural networks multiconductor transmission lines and analysis and synthesis of distributed circuits Nonlinear and Distributed Circuits builds a strong theoretical foundation for the design and analysis of both distributed and nonlinear circuits while serving as a handy reference for experienced engineers making it a must have for both beginners and seasoned experts

Piecewise Linear Control Systems Mikael K.-J. Johansson,2014-03-12 2 Piecewise Linear Modeling 9 2 1 Model Representation 9 2 2 Solution Concepts 2 3 Uncertainty Models 2 4 Modularity and Interconnections 26 2 5 Piecewise Linear Function Representations 28 2 6 Comments and References 30 3 Structural Analysis 32 3 1 Equilibrium Points and the Steady State Characteristic 32 3 2 Constraint Verification and Invariance 35 3 3 Detecting Attractive Sliding Modes on Cell Boundaries 37 3 4 Comments and References 39 4 Lyapunov Stability 41 4 1 Exponential Stability 41 4 2 Quadratic Stability 42 4 3 Conservatism of Quadratic Stability 46 4 4 From Quadratic to Piecewise Quadratic 48 4 5 Interlude Describing Partition Properties 51 4 6 Piecewise Quadratic Lyapunov Functions 55 4 7 Analysis of Piecewise Linear Differential Inclusions 61 4 8 Analysis of Systems with Attractive Sliding Modes 63 4 9 Improving Computational Efficiency 66 4 10 Piecewise Linear Lyapunov Functions 72 4 11 A Unifying View 77 4 12 Comments and References 82 5 Dissipativity Analysis 85 5 1 Dissipativity Analysis via Convex Optimization 86 21 14 Contents Contents 5 2 Computation of 2 induced Gain 88 5 3 Estimation of Transient Energy 89 5 4 Dissipative Systems with Quadratic Supply Rates 91 5 5 Comments and References 95 Controller Design 96 6 1 Quadratic Stabilization of Piecewise Linear Systems 97 6 2 Controller Synthesis based on Piecewise Quadratics 98 6 3 Comments and References 105 7 Selected Topics 107 7 1 Estimation of Regions of Attraction

Canonical Piecewise-linear Analysis and Modeling An-Chang Deng,1986 Dynamics and Control of Switched Electronic Systems Francesco Vasca,Luigi Iannelli,2012-03-30 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 *Recent Advances In Circuits And Systems* Nikos E Mastorakis,1998-10-12 Recent Advances in Circuits and Systems brings you a balanced state of the art presentation of the latest concepts methods algorithms techniques procedures and applications of the fascinating field of Circuits and Systems Written by eminent leading international experts the contributors provide up to date aspects of topics discussed and present fresh original insights into their own experience with Circuits and Systems The main aim of this book is to present most of the new trends and recent advances of the impressive evolution in the discipline of circuits and systems Special emphasis is given in the interaction between the classic areas of systems theory feedback control circuits design electronics etc and the modern techniques of computational intelligence neural networks genetic algorithms fuzzy logic and expert systems since this fertile interaction promises to open up new horizons in circuits and systems theory This book is composed of four parts Part I is devoted to Circuits and Electronics and also includes Power Systems Part II refers to Systems Theory and Control H infinity problems feedback control non linear systems robust stability and robust control multivariable systems hybrid systems and hydraulic systems Part III presents the latest developments in the Robotics theory and applications while Part IV is devoted to Computational Intelligence in Systems Theory **Hybrid Dynamical Systems** Hai Lin,Panos J. Antsaklis,2021-11-18 A graduate level textbook Hybrid Dynamical Systems provides an accessible and comprehensive introduction to the theory of hybrid systems It emphasizes results that are central to a good understanding of the importance and role of such systems The authors have developed the materials in this book while teaching courses on hybrid systems cyber physical systems and

formal methods This textbook helps students to become familiar with both the major approaches coloring the study of hybrid dynamical systems The computer science and control systems points of view emphasizing discrete dynamics and real time and continuous dynamics with switching respectively are each covered in detail The book shows how the behavior of a system with tightly coupled cyber discrete and physical continuous elements can best be understood by a model simultaneously encompassing all the dynamics and their interconnections The theory presented is of fundamental importance in a wide range of emerging fields from next generation transportation systems to smart manufacturing Features of the text include extensive use of examples to illustrate the main concepts and to provide insights additional to those acquired from the main text chapter summaries enabling students to assess their progress end of chapter exercises which test learning as a course proceeds an instructor s guide showing how different parts of the book can be exploited for different course requirements and a solutions manual freely available for download by instructors adopting the book for their teaching Access to MATLAB and Stateflow is not required but would be beneficial especially for exercises in which simulations are a key tool

Modeling and Simulation of Mixed Analog-Digital Systems B. Antao,2012-12-06 Modeling and Simulation of Mixed Analog Digital Systems brings together in one place important contributions and state of the art research results in this rapidly advancing area Modeling and Simulation of Mixed Analog Digital Systems serves as an excellent reference providing insight into some of the most important issues in the field *Feedback, Nonlinear, and Distributed Circuits* Wai-Kai Chen,2018-10-08 Upon its initial publication the Handbook of Circuits and Filters broke new ground It quickly became the resource for comprehensive coverage of issues and practical information that can be put to immediate use Not content to rest on his laurels editor Wai kai Chen divided the second edition into volumes making the information easily accessible and digestible In the third edition these volumes have been revised updated and expanded so that they continue to provide solid coverage of standard practices and enlightened perspectives on new and emerging techniques Feedback Nonlinear and Distributed Circuits draws together international contributors who discuss feedback amplifier theory and then move on to explore feedback amplifier configurations They develop Bode s feedback theory as an example of general feedback theory The coverage then moves on to the importance of complementing numerical analysis with qualitative analysis to get a global picture of a circuit s performance After reviewing a wide range of approximation techniques and circuit design styles for discreet and monolithic circuits the book presents a comprehensive description of the use of piecewise linear methods in modeling analysis and structural properties of nonlinear circuits highlighting the advantages It describes the circuit modeling in the frequency domain of uniform MTL based on the Telegrapher s equations and covers frequency and time domain experimental characterization techniques for uniform and nonuniform multiconductor structures This volume will undoubtedly take its place as the engineer s first choice in looking for solutions to problems encountered in the analysis and behavior predictions of circuits and filters *Statistical Performance Analysis and Modeling Techniques for Nanometer*

VLSI Designs Ruijing Shen,Sheldon X.-D. Tan,Hao Yu,2014-07-08 Since process variation and chip performance uncertainties have become more pronounced as technologies scale down into the nanometer regime accurate and efficient modeling or characterization of variations from the device to the architecture level have become imperative for the successful design of VLSI chips This book provides readers with tools for variation aware design methodologies and computer aided design CAD of VLSI systems in the presence of process variations at the nanometer scale It presents the latest developments for modeling and analysis with a focus on statistical interconnect modeling statistical parasitic extractions statistical full chip leakage and dynamic power analysis considering spatial correlations statistical analysis and modeling for large global interconnects and analog mixed signal circuits Provides readers with timely systematic and comprehensive treatments of statistical modeling and analysis of VLSI systems with a focus on interconnects on chip power grids and clock networks and analog mixed signal circuits Helps chip designers understand the potential and limitations of their design tools improving their design productivity Presents analysis of each algorithm with practical applications in the context of real circuit design Includes numerical examples for the quantitative analysis and evaluation of algorithms presented Provides readers with timely systematic and comprehensive treatments of statistical modeling and analysis of VLSI systems with a focus on interconnects on chip power grids and clock networks and analog mixed signal circuits Helps chip designers understand the potential and limitations of their design tools improving their design productivity Presents analysis of each algorithm with practical applications in thecontext of real circuit design Includes numerical examples for the quantitative analysis and evaluation of algorithms presented **Engineering Circuit Analysis** J. David Irwin,R. M. Nelms,2021-12-07 Circuit analysis is the fundamental gateway course for computer and electrical engineering majors Irwin and Nelms Engineering Circuit Analysis has long been regarded as the most dependable textbook on the subject Focusing on the most complete set of pedagogical tools available and student centered learning design this book helps students complete the connection between theory and practice and build their problem solving skills Key concepts are explained multiple times in varying formats to support diverse learning styles followed by detailed examples including application and design examples These are then followed by Learning Assessments which allow students to work similar problems and check their results against the answers provided At the end of each chapter the book includes a robust set of conceptual and computational problems at a wide range of difficulty levels This International Adaptation enhances the coverage of network theorems by adding new theorems such as reciprocity compensation and Millman s and strengthens the topic of filter networks by including cascaded and Butterworth filters This edition also includes inverse hybrid and inverse transmission parameters to describe two port networks and a dedicated chapter on diodes *Model Reduction Techniques for Enriching Circuit Analysis* Pasquale De Marco,2025-05-02 Model Reduction Techniques for Enriching Circuit Analysis provides a comprehensive introduction to model reduction techniques with a focus on their application to circuit analysis The book covers the mathematical

foundations of model reduction as well as the most popular model reduction algorithms It also includes a number of case studies that illustrate how model reduction can be used to solve real world problems Model reduction is a powerful technique that enables engineers to simplify complex systems while preserving their essential characteristics This makes it possible to analyze and design systems that would otherwise be intractable and to do so with reduced computational cost and time Model reduction has applications in a wide range of engineering disciplines including circuit analysis control systems and structural mechanics In circuit analysis model reduction can be used to simplify the analysis of large scale circuits such as those found in integrated circuits ICs and printed circuit boards PCBs This can lead to significant savings in simulation time and memory usage The book is intended for engineers and researchers who want to learn about model reduction techniques It is also a valuable resource for practitioners who are using model reduction in their work Key Features Comprehensive coverage of model reduction techniques from the mathematical foundations to the most popular algorithms Case studies that illustrate how model reduction can be used to solve real world problems Focus on circuit analysis with examples and applications drawn from this domain Benefits Readers will learn about the mathematical foundations of model reduction Readers will be able to apply model reduction techniques to their own work Readers will gain a deeper understanding of circuit analysis Target Audience Engineers and researchers who want to learn about model reduction techniques Practitioners who are using model reduction in their work Students in electrical engineering and computer science If you like this book write a review on google books **Economic-Mathematical Methods and Models under Uncertainty** A. G. Aliyev,2013-12-07 In this book on mathematical programming the postulate spacial time certainty of economic process at uncertainty conditions in finite dimensional vector space and the principle piecewise linear homogeneity of economic process at uncertainty conditions in finite dimensional vector space are first suggested A special theory on constructing piecewise linear economic mathematical models was developed and a criterion of multivariate prediction of economic process and their control at uncertainty conditions in a finite dimensional vector space was suggested A packet of numerical programs for computer simulation in constructing and multivariate prediction of economic state with the help of n element piecewise linear economic mathematical models with regard to the uncertainty factors effect in m dimensional vector space is also suggested This book is intended for students of economic and administrative specialties as well as for research associates in the sphere of economic mathematical methods management and banking **Chua's Circuit: A Paradigm For Chaos** Rabinder N Madan,1993-11-20 For uninitiated researchers engineers and scientists interested in a quick entry into the subject of chaos this book offers a timely collection of 55 carefully selected papers covering almost every aspect of this subject Because Chua s circuit is endowed with virtually every bifurcation phenomena reported in the extensive literature on chaos and because it is the only chaotic system which can be easily built by a novice simulated in a personal computer and tractable mathematically it has become a paradigm for chaos and a vehicle for illustrating this ubiquitous phenomenon Its

supreme simplicity and robustness has made it the circuit of choice for generating chaotic signals for practical applications In addition to the 48 illuminating papers drawn from a recent two part Special Issue March and June 1993 of the Journal of Circuits Systems and Computers devoted exclusively to Chua s circuit several highly illustrative tutorials and incisive state of the art reviews on the latest experimental computational and analytical investigations on chaos are also included To enhance its pedagogical value a diskette containing a user friendly software and data base on many basic chaotic phenomena is attached to the book as well as a gallery of stunningly colorful strange attractors Beginning with an elementary freshman level physics introduction on experimental chaos the book presents a step by step guided tour with papers of increasing complexity which covers almost every conceivable aspects of bifurcation and chaos The second half of the book contains many original materials contributed by world renowned authorities on chaos including L P Shil nikov A N Sharkovsky M Misiurewicz A I Mees R Lozi L O Chua and V S Afraimovich The scope of topics covered is quite comprehensive including at least one paper on each of the following topics routes to chaos 1 D maps universality self similarity 2 parameter renormalization group analysis piecewise linear dynamics slow fast dynamics confinor analysis symmetry breaking strange attractors basins of attraction geometric invariants time series reconstruction Lyapunov exponents bispectral analysis homoclinic bifurcation stochastic resonance synchronization and control of chaos as well as several novel applications of chaos including secure communications visual sensing neural networks dry turbulence nonlinear waves and music

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