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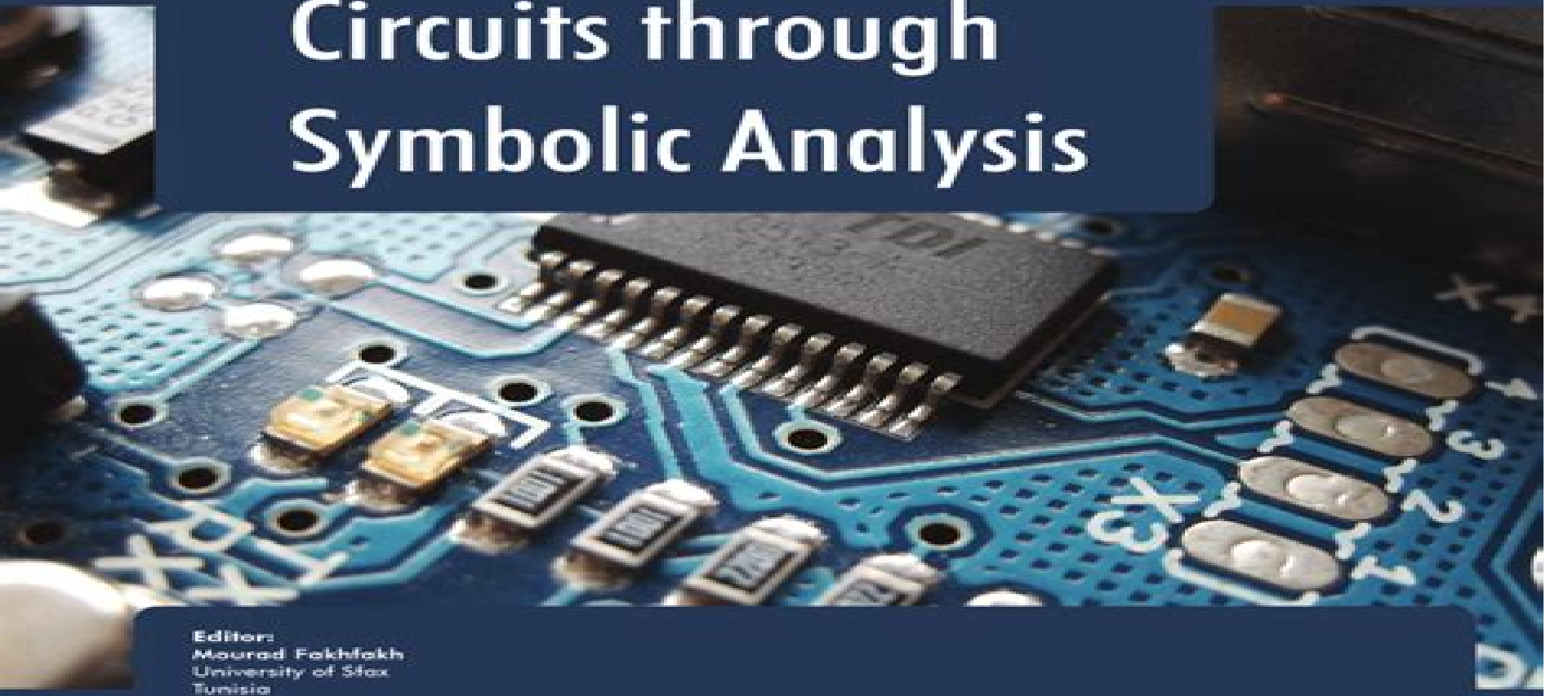
Design of Analog Circuits through Symbolic Analysis



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Symbolic Analysis Of Analog Circuits

Zhanhai Qin,Chung-Kuan Cheng

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Symbolic Analysis of Analog Circuits: Techniques and Applications Lawrence P. Huelsman,Georges Gielen,2012-12-06 This book brings together important contributions and state of the art research results in the rapidly advancing area of symbolic analysis of analog circuits It is also of interest to those working in analog CAD The book is an excellent reference providing insights into some of the most important issues in the symbolic analysis of analog circuits **Design of Analog Circuits Through Symbolic Analysis** Mourad Fakhfakh,Esteban Tlelo-Cuautle,Francisco V. Fernández,2012 Symbolic analyzers have the potential to offer knowledge to sophomores as well as practitioners of analog circuit design Actually they are an essential complement to numerical simulators since they provide insight into circuit behavior which numerical

Symbolic Analysis in Analog Integrated Circuit Design Henrik Floberg,2012-12-06 Symbolic Analysis in Analog Integrated Circuit Design provides an introduction to computer aided circuit analysis and presents systematic methods for solving linear i e small signal and nonlinear circuit problems which are illustrated by concrete examples Computer aided symbolic circuit analysis is useful in analog integrated circuit design Analytic expressions for the network transfer functions contain information that is not provided by a numerical simulation result However these expressions are generally extremely long and difficult to interpret therefore it is necessary to be able to approximate them guided by the magnitude of the individual circuit parameters Engineering has been described as the art of making approximations The inclusion of symbolic analysis in analog circuit design reduces the implied risk of ambiguity during the approximation process A systematic method based on the nullor concept is used to obtain the basic feedback transistor amplifier configurations Approximate expressions for the locations of poles and zeros for linear networks are obtained using the extended pole splitting technique An unusual feature in Symbolic Analysis in Analog Integrated Circuit Design is the consistent use of the transadmittance element with finite linear or nonlinear or infinite i e nullor gain as the only requisite circuit element The describing function method is used to obtain approximate symbolic expressions for the harmonic distortion generated by a soft or hard transconductance nonlinearity embedded in an arbitrary linear network The design and implementation of a program i e CASCA for symbolic analysis of time continuous networks is described The algorithms can also be used to solve other linear problems e g the analysis of time discrete switched capacitor networks Symbolic Analysis in Analog Integrated Circuit Design serves as an excellent resource for students and researchers as well as for industry designers who want to familiarize themselves with circuit analysis This book may also be used for advanced courses on the subject **Symbolic Analysis for Automated Design of Analog Integrated Circuits** Georges Gielen,Willy M.C. Sansen,2012-12-06 It is a great honor to provide a few words of introduction for Dr Georges Gielen s and Prof Willy Sansen s book Symbolic analysis for automated design of analog integrated circuits The symbolic analysis method presented in this book represents a significant step forward in the area of analog circuit design As demonstrated in this book symbolic analysis opens up new possibilities for the development of

computer aided design CAD tools that can analyze an analog circuit topology and automatically size the components for a given set of specifications Symbolic analysis even has the potential to improve the training of young analog circuit designers and to guide more experienced designers through second order phenomena such as distortion This book can also serve as an excellent reference for researchers in the analog circuit design area and creators of CAD tools as it provides a comprehensive overview and comparison of various approaches for analog circuit design automation and an extensive bibliography The world is essentially analog in nature hence most electronic systems involve both analog and digital circuitry As the number of transistors that can be integrated on a single integrated circuit IC substrate steadily increases over time an ever increasing number of systems will be implemented with one or a few very complex ICs because of their lower production costs **Design of Analog Circuits Through Symbolic Analysis** Mourad Fakhfakh,Esteban Tlelo-Cuautle,Francisco V. Fernández,2012-08-13 Symbolic analyzers have the potential to offer knowledge to sophomores as well as practitioners of analog circuit design Actually they are an essential complement to numerical simulators since they provide insight into circuit behavior which numerical **Symbolic Analysis Techniques** Francisco Fernández,1998 Electrical Engineering Symbolic Analysis Techniques Applications to Analog Design Automation Symbolic Analysis Techniques is a collection of original contributions from renowned experts in the field presenting the most recent and important applications of symbolic analysis to analog circuit design This timely self contained volume features an in depth tutorial introduction to the techniques and algorithms underlying modern symbolic analyzers and includes many references at the end of each chapter Applications are discussed in a variety of important fields Automatic generation of optimum circuit topologies Interactive circuit improvement and automated design space exploration Non fixed topology analog synthesis tools Semiconductor parameter extraction Analog testability and fault diagnosis And many more related areas Symbolic Analysis Techniques also features an extensive comparison of modern symbolic analyzer characteristics and limitations Brimming with practical instructions on tasks like formula simplification and post processing this book will be of use and interest to graduate students researchers and engineers involved in computer aided circuits analysis and analog design automation *Special Issue on Symbolic Analysis of Analog Circuits* Lawrence P. Huelsman,Georges Gielen,1993 A Perturbation Approach to the Symbolic Analysis of Analog Circuits Cheng-Shiang Chiang,1992 **Pathological Elements in Analog Circuit Design** Mourad Fakhfakh,Marian Pierzchala,2018-03-23 This book is a compilation and a collection of tutorials and recent advances in the use of nullors combinations of nullators and norators and pathological mirrors in analog circuit and system design It highlights the basic theory trends and challenges in the field making it an excellent reference resource for researchers and designers working in the synthesis analysis and design of analog integrated circuits With its tutorial character it can also be used for teaching Singular elements such as nullors and pathological mirrors can arguably be considered as universal blocks since they can represent all existing analog building blocks and they allow complex integrated circuits to be designed simply

and effectively These pathological elements are now used in a wide range of applications in modern circuit system theory and also in design practice *Symbolic analysis for analog circuit design automation* Steven J. Seda,1993 *Symbolic Analysis and Reduction of VLSI Circuits* Zhanhai Qin,Chung-Kuan Cheng,2009-03-13 Symbolic analysis is an intriguing topic in VLSI designs The analysis methods are crucial for the applications to the parasitic reduction and analog circuit evaluation However analyzing circuits symbolically remains a challenging research issue Therefore in this book we survey the recent results as the progress of on going works rather than as the solution of the field For parasitic reduction we approximate a huge amount of electrical parameters into a simplified RLC network This reduction allows us to handle very large integrated circuits with given memory capacity and CPU time A symbolic analysis approach reduces the circuit according to the network topology Thus the designer can maintain the meaning of the original network and perform the analysis hierarchically For analog circuit designs symbolic analysis provides the relation between the tunable parameters and the characteristics of the circuit The analysis allows us to optimize the circuit behavior The book is divided into three parts Part I touches on the basics of circuit analysis in time domain and in s domain For an s domain expression the Taylor s expansion with s approaching infinity is equivalent to the time domain solution after the inverse Laplace transform On the other hand the Taylor s expansion when s approaches zero derives the moments of the output responses in time domain Part II focuses on the techniques for parasitic reduction In Chapter 2 we present the approximation methods to match the first few moments with reduced circuit orders In Chapter 3 we apply the Y Delta transformation to reduce the dynamic linear network The method finds the exact values of the low order coefficients of the numerator and denominator of the transfer function and thus matches part of the moments In Chapter 4 we handle two major issues of the Y Delta transformation common factors in fractional expressions and round off errors Chapter 5 explains the stability of the reduced expression in particular the Ruth Hurwitz Criterion We make an effort to describe the proof of the Criterion because the details are omitted in most of the contemporary textbooks In Chapter 6 we present techniques to synthesize circuits to approximate the reduced expressions after the transformation In Part III we discuss symbolic generation of the determinants and cofactors for the application to analog designs In Chapter 7 we depict the classical topological analysis approach In Chapter 8 we describe a determinant decision diagram approach that exploits the sparsity of the matrix to accelerate the computation In Chapter 9 we take only significant terms when we search through determinant decision diagram to approximate the solution In Chapter 10 we extend the determinant decision diagram to a hierarchical model The construction of the modules through the hierarchy is similar to the Y Delta transformation in the sense that a byproduct of common factors appears in the numerator and denominator Therefore we describe the method to prune the common factors Advanced Symbolic Analysis for VLSI Systems Guoyong Shi,Sheldon X.-D. Tan,Esteban Tlelo Cuautle,2014-06-19 This book provides comprehensive coverage of the recent advances in symbolic analysis techniques for design automation of nanometer VLSI systems The presentation is

organized in parts of fundamentals basic implementation methods and applications for VLSI design Topics emphasized include statistical timing and crosstalk analysis statistical and parallel analysis performance bound analysis and behavioral modeling for analog integrated circuits Among the recent advances the Binary Decision Diagram BDD based approaches are studied in depth The BDD based hierarchical symbolic analysis approaches have essentially broken the analog circuit size barrier **Symbolic Analysis of Large Analog Circuits with Determinant Decision Diagrams** Sheldon X. D. Tan,1999

Computer-Aided Design of Analog Integrated Circuits and Systems Rob A. Rutenbar,Georges G. E. Gielen,2002-05-06 The tools and techniques you need to break the analog design bottleneck Ten years ago analog seemed to be a dead end technology Today System on Chip SoC designs are increasingly mixed signal designs With the advent of application specific integrated circuits ASIC technologies that can integrate both analog and digital functions on a single chip analog has become more crucial than ever to the design process Today designers are moving beyond hand crafted one transistor at a time methods They are using new circuit and physical synthesis tools to design practical analog circuits new modeling and analysis tools to allow rapid exploration of system level alternatives and new simulation tools to provide accurate answers for analog circuit behaviors and interactions that were considered impossible to handle only a few years ago To give circuit designers and CAD professionals a better understanding of the history and the current state of the art in the field this volume collects in one place the essential set of analog CAD papers that form the foundation of today s new analog design automation tools Areas covered are Analog synthesis Symbolic analysis Analog layout Analog modeling and analysis Specialized analog simulation Circuit centering and yield optimization Circuit testing Computer Aided Design of Analog Integrated Circuits and Systems is the cutting edge reference that will be an invaluable resource for every semiconductor circuit designer and CAD professional who hopes to break the analog design bottleneck *Fundamentals of Circuits and Filters* Wai-Kai Chen,2018-10-08 This volume drawn from the Circuits and Filters Handbook focuses on mathematics basics circuit elements devices and their models and linear circuit analysis It examines Laplace transformation Fourier methods for signal analysis and processing z transform and wavelet transforms It also explores network laws and theorems terminal and port represetnation analysis in the frequency domain and more **Scientific Computing in Electrical Engineering** Angelo Marcello Anile,Giuseppe Alì,G. Mascali,2007-01-10 This book is a collection of papers presented at the last Scientific Computing in Electrical Engineering SCEE Conference held in Sicily in 2004 The series of SCEE conferences aims at addressing mathematical problems which have a relevancy to industry The areas covered at SCEE 2004 were Electromagnetism Circuit Simulation Coupled Problems and General mathematical and computational methods

EDA for IC Implementation, Circuit Design, and Process Technology Luciano Lavagno,Louis Scheffer,Grant Martin,2018-10-03 Presenting a comprehensive overview of the design automation algorithms tools and methodologies used to design integrated circuits the Electronic Design Automation for Integrated Circuits Handbook is available in two volumes

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Analog Circuits Esteban Tlelo-Cuautle,Mourad Fakhfakh,Luis Gerardo de la Fraga,2017 This book includes recent research that focuses on analog integrated circuits and covers three main topics namely fundamentals synthesis and performance Eleven chapters are divided among these three topics as follows Chapters One to Four are a part of fundamentals The first chapter The Next Generation of Nanomaterials for Designing Analog Integrated Circuits describes new directions for applying nanomaterials for the design of modern analog circuits Chapter Two Application of Nullors in Designing Analog Circuits for Frequency Bandwidth uses the pathological circuit element known as a nullor to design analog integrated circuits with frequency specifications to accomplish a desired bandwidth Chapter Three RC and RL to LC Circuit Conversion and its Application in Poles and Zeros Identification details an important property from circuit theory to estimate roots by performing conversions of passive elements Chapter Four Enhanced and Improved Symbolic Circuit Analysis Using MATLAB relays the development of symbolic circuit analysis and focuses on enhancing an already developed symbolic tool to allow the symbolic analysis of large circuits The synthesis of analog integrated circuits has been a challenge because there is no way to establish general rules to cover the gap between the behavioral and transistor circuit levels of abstraction In this book the second topic includes four chapters from Five to Eight Chapter Five On the Synthesis of Sinusoidal Oscillators Using Nullors just as in Chapter Two uses the pathological circuit element known as a nullor to perform the synthesis of sinusoidal oscillators which are quite useful in many electronic systems Other kinds of oscillators are described in Chapter Six Synthesis of SRCOs and Multi Phase Oscillators from State Variables to their Implementation Using CMOS IC Technology where the synthesis process identifies the resistor that controls the oscillating frequency and applies a state variable approach Chapter Seven Evolutionary Optimisation in the Design of CMOS Analog Integrated Circuits shows the application of heuristics for circuit optimisation and how it can be extended to bigger analog integrated circuits Chapter Eight provides details on the synthesis and design of a CMOS harmonic mixer with output power management for narrowband and wideband wireless communications the Bluetooth and UWB cases The third part of this book is devoted to analog circuit performances and includes three chapters Chapter Nine details the FPGA realisation of radio frequency RF power amplifier models In this case the system is modeled in the analog domain and implemented in the digital one Chapter Ten White Box Models of Optimal Sized Solutions of Analog Integrated Circuits generates analytical expressions for modeling the dominant behavior of CMOS analog circuits Finally Chapter Eleven Radial Basis Function Surrogate Modeling for the Accurate Design of Analog Circuits applies modern modeling approaches to accomplish real target specifications and to improve the design of

reliable circuits **Electronic Design Automation for IC Implementation, Circuit Design, and Process Technology** Luciano Lavagno,Igor L. Markov,Grant Martin,Louis K. Scheffer,2017-02-03 The second of two volumes in the Electronic Design Automation for Integrated Circuits Handbook Second Edition Electronic Design Automation for IC Implementation Circuit Design and Process Technology thoroughly examines real time logic RTL to GDSII a file format used to transfer data of semiconductor physical layout design flow analog mixed signal design physical verification and technology computer aided design TCAD Chapters contributed by leading experts authoritatively discuss design for manufacturability DFM at the nanoscale power supply network design and analysis design modeling and much more New to This Edition Major updates appearing in the initial phases of the design flow where the level of abstraction keeps rising to support more functionality with lower non recurring engineering NRE costs Significant revisions reflected in the final phases of the design flow where the complexity due to smaller and smaller geometries is compounded by the slow progress of shorter wavelength lithography New coverage of cutting edge applications and approaches realized in the decade since publication of the previous edition these are illustrated by new chapters on 3D circuit integration and clock design Offering improved depth and modernity Electronic Design Automation for IC Implementation Circuit Design and Process Technology provides a valuable state of the art reference for electronic design automation EDA students researchers and professionals *Symbolic Analysis and Reduction of VLSI Circuits* Qin Zhanhai,Chung-Kuan Cheng,2008-11-01 Symbolic analysis is an intriguing topic in VLSI designs The analysis methods are crucial for the applications to the parasitic reduction and analog circuit evaluation However analyzing circuits symbolically remains a challenging research issue Therefore in this book we survey the recent results as the progress of on going works rather than as the solution of the field For parasitic reduction we approximate a huge amount of electrical parameters into a simplified RLC network This reduction allows us to handle very large integrated circuits with given memory capacity and CPU time A symbolic analysis approach reduces the circuit according to the network topology Thus the designer can maintain the meaning of the original network and perform the analysis hierarchically For analog circuit designs symbolic analysis provides the relation between the tunable parameters and the characteristics of the circuit The analysis allows us to optimize the circuit behavior The book is divided into three parts Part I touches on the basics of circuit analysis in time domain and in s domain For an s domain expression the Taylor s expansion with s approaching infinity is equivalent to the time domain solution after the inverse Laplace transform On the other hand the Taylor s expansion when s approaches zero derives the moments of the output responses in time domain Part II focuses on the techniques for parasitic reduction In Chapter 2 we present the approximation methods to match the first few moments with reduced circuit orders In Chapter 3 we apply the Y Delta transformation to reduce the dynamic linear network The method finds the exact values of the low order coefficients of the numerator and denominator of the transfer function and thus matches part of the moments In Chapter 4 we handle two major issues of the Y Delta transformation common factors in

fractional expressions and round off errors Chapter 5 explains the stability of the reduced expression in particular the Ruth Hurwitz Criterion We make an effort to describe the proof of the Criterion because the details are omitted in most of the contemporary textbooks In Chapter 6 we present techniques to synthesize circuits to approximate the reduced expressions after the transformation In Part III we discuss symbolic generation of the determinants and cofactors for the application to analog designs In Chapter 7 we depict the classical topological analysis approach In Chapter 8 we describe a determinant decision diagram approach that exploits the sparsity of the matrix to accelerate the computation In Chapter 9 we take only significant terms when we search through determinant decision diagram to approximate the solution In Chapter 10 we extend the determinant decision diagram to a hierarchical model The construction of the modules through the hierarchy is similar to the Y Delta transformation in the sense that a byproduct of common factors appears in the numerator and denominator Therefore we describe the method to prune the common factors

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