Cmos Circuit Design Layout And Simulation Solution Manual

This book conveys an understanding of CMOS technology, circuit design, layout, and system design sufficient to the designer. The book deals with the technology down to the layout level of detail, thereby providing a bridge from a circuit to a form that may be fabricated. The early chapters provide a circuit view of the CMOS IC design, the middle chapters cover a sub-system view of CMOS VLSI, and the final section illustrates these techniques using a real-world case study. The book gives an understanding of the underlying principles of advanced VLSI technology. It not only focuses on circuit design process obeying VLSI rules but also on technological aspects of prototyping and fabrication. All the clocking processes, interconnects, and circuits of CMOS are explained in this book in an understandable format. The book provides contents on VLSI Physical Design Automation, Design of VLSI Devices and also its Impact on Physical Design. Praise for CMOS: Circuit Design, Layout, and SimulationRevised Second Edition from the Technical Reviewers "A refreshing industrial flavor. Design concepts are presented as they are needed for 'just-in-time' learning. Simulating and designing circuits using SPICE is emphasized with literally hundreds of examples. Very few textbooks contain as much detail as this one. Highly recommended!" --Paul M. Furth, New Mexico State University "This book builds a solid knowledge of CMOS circuit design from the ground up. With coverage of process integration, layout, analog and digital models, noise mechanisms, memory circuits, references, amplifiers, PLLs/DLLs, dynamic circuits, and data converters, the text is an excellent reference for both experienced and novice designers alike." --Tyler J. Gomm, Design Engineer, Micron Technology, Inc. "The Second Edition builds upon the success of the first with new chapters that cover additional material such as oversampled converters and non-volatile memories. This is becoming the de facto standard textbook to have on every analog and mixed-signal designer's bookshelf." --Joe Walsh, Design Engineer, AMI Semiconductor CMOS circuits from design to implementation CMOS: Circuit Design, Layout, and Simulation, Revised Second Edition covers the practical design of both analog and digital integrated circuits, offering a vital, contemporary view of a wide range of analog/digital circuit blocks, the BSIM model, data converter architectures, and much more. This edition takes a two-path approach to the topics: design techniques are developed for both long- and short-channel CMOS technologies and then compared. The results are multidimensional explanations that allow readers to gain deep insight into the design process. Features include: Updated materials to reflect CMOS technology's movement into nanometer sizes Discussions on phase- and delay-locked loops, mixed-signal circuits, data converters, and circuit noise More than 1,000 figures, 200 examples, and over 500 end-of-chapter problems In-depth coverage of both analog and digital circuit-level design techniques Real-world process parameters and design rules The

book's Web site, CMOSedu.com, provides: solutions to the book's problems; additional homework problems without solutions; SPICE simulation examples using HSPICE, LTspice, and WinSpice; layout tools and examples for actually fabricating a chip; and videos to aid learning

"This exceptionally comprehensive tutorial presentation of complementary metal oxide semiconductor (CMOS) integrated circuits will guide you through the process of implementing a chip from the physical definition through the design and simulation of the finished chip. CMOS: CIRCUIT DESIGN, LAYOUT, AND SIMULATION provides an important contemporary view of a wide range of circuit blocks, the BSIM model, data converter architectures, and much more. Outstanding features of this text include: * Phase- and delay-locked loops, mixed-signal circuits, and data converters * More than 1,000 figures, 200 examples, and over 500 end-of-chapter problems * In-depth coverage of both analog and digital circuit-level design techniques * Real-world process parameters and design rules * Information on MOSIS fabrication procedures, and other key topics of interest * Information and directions on submitting chips of MOSIS * Tutorial presentation of material suitable for self study or as a university textbook * Numerous examples and homework problems For more information and links related to CMOS design, go to http://cmosedu.com. Professors: To request an examination copy simply e-mail collegeadoption@ieee.org." Sponsored by: IEEE Solid-State Circuits Council/Society, IEEE Circuits and Systems Society.

A practical overview of CMOS circuit design, this book coversthe technology, analysis, and design techniques of voltagereference circuits. The design requirements covered followmodern CMOS processes, with an emphasis on low power, low voltage,and low temperature coefficient voltage reference design.Dedicating a chapter to each stage of the design process, theauthors have organized the content to give readers the tools theyneed to implement the technologies themselves. Readers will gain anunderstanding of device characteristics, the practicalconsiderations behind circuit topology, and potential problems witheach type of circuit. Many design examples are used throughout, most of which havebeen tested with silicon implementation or employed in real-worldproducts. This ensures that the material presented relevant to bothstudents studying the topic as well as readers requiring apractical viewpoint. Covers CMOS voltage reference circuit design, from the basicsthrough to advanced topics Provides an overview of basic device physics and differentbuilding blocks of voltage reference designs Features real-world examples based on actual siliconimplementation Includes analytical exercises, simulation exercises, andsilicon layout exercises, giving readers guidance and design layoutexperience for voltage reference circuits Solution manual available to instructors from the book’scompanion website This book is highly useful for graduate students in VLSI design,as well as practicing analog engineers and IC design professionals.Advanced undergraduates preparing for further study in VLSI willalso find this book a helpful companion text.

This book was written to arm engineers qualified and knowledgeable in the area of VLSI circuits with the essential knowledge they need to get into this exciting field and to help those already in it achieve a higher level of proficiency. Few people truly understand how a large chip is developed, but an understanding of the whole process is necessary to appreciate the importance of each part of it and to understand the process from concept to silicon. It will teach readers how to become better engineers through a practical approach of diagnosing and attacking real-world problems.

A comprehensive introduction to CMOS and bipolar analog IC design. The book presumes no prior knowledge of linear design, making it comprehensible to engineers with a non-analog back-ground. The emphasis is on practical design, covering the entire field with hundreds of examples to explain the choices. Concepts are presented following the history of their discovery. Content: 1. Devices Semiconductors, The Bipolar Transistor, The Integrated Circuit, Integrated NPN Transistors, The Case of the Lateral PNP Transistor, CMOS Transistors, The Substrate PNP Transistor, Diodes, Zener Diodes, Resistors, Capacitors, CMOS vs. Bipolar; 2. Simulation, DC Analysis, AC Analysis, Transient Analysis, Variations, Models, Diode Model, Bipolar Transis-tor Model, Model for the Lateral PNP Transistor, MOS Transistor Models, Resistor Models, Models for Capacitors; 3. Current Mirrors; 4. Differential Pairs; 5. Current Sources; 6. Time Out: Analog Measures, dB, RMS, Noise, Fourier Analysis, Distortion, Frequency Compensation; 7. Bandgap References; 8. Op Amps; 9. Comparators; 10. Transimpedance Amplifiers; 11. Timers and Oscillators; 12. Phase-Locked Loops; 13. Filters; 14. Power, Linear Regulators, Low Drop-Out Regulators, Switching Regulators, Linear Power Amplifiers, Switching Power Amplifiers; 15. A to D and D to A, The Delta-Sigma Converter; 16. Odds and Ends, Gilbert Cell, Multipliers, Peak Detectors, Rectifiers and Averaging Circuits, Thermometers, Zero-Crossing Detectors; 17. Layout.

"DRAM Circuit Design" teaches readers the introductory level design of DRAM memory chips. It focuses on giving readers a reference that can be used to educate students or practicing design engineers in DRAM circuit design.

During the last decade, CMOS has become increasingly attractive as a basic integrated circuit technology due to its low power (at moderate frequencies), good scalability, and rail-to-rail operation. There are now a variety of CMOS circuit styles, some based on static complementary con ductance properties, but others borrowing from earlier NMOS techniques and the advantages of using clocking disciplines for precharge-evaluate se quencing. In this comprehensive book, the reader is led systematically through the entire range of CMOS circuit design. Starting with the in dividual MOSFET, basic circuit building blocks are described, leading to a broad view of both combinatorial and sequential circuits. Once these circuits are considered in the light of CMOS process technologies, impor tant topics in circuit performance are considered, including characteristics of interconnect, gate delay, device sizing, and I/O buffering. Basic circuits are then composed to form macro elements such as multipliers, where the reader acquires a unified view of architectural performance through par allelism, and

circuit performance through careful attention to circuit-level and layout design optimization. Topics in analog circuit design reflect the growing tendency for both analog and digital circuit forms to be combined on the same chip, and a careful treatment of BiCMOS forms introduces the reader to the combination of both FET and bipolar technologies on the same chip to provide improved performance.

Many interesting design trends are shown by the six papers on operational amplifiers (Op Amps). Firstly. there is the line of stand-alone Op Amps using a bipolar IC technology which combines high-frequency and high voltage. This line is represented in papers by Bill Gross and Derek Bowers. Bill Gross shows an improved high-frequency compensation technique of a high quality three stage Op Amp. Derek Bowers improves the gain and frequency behaviour of the stages of a two-stage Op Amp. Both papers also present trends in current-mode feedback Op Amps. Low-voltage bipolar Op Amp design is presented by leroen Fonderie. He shows how multipath nested Miller compensation can be applied to turn rail-to-rail input and output stages into high quality low-voltage Op Amps. Two papers on CMOS Op Amps by Michael Steyaert and Klaas Bult show how high speed and high gain VLSI building blocks can be realised. Without departing from a single-stage OT A structure with a folded cascode output, a thorough high frequency design technique and a gain-boosting technique contributed to the high-speed and the high-gain achieved with these Op Amps. . Finally. Rinaldo Castello shows us how to provide output power with CMOS buffer amplifiers. The combination of class A and AB stages in a multipath nested Miller structure provides the required linearity and bandwidth.

Top-down approach to practical, tool-independent, digital circuit design, reflecting how circuits are designed.

This book describes recent research on terahertz CMOS design for high-speed wireless communication. The topics covered include fundamental technologies for terahertz CMOS design, amplifier design, physical design approaches, transceiver design, and future prospects.

Electrical and Electronic Engineering Design Series Vol 3 CMOS Circcuit Design - Analog, digital, IC Layout This university level Electrical Engineering text is for anyone who wants to know how to design products using CMOS circuits. The present text is unusually accessible to readers who want to acquire the skills of CMOS circuit design as well as the skill making Integrated Circuit Chip Layouts. We present a thorough foundation so that you can proceed to learn how to design and layout CMOS circuits. This text is different from other CMOS design texts, because not only do we actually show how to design CMOS circuits selecting transistor Length, Width and the correct value of mobility (a small detail that is usually overlooked if not ignored) we show how to make accurate, functioning circuit layouts that can be used in a chip. Furthermore we ask you to work hard drawing over 60 layouts that give you real world experience. This is not about logic design. CMOS technology is the preferred technology for implementing modern digital and analog integrated circuits. We show, step by step, how layouts are made that conform to Mosis rules. A brief review of MOS transistors sets the stage for CMOS circuit design. Digital circuits with no memory implement logic equations as sums of minterms (OR of ANDs) or products of maxterms (AND of ORs). We show how to design circuits such as NOT (Inverter), NAND, NOR, XOR, Multiplexer, and Adder. As we proceed we show how to plan and execute layouts for

each circuit. One bit digital circuits with memory are used in state machines. The RS Latch is the most elementary one-bit circuit with memory. Latches do not have clock inputs, whereas flip-flops and edge triggered flip-flops are one-bit memory circuits with clock inputs. The flip-flops are synchronous circuits. We show how to design and layout the RS Latch and the D edge triggered flip-flop. We show that the JK design and layout is a straightforward adaptation of the D design and layout. The D and JK edge triggered flip-flops are the flip-flop circuits in commercial use today. Next the emphasis is on digital circuits that are an assembly of identical cells, such as the cell of a shift register. The integrated circuit layout of an assembly of cells is an orderly, repetitive pattern. Orderly, repetitive patterns are intrinsically free of layout errors. We say orderly layouts are mandatory for non trivial circuits (random logic layouts are high risk). We show how to make orderly systematic layouts, and how to write Spice programs that evaluate their performance. We design and layout well known digital circuits such as shift registers, storage registers with load control, registers on a bus, and programmable logic arrays of logic with no memory. The well known current mirror, differential amplifier, operational amplifier, resistors and capacitors are designed and their performance is evaluated by Spice. Layout procedures for the circuits as well as the resistors and capacitors are presented. Spice is used to plot DC response, AC frequency response, and TRAN transient response performance of circuits that are analyzed and designed in the text. We show how to write these programs. We ask you to draw over 60 layouts, which we consider to be useful experiments that give you real world experience. We consider drawing the more than 60 layouts to be a significant learning activity. The presentations are eminently clear, because they are based on the policies assume nothing and nothing is obvious. The present text's contents are topics one actually uses when engaged in CMOS circuit analysis and design.

The fourth edition of CMOS Digital Integrated Circuits: Analysis and Design continues the well-established tradition of the earlier editions by offering the most comprehensive coverage of digital CMOS circuit design, as well as addressing state-of-the-art technology issues highlighted by the widespread use of nanometer-scale CMOS technologies. In this latest edition, virtually all chapters have been re-written, the transistor model equations and device parameters have been revised to reflect the sigificant changes that must be taken into account for new technology generations, and the material has been reinforced with up-to-date examples. The broad-ranging coverage of this textbook starts with the fundamentals of CMOS process technology, and continues with MOS transistor models, basic CMOS gates, interconnect effects, dynamic circuits, memory circuits, arithmetic building blocks, clock and I/O circuits, low power design techniques, design for manufacturability and design for testability.

This is an up-to-date treatment of the analysis and design of CMOS integrated digital logic circuits. The self-contained book covers all of the important digital circuit design styles found in modern CMOS chips, emphasizing solving design problems using the various logic styles available in CMOS.

Based on the authors' expansive collection of notes taken over the years, Nano-CMOS Circuit and Physical Design bridges the gap between physical and circuit design and fabrication processing, manufacturability, and yield. This innovative book covers: process technology, including sub-wavelength optical lithography; impact of process scaling on circuit and physical implementation and low power with leaky transistors; and

DFM, yield, and the impact of physical implementation.

This book teaches the principles of physical design, layout, and simulation of CMOS integrated circuits. It is written around a very powerful CAD program called Microwind that is available on the accompanying CD-ROM. Featuring a friendly interface, Microwind is both educational and useful for designing CMOS chips.

The purpose of this book is to provide a complete working knowledge of the Complementary Metal-Oxide Semiconductor (CMOS) analog and mixed-signal circuit design, which can be applied for System on Chip (SOC) or Application-Specific Standard Product (ASSP) development. It begins with an introduction to the CMOS analog and mixed-signal circuit design with further coverage of basic devices, such as the Metal-Oxide Semiconductor Field-Effect Transistor (MOSFET) with both long- and short-channel operations, photo devices, fitting ratio, etc. Seven chapters focus on the CMOS analog and mixed-signal circuit design of amplifiers, low power amplifiers, voltage regulator-reference, data converters, dynamic analog circuits, color and image sensors, and peripheral (oscillators and Input/Output [I/O]) circuits, and Integrated Circuit (IC) layout and packaging. Features: Provides practical knowledge of CMOS analog and mixed-signal circuit design Includes recent research in CMOS color and image sensor technology Discusses sub-blocks of typical analog and mixed-signal IC products Illustrates several design examples of analog circuits together with layout Describes integrating based CMOS color circuit

A practical guide to the successful integration of digital and analog circuits Mixed-signal processing-the integration of digital and analog circuitry within computer systems-enables systems to take signals from the analog world and process them within a digital system. In fact, recent advances in VLSI technology performance now allow for the integration of digital and analog circuits on a single chip, a process that requires the use of analog pre- and post-processing systems such as converters, filters, sensors, drivers, buffers, and actuators. However, the lack of universal CAD tools for the synthesis, simulation, and layout of the analog part of the chip represents a design bottleneck of today's VLSI circuits. Mixed-Signal Systems: A Guide to CMOS Circuit Design presents a comprehensive general overview of the latest CMOS technology and covers the various computer systems that may be used for designing integrated circuits. Taking an original approach to one- and two-dimensional filter design, the author explores the many digital-oriented design systems, or silicon compilers, currently being used, and presents the basic methods, procedures, and tools used by each. In a thorough and systematic manner, the text: * Presents common features of digital-oriented design systems * Describes methods and tools that are not yet being applied in any compiler * Illustrates image processing systems that can be implemented on a single chip * Demonstrates the path from synthesis methods to the actual silicon assembly Essential reading for integrated circuit designers and developers of related computer programs, as well as advanced students of system design, this book represents an invaluable resource for anyone involved in the development of mixed-signal systems.

This book includes basic methodologies, review of basic electrical rules and how they apply, design rules, IC planning, detailed checklists for design review, specific layout design flows, specialized block design, interconnect design, and also additional information on design limitations due to production requirements. *Practical, hands-on

approach to CMOS layout theory and design *Offers engineers and technicians the training materials they need to stay current in circuit design technology. *Covers manufacturing processes and their effect on layout and design decisions
Special Features: · Written by the author of the best-seller, CMOS: Circuit Design, Layout, and Simulation· Fills a hole in the technical literature for an advanced-tutorial book on mixed-signal circuit design from a circuit designer's point of view· Presents more advance topics, and will be an excellent companion to the first volume About The Book: This book will fill a hole in the technical literature for an advanced-tutorial book on mixed-signal circuit design. There are no competitors in this area. Mixed-signal design is performed in industry by a select few gurus . The techniques can be found in hard-to-digest technical papers.

Intuitive Analog Circuit Design outlines ways of thinking about analog circuits and systems that let you develop a feel for what a good, working analog circuit design should be. This book reflects author Marc Thompson's 30 years of experience designing analog and power electronics circuits and teaching graduate-level analog circuit design, and is the ideal reference for anyone who needs a straightforward introduction to the subject. In this book, Dr. Thompson describes intuitive and "back-of-the-envelope" techniques for designing and analyzing analog circuits, including transistor amplifiers (CMOS, JFET, and bipolar), transistor switching, noise in analog circuits, thermal circuit design, magnetic circuit design, and control systems. The application of some simple rules of thumb and design techniques is the first step in developing an intuitive understanding of the behavior of complex electrical systems. Introducing analog circuit design with a minimum of mathematics, this book uses numerous real-world examples to help you make the transition to analog design. The second edition is an ideal introductory text for anyone new to the area of analog circuit design. Design examples are used throughout the text, along with end-of-chapter examples Covers real-world parasitic elements in circuit design and their effects Discover innovative tools that pave the way from circuit and physical design to fabrication processing Nano-CMOS Design for Manufacturability examines the challenges that design engineers face in the nano-scaled era, such as exacerbated effects and the proven design for manufacturability (DFM) methodology in the midst of increasing variability and design process interactions. In addition to discussing the difficulties brought on by the continued dimensional scaling in conformance with Moore's law, the authors also tackle complex issues in the design process to overcome the difficulties, including the use of a functional first silicon to support a predictable product ramp. Moreover, they introduce several emerging concepts, including stress proximity effects, contour-based extraction, and design process interactions. This book is the sequel to Nano-CMOS Circuit and Physical Design, taking design to technology nodes beyond 65nm geometries. It is divided into three parts: Part One, Newly Exacerbated Effects, introduces the newly exacerbated effects that require designers' attention, beginning with a discussion of the lithography aspects of DFM, followed by the impact of layout on transistor performance Part Two,

Design Solutions, examines how to mitigate the impact of process effects, discussing the methodology needed to make sub-wavelength patterning technology work in manufacturing, as well as design solutions to deal with signal, power integrity, WELL, stress proximity effects, and process variability Part Three, The Road to DFM, describes new tools needed to support DFM efforts, including an auto-correction tool capable of fixing the layout of cells with multiple optimization goals, followed by a look ahead into the future of DFM Throughout the book, real-world examples simplify complex concepts, helping readers see how they can successfully handle projects on Nano-CMOS nodes. It provides a bridge that allows engineers to go from physical and circuit design to fabrication processing and, in short, make designs that are not only functional, but that also meet power and performance goals within the design schedule.

An important continuation to CMOS: Circuit Design, Layout, and Simulation The power of mixed-signal circuit designs, and perhaps the reason they are replacing analog-only designs in the implementation of analog interfaces, comes from the marriage of analog circuits with digital signal processing. This book builds on the fundamental material in the author's previous book, CMOS: Circuit Design, Layout, and Simulation, to provide a solid textbook and reference for mixed-signal circuit design. The coverage is both practical and in-depth, integrating experimental, theoretical, and simulation examples to drive home the why and the how of doing mixed-signal circuit design. Some of the highlights of this book include: A practical/theoretical approach to mixed-signal circuit design with an emphasis on oversampling techniques An accessible and useful alternative to hard-to-digest technical papers without losing technical depth Coverage of delta-sigma data converters, custom analog and digital filter design, design with submicron CMOS processes, and practical at-the-bench deadbug prototyping techniques Hundreds of worked examples and questions covering all areas of mixed-signal circuit design A helpful companion Web site, http://cmosedu.com, provides worked solutions to textbook problems, SPICE simulation netlist examples, and discussions concerning mixed-signal circuit design.

This modern, pedagogic textbook from leading author Behzad Razavi provides a comprehensive and rigorous introduction to CMOS PLL design, featuring intuitive presentation of theoretical concepts, extensive circuit simulations, over 200 worked examples, and 250 end-of-chapter problems. The perfect text for senior undergraduate and graduate students.

Discover a fresh approach to efficient and insight-driven analog integrated circuit design in nanoscale-CMOS with this hands-on guide. Expert authors present a sizing methodology that employs SPICE-generated lookup tables, enabling close agreement between hand analysis and simulation. This enables the exploration of analog circuit tradeoffs using the gm/ID ratio as a central variable in script-based design flows, and eliminates time-consuming iterations in a circuit simulator. Supported by downloadable MATLAB code, and including over forty detailed worked examples, this book will provide professional analog circuit

designers, researchers, and graduate students with the theoretical know-how and practical tools needed to acquire a systematic and re-use oriented design style for analog integrated circuits in modern CMOS.

The Third Edition of CMOS Circuit Design, Layout, and Simulation continues to cover the practical design of both analog and digital integrated circuits, offering a vital, contemporary view of a wide range of analog/digital circuit blocks including: phase-locked-loops, delta-sigma sensing circuits, voltage/current references, op-amps, the design of data converters, and much more. Regardless of one's integrated circuit (IC) design skill level, this book allows readers to experience both the theory behind, and the hands-on implementation of, complementary metal oxide semiconductor (CMOS) IC design via detailed derivations, discussions, and hundreds of design, layout, and simulation examples.

High-speed, power-efficient analog integrated circuits can be used as standalone devices or to interface modern digital signal processors and micro-controllers in various applications, including multimedia, communication, instrumentation, and control systems. New architectures and low device geometry of complementary metaloxidesemiconductor (CMOS) technologies have accelerated the movement toward system on a chip design, which merges analog circuits with digital, and radio-frequency components.

- Applicable for bookstore catalogue

Market_Desc: This is an advanced-level textbook or reference for engineers, engineering managers, layout designers, layout draftsmen, computer engineers, professors, and computer scientists. Special Features: · The content of the second edition has been updated to reflect CMOS technology's movement into nanometer sizes.· Discussions on phase-and delay-locked loops, mixed-signal circuits, data converters, and circuit noise· More than 1,000 figures, 200 examples, and over 500 end-of-chapter problems· In-depth coverage of both analog and digital circuit-level design techniques· Real-world process parameters and design rules· The book's website (cmosedu.com) provides examples, solutions, and SPICE simulation netlists. About The Book: In this second edition, the authors have taken a new, two path approach to the topic. They develop design techniques for both long- and short-channel CMOS technologies and then compare the two. This approach results in explanations that are multi-dimensional and allows the reader deep insight into the design process. Complete with layout software for the PC, this exceptionally comprehensive presentation of CMOS integrated circuit design will guide you through the process of implementing a chip from the physical definition through the design and simulation of the finished chip.

The demand for ever smaller and portable electronic devices has driven metal oxide semiconductor-based (CMOS) technology to its physical limit with the smallest possible feature sizes. This presents various size-related problems such as high power leakage, low-reliability, and thermal effects, and is a limit on further miniaturization. To enable even smaller electronics, various nanodevices including carbon nanotube transistors, graphene transistors, tunnel transistors and memristors (collectively called post-CMOS devices) are emerging that could replace the traditional and ubiquitous silicon transistor. This book explores these nanoelectronics at the device level including modelling and design. Topics covered include high-k dielectrics; high mobility n and p

channels on gallium arsenide and silicon substrates using interfacial misfit dislocation arrays; anodic metal-insulator-metal (MIM) capacitors; graphene transistors; junction and doping free transistors; nanoscale gigh-k/metal-gate CMOS and FinFET based logic libraries; multiple-independent-gate nanowire transistors; carbon nanotubes for efficient power delivery; timing driven buffer insertion for carbon nanotube interconnects; memristor modeling; and neuromorphic devices and circuits. This book is essential reading for researchers, research-focused industry designers/developers, and advanced students working on next-generation electronic devices and circuits.
CMOSCircuit Design, Layout, and SimulationJohn Wiley & Sons