#### CHAPTER 1 INTRODUCTION

- 1.1 An ADD/SUBTRACT logic circuit is shown below. It performs the ADD operation for P = 0, and SUBTRACT for P = 1.
  - (a) Draw an equivalent CMOS logic diagram by noting that most CMOS gates, except for transmission gate and XOR, are inverting. For example, AND gate is implemented with NAND followed by an inverter.
  - (b) By using the gate array platform given on page 47, implement the CMOS circuit as compactly as possible with the aspect ratio, which is the ratio of vertical dimension to horizontal dimension, as close to 1 as possible.

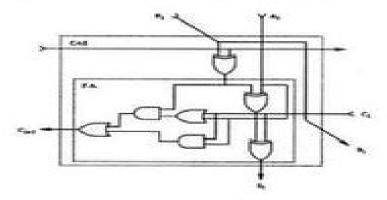


Figure P14.1(a)

#### SOLUTION:

(b) The CMOS circuit implementation using the gate array piatform:

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**Anant Agarwal, Jeffrey Lang** 

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Foundations of Analog and Digital Electronic Circuits Anant Agarwal, Jeffrey Lang, 2005-07-01 Unlike books currently on the market this book attempts to satisfy two goals combine circuits and electronics into a single unified treatment and establish a strong connection with the contemporary world of digital systems It will introduce a new way of looking not only at the treatment of circuits but also at the treatment of introductory coursework in engineering in general Using the concept of abstraction the book attempts to form a bridge between the world of physics and the world of large computer systems In particular it attempts to unify electrical engineering and computer science as the art of creating and exploiting successive abstractions to manage the complexity of building useful electrical systems Computer systems are simply one type of electrical systems Balances circuits theory with practical digital electronics applications Illustrates concepts with real devices Supports the popular circuits and electronics course on the MIT OpenCourse Ware from which professionals worldwide study this new approach Written by two educators well known for their innovative teaching and research and their collaboration with industry Focuses on contemporary MOS technology **Digital Integrated Circuit Design** Hubert Kaeslin, 2008-04-28 This practical tool independent guide to designing digital circuits takes a unique top down approach reflecting the nature of the design process in industry Starting with architecture design the book comprehensively explains the why and how of digital circuit design using the physics designers need to know and no more Gallium Arsenide Digital Integrated Circuit Design Stephen I. Long, 1990 Analysis and Design of Digital

Integrated Circuits David A. Hodges, Horace G. Jackson, 1988 This is a state of the art treatment of the circuit design of digital integrated circuits It includes coverage of the basic concepts of static characteristics voltage transfer characteristics noise margins fanout power dissipation and dynamic characteristics propagation delay times and the interrelationships among these parameters The authors are regarded as leading authorities in integrated circuits and MOS technology Circuit Design Xiaokun Yang, 2024-11-20 This textbook seeks to foster a deep understanding of the field by introducing the industry integrated circuit IC design flow and offering tape out or pseudo tape out projects for hands on practice facilitating project based learning PBL experiences Integrated Circuit Design IC Design Flow and Project Based Learning aims to equip readers for entry level roles as IC designers in the industry and as hardware design researchers in academia The book commences with an overview of the industry IC design flow with a primary focus on register transfer level RTL design the automation of simulation and verification and system on chip SoC integration To build connections between RTL design and physical hardware FPGA field programmable gate array synthesis and implementation is utilized to illustrate the hardware description and performance evaluation The second objective of this book is to provide readers with practical hands on experience through tape out or pseudo tape out experiments labs and projects These activities are centered on coding format industry design rules synthesizable Verilog designs clock domain crossing etc and commonly used bus protocols arbitration handshaking etc as well as established design methodologies for widely adopted hardware components including counters timers finite state machines FSMs I2C single dual port and ping pong buffers register files FIFOs floating point units FPUs numerical hardware Fourier transform matrix multiplication etc direct memory access DMA image processing designs neural networks and more The textbook caters to a diverse readership including junior and senior undergraduate students as well as graduate students pursuing degrees in electrical engineering computer engineering computer science and related fields The target audience is expected to have a basic understanding of Boolean Algebra and Karnaugh Maps as well as prior familiarity with digital logic components such as AND OR gates latches and flip flops The book will also be useful for entry level RTL designers and verification engineers who are embarking on their journey in application specific IC ASIC and FPGA design industry Solutions Manual to Accompany Digital Concepts Using Standard Integrated Circuits Richard S. Sandige, 1978 Engineering Education ,1990 **Digital Integrated Electronics** Herbert Taub, Donald L. Schilling, 1977 Table of Contents 1 Electronic Devices 2 Operational Amplifiers and Comparators 3 Logic Circuits 4 Resistor Transistor Logic and Integrated Injunction Logic 5 Diode Transistor Logic 6 Transistor Transistor Logic 7 Emitter Coupled Logic8 MOS Gates9 Flip Flops10 Registers and Counters11 Arithmetic Operations12 Semiconductor For Memories13 Analog Switches14 Analog to Digital Conversions15 Timing Circuits Solution Manual to Accompany Gallium Arsenide Digital Integrated Circuit Design Stephen I. Long, Steven E. Butner, 1991 **Introduction to VLSI Systems** Ming-Bo Lin,2011-11-28 With the advance of semiconductors and ubiquitous computing the use of system on a chip SoC has become

an essential technique to reduce product cost With this progress and continuous reduction of feature sizes and the development of very large scale integration VLSI circuits addressing the harder problems requires fundamental understanding of circuit and layout design issues Furthermore engineers can often develop their physical intuition to estimate the behavior of circuits rapidly without relying predominantly on computer aided design CAD tools Introduction to VLSI Systems A Logic Circuit and System Perspective addresses the need for teaching such a topic in terms of a logic circuit and system design perspective To achieve the above mentioned goals this classroom tested book focuses on Implementing a digital system as a full custom integrated circuit Switch logic design and useful paradigms that may apply to various static and dynamic logic families The fabrication and layout designs of complementary metal oxide semiconductor CMOS VLSI Important issues of modern CMOS processes including deep submicron devices circuit optimization interconnect modeling and optimization signal integrity power integrity clocking and timing power dissipation and electrostatic discharge ESD Introduction to VLSI Systems builds an understanding of integrated circuits from the bottom up paying much attention to logic circuit layout and system designs Armed with these tools readers can not only comprehensively understand the features and limitations of modern VLSI technologies but also have enough background to adapt to this ever changing field

Automatic Analog IC Sizing and Optimization Constrained with PVT Corners and Layout Effects Nuno Lourenço, Ricardo Martins, Nuno Horta, 2016-07-29 This book introduces readers to a variety of tools for automatic analog integrated circuit IC sizing and optimization The authors provide a historical perspective on the early methods proposed to tackle automatic analog circuit sizing with emphasis on the methodologies to size and optimize the circuit and on the methodologies to estimate the circuit's performance The discussion also includes robust circuit design and optimization and the most recent advances in layout aware analog sizing approaches The authors describe a methodology for an automatic flow for analog IC design including details of the inputs and interfaces multi objective optimization techniques and the enhancements made in the base implementation by using machine leaning techniques The Gradient model is discussed in detail along with the methods to include layout effects in the circuit sizing The concepts and algorithms of all the modules are thoroughly described enabling readers to reproduce the methodologies improve the quality of their designs or use them as starting point for a new tool An extensive set of application examples is included to demonstrate the capabilities and features of the methodologies described Subject Guide to Books in Print ,1993 **Extreme Low-Power Mixed Signal IC Design** Armin Tajalli, Yusuf Leblebici, 2010-09-14 Design exibility and power consumption in addition to the cost have always been the most important issues in design of integrated circuits ICs and are the main concerns of this research as well Energy Consumptions Power dissipation P and energy consumption are diss pecially important when there is a limited amount of power budgetor limited source of energy Very common examples are portable systems where the battery life time depends on system power consumption Many different techniques have been veloped to reduce or manage the circuit power

consumption in this type of systems Ultra low power ULP applications are another examples where power dissipation is the primary design issue In such applications the power budget is so restricted that very special circuit and system level design techniquesare needed to satisfy the requirements Circuits employed in applications such as wireless sensor networks WSN wearable battery powered systems 1 and implantable circuits for biol ical applications need to consume very low amount of power such that the entire system can survive for a very long time without the need for changingor recharging battery 2 4 Using newpowersupplytechniquessuchas energyharvesting 5 and printable batteries 6 is another reason for reducing power dissipation Devel ing special design techniques for implementing low power circuits 7 9 as well as dynamic power management DPM schemes 10 are the two main approaches to control the system power consumption Design Flexibility Design exibility is the other important issue in modern in grated systems

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