Fundamentals of Digital Logic with VHDL Design

Fundamentals of Digital Logic with VHDL Design form the backbone of modern digital systems and embedded hardware development. Understanding these fundamentals is crucial for designing reliable and efficient digital circuits, which are widely used in computing, telecommunications, and automation. VHDL (VHSIC Hardware Description Language) is an essential tool for describing and modeling digital logic in a hardware-oriented manner, allowing engineers to simulate and implement complex designs on FPGAs and ASICs. This article explores the core principles of digital logic, the role of VHDL in digital design, and practical guidelines for combining these concepts effectively. The discussion includes an overview of logic gates, combinational and sequential circuits, and the syntax and semantics of VHDL for hardware description. Additionally, it covers best practices for writing VHDL code, simulation techniques, and synthesis considerations to optimize hardware performance. These insights provide a comprehensive foundation for professionals and students aiming to excel in digital hardware design using VHDL.

- Overview of Digital Logic Fundamentals
- Introduction to VHDL and Its Role in Digital Design
- Combinational Logic Design Using VHDL
- Sequential Logic and State Machines in VHDL
- Simulation, Testing, and Synthesis of VHDL Designs

Overview of Digital Logic Fundamentals

Digital logic is the foundation of digital electronics, involving the manipulation of binary signals to perform computation and control tasks. At its core, digital logic uses two voltage levels representing binary values 0 and 1. The simplest building blocks of digital circuits are logic gates, which perform basic Boolean operations such as AND, OR, NOT, NAND, NOR, XOR, and XNOR. These gates can be combined to form more complex combinational logic circuits that produce outputs solely based on current inputs.

Basic Logic Gates and Boolean Algebra

Understanding the behavior of basic logic gates is essential for designing any digital system. Boolean algebra provides the mathematical framework to describe and simplify logic expressions, facilitating circuit optimization. Each logic gate corresponds to a fundamental Boolean operation:

- **AND Gate:** Output is 1 only if all inputs are 1.
- **OR Gate:** Output is 1 if any input is 1.
- **NOT Gate:** Inverts the input signal.
- **NAND, NOR Gates:** Complementary operations of AND and OR gates.
- **XOR, XNOR Gates:** Perform exclusive OR and its complement.

Using Boolean algebra, complex logical expressions can be minimized, reducing hardware resources and improving circuit efficiency.

Combinational vs. Sequential Logic

Digital circuits are classified into combinational and sequential logic. Combinational logic outputs depend only on present input values, without memory elements. Examples include adders, multiplexers, and encoders. Sequential logic, however, incorporates memory elements like flip-flops and latches to store past states, enabling designs such as counters, registers, and finite state machines (FSMs). Sequential circuits depend on both current inputs and previous states, thus allowing time-dependent behavior and complex control logic.

Introduction to VHDL and Its Role in Digital Design

VHDL is a hardware description language used to model digital systems at various abstraction levels, from gate-level to system-level design. It allows engineers to write descriptive code that specifies the behavior and structure of digital circuits, facilitating design verification through simulation and enabling automated synthesis into hardware.

History and Importance of VHDL

Originally developed in the 1980s under the VHSIC program, VHDL became a standard IEEE language for hardware description. It supports the concurrent nature of hardware, enabling parallel processing and precise timing control. VHDL's strong typing, modularity, and support for abstraction make it ideal for complex digital logic design and verification.

Basic Structure of a VHDL Design

A typical VHDL design consists of two main parts: the entity and the architecture. The entity defines the input and output interface of the digital module, specifying signal names and data types. The architecture describes the internal behavior or structure, using concurrent statements, processes, and component instantiations to model functionality.

Combinational Logic Design Using VHDL

Combinational logic can be effectively described in VHDL using concurrent signal assignments or processes. The language supports multiple modeling styles, including dataflow, behavioral, and structural, allowing flexibility in design approaches.

Dataflow and Behavioral Modeling

Dataflow modeling uses concurrent signal assignments to describe logical operations directly, closely mirroring Boolean equations. Behavioral modeling employs processes and sequential statements to define logic in a more algorithmic manner, enhancing readability and maintainability.

Example: Implementing a 4-to-1 Multiplexer

A 4-to-1 multiplexer selects one of four inputs based on two select signals. In VHDL, this can be implemented using a with-select statement or a process block:

- Define entity with input and output ports.
- Use concurrent signal assignments or a process to describe selection logic.

- Simulate and verify correct output for all input combinations.

This exemplifies how combinational circuits are translated into VHDL code.

Sequential Logic and State Machines in VHDL

Sequential logic design in VHDL involves describing circuits that maintain state information, enabling complex control and timing behavior. Flip-flops and registers are modeled using clocked processes, and finite state machines are commonly used to represent control logic.

Clocked Processes and Flip-Flops

Clocked processes in VHDL use the rising_edge or falling_edge function to detect clock transitions, inside which signal assignments emulate flip-flop behavior. This approach models synchronous circuits where state changes occur on clock edges, ensuring predictable timing and synchronization.

Designing Finite State Machines (FSMs)

FSMs are fundamental in sequential logic, consisting of a set of states, transitions, and outputs. VHDL supports FSM design through enumerated types for state representation and case statements for transition logic. Proper FSM design improves system reliability and simplifies debugging.

Simulation, Testing, and Synthesis of VHDL Designs

Simulation and testing are critical steps in the digital design workflow, allowing verification of functionality before hardware implementation. Synthesis translates VHDL code into gate-level netlists for physical hardware realization.

Testbenches and Functional Verification

Testbenches are specialized VHDL modules that apply stimulus to the design under test (DUT) and monitor outputs. They enable automated testing of various input scenarios, helping detect logical errors early. Writing comprehensive testbenches ensures robust and fault-tolerant design.

Synthesis Considerations and Optimization

Not all VHDL constructs are synthesizable; designers must adhere to synthesis guidelines to ensure successful hardware implementation. Optimization techniques include minimizing logic levels, using efficient coding styles, and leveraging vendor-specific synthesis attributes. These practices enhance performance, reduce resource utilization, and minimize power consumption.

Common Tools for Simulation and Synthesis

Several industry-standard tools support VHDL simulation and synthesis, including ModelSim, Vivado, Quartus, and Synopsys Design Compiler. These tools provide robust environments for code debugging, waveform analysis, and mapping designs onto target hardware platforms.

Frequently Asked Questions

What are the fundamental concepts of digital logic in VHDL design?

The fundamental concepts include understanding basic logic gates (AND, OR, NOT), combinational and sequential circuits, binary arithmetic, and how to represent these concepts using VHDL syntax for designing digital hardware.

How does VHDL help in designing digital logic circuits?

VHDL (VHSIC Hardware Description Language) allows designers to describe the behavior and structure of digital circuits at various abstraction levels, enabling simulation, verification, and synthesis of hardware designs efficiently.

What is the difference between combinational and sequential logic in VHDL?

Combinational logic outputs depend only on current inputs, and are described using concurrent statements in VHDL. Sequential logic outputs depend on current inputs and past states, requiring clock signals and typically using processes with sensitivity lists.

How do you implement a basic AND gate in VHDL?

A basic AND gate can be implemented using the 'and' operator in an architecture block, for example: output <= input1 and input2; where output, input1, and input2 are signals or ports.

What are processes in VHDL and why are they important?

Processes are sequential blocks in VHDL used to describe behavior that depends on clock edges or other sequential events, crucial for modeling flip-flops, registers, and other sequential logic elements.

How can you model a flip-flop in VHDL?

A flip-flop can be modeled using a process sensitive to the clock signal, with conditional statements to capture data on a specific clock edge, for example using 'if rising_edge(clk) then q <= d;' inside a process.

What is the role of testbenches in VHDL design?

Testbenches simulate the VHDL design by providing stimulus inputs and checking outputs, which helps verify the correctness and functionality of digital logic before hardware implementation.

How do you handle timing issues in VHDL digital logic design?

Timing issues are handled by using proper clocking schemes, synchronizing signals, avoiding combinational loops, and specifying timing constraints during synthesis and simulation to ensure reliable operation.

Additional Resources

1. *Digital Design and Computer Architecture: VHDL Edition*
This book offers a comprehensive introduction to digital design using VHDL, combining the fundamentals of logic design with computer architecture concepts. It guides readers through designing combinational and sequential circuits, with practical examples and exercises. The VHDL approach is integrated throughout, making it ideal for students and professionals looking to apply digital logic principles in hardware description languages.

2. *Fundamentals of Digital Logic with VHDL Design*
A focused text that introduces digital logic fundamentals alongside VHDL programming, this book balances theory and practice. It covers basic gates, combinational and sequential circuits, and state machines, with detailed VHDL examples to reinforce learning. The clear explanations make it suitable for beginners and those seeking to strengthen their understanding of hardware description languages.

3. *Digital Logic Design Using VHDL: A Systems Approach*
This book emphasizes a systems-level perspective, teaching digital logic design through VHDL with practical system design examples. It covers essential topics like Boolean algebra, multiplexers, flip-flops, and counters, while incorporating design methodologies. Its hands-on approach helps readers develop skills in modeling and simulating digital systems effectively.

4. *VHDL for Engineers*
Targeted at engineering students and practitioners, this book provides a solid foundation in both digital logic theory and VHDL programming. It explains the synthesis process and offers numerous VHDL examples to illustrate concepts like combinational logic, sequential circuits, and finite state machines. The text balances theoretical background with practical design insights.

5. *Digital Logic and VHDL Design*
This text introduces digital logic concepts alongside VHDL design techniques, aiming to bridge the gap between theory and practical implementation. It covers fundamental topics such as logic gates, Boolean algebra, and timing analysis, complemented by VHDL coding exercises. Readers gain experience in both designing and simulating digital circuits.

6. *Introduction to Digital Logic Design with VHDL*
A beginner-friendly book that presents the basics of digital logic design paired with VHDL programming fundamentals. It includes a step-by-step approach to designing combinational and sequential circuits, state machines, and memory elements. The inclusion of real-world examples and simulation practices makes it accessible for students new to the subject.

7. *Digital Systems Design with VHDL and Synthesis: An Integrated Approach*
This book merges digital system design principles with VHDL coding and synthesis techniques, offering a comprehensive resource for hardware design. It covers logic design, state machine modeling, and timing analysis, with a focus on synthesizable VHDL. The integrated approach helps readers understand the entire design flow from concept to implementation.

8. *Contemporary Logic Design with VHDL*
Focusing on modern digital design practices, this book presents digital logic fundamentals alongside VHDL for hardware description and verification. It explores combinational and sequential logic, programmable logic devices, and design optimization. The book is well-suited for those interested in current industry standards and methodologies.

9. *Principles of Digital Design with VHDL*
This title covers the essential principles of digital logic design combined with practical VHDL programming techniques. It offers detailed discussions on logic functions, circuit design, state machines, and timing considerations. Through numerous VHDL examples and exercises, readers develop a strong foundation for digital system development.

Fundamentals Of Digital Logic With Vhdl Design

Fundamentals of Digital Logic with VHDL Design: A Comprehensive Guide to Hardware Description Languages

This ebook delves into the crucial intersection of digital logic and VHDL (VHSIC Hardware Description Language) design, exploring the fundamental principles of digital circuits and their practical implementation using this powerful hardware description language. Understanding digital logic and VHDL is paramount for anyone involved in designing and implementing digital systems, from embedded systems and FPGAs to ASICs and VLSI circuits. The rapid advancement in technology necessitates a strong grasp of these concepts for innovation in various fields.

Ebook Title: Mastering Digital Logic and VHDL: From Gates to Integrated Circuits

Contents Outline:

Introduction: What is Digital Logic and Why VHDL?
Chapter 1: Boolean Algebra and Logic Gates: Fundamentals of Boolean algebra, logic gates (AND, OR, NOT, XOR, NAND, NOR), truth tables, Karnaugh maps, and simplification techniques.
Chapter 2: Combinational Logic Circuits: Design and analysis of combinational circuits, multiplexers, demultiplexers, encoders, decoders, adders, subtractors, comparators, and arithmetic logic units (ALUs).
Chapter 3: Sequential Logic Circuits: Flip-flops (SR, JK, D, T), counters (synchronous and asynchronous), registers, shift registers, finite state machines (FSMs), and state diagrams.
Chapter 4: Introduction to VHDL: VHDL syntax, data types, operators, concurrent and sequential statements, entities, architectures, and design units.
Chapter 5: VHDL Modeling of Combinational Logic: Modeling combinational circuits using VHDL, including dataflow, behavioral, and structural modeling styles. Examples and practical applications will be demonstrated.
Chapter 6: VHDL Modeling of Sequential Logic: Modeling sequential circuits using VHDL, including different modeling techniques for flip-flops, counters, and registers. Emphasis on efficient and synthesizable code.
Chapter 7: Advanced VHDL Concepts: Processes, functions, procedures, generics, and ports. Design of complex digital systems using VHDL.
Chapter 8: Simulation and Synthesis: Introduction to VHDL simulation using ModelSim or similar tools. Synthesis process and generating netlists for FPGA or ASIC implementation.
Conclusion: Future trends in digital logic design and VHDL applications.

Detailed Explanation of Outline Points:

Introduction: This section sets the stage by defining digital logic, explaining its importance in modern electronics, and introducing VHDL as the primary tool for its implementation. It highlights the benefits of using VHDL for designing and verifying digital circuits.

Chapter 1: Boolean Algebra and Logic Gates: This foundational chapter covers the mathematical basis of digital logic—Boolean algebra—and introduces the fundamental building blocks: logic gates. It explains how to represent logical operations using truth tables and employs Karnaugh maps for

circuit optimization.

Chapter 2: Combinational Logic Circuits: This chapter explores circuits whose output depends solely on the current input. It delves into the design and analysis of essential combinational circuits, including multiplexers, adders, and ALUs, providing practical examples and design considerations.

Chapter 3: Sequential Logic Circuits: This chapter focuses on circuits whose output depends on both the current and past inputs, introducing fundamental sequential elements like flip-flops and registers. It covers the design of counters and finite state machines, crucial for state-based system design.

Chapter 4: Introduction to VHDL: This chapter provides a comprehensive introduction to the VHDL language, covering its syntax, data types, and fundamental constructs. It lays the groundwork for effectively using VHDL to describe digital circuits.

Chapter 5: VHDL Modeling of Combinational Logic: This chapter teaches how to translate the combinational circuits designed in Chapter 2 into VHDL code, focusing on different modeling styles (dataflow, behavioral, structural) and their trade-offs.

Chapter 6: VHDL Modeling of Sequential Logic: Building on Chapter 5, this chapter demonstrates how to model sequential circuits from Chapter 3 using VHDL. It emphasizes techniques for creating efficient and synthesizable code for implementation on hardware.

Chapter 7: Advanced VHDL Concepts: This chapter explores more advanced VHDL features, such as processes, functions, and generics, showing how they enable the design of more complex and reusable components.

Chapter 8: Simulation and Synthesis: This crucial chapter covers the practical aspects of VHDL design, demonstrating how to simulate the designed circuits using industry-standard tools (like ModelSim) and synthesize the VHDL code for target FPGA or ASIC platforms.

Conclusion: This section summarizes the key concepts covered, discusses recent research advancements in digital logic and VHDL, and highlights future trends and applications.

Recent Research and Practical Tips:

Recent research in digital logic design focuses on low-power design techniques, using advanced VHDL coding styles to minimize power consumption in embedded systems and mobile devices. Furthermore, research explores efficient hardware implementations of artificial intelligence algorithms using VHDL and FPGAs.

Practical Tips:

Start with the basics: Thoroughly understand Boolean algebra and logic gates before moving to complex circuits.
Use a systematic approach: Employ a structured design methodology for complex circuits, breaking down the problem into smaller, manageable modules.

Master VHDL syntax and semantics: Understanding VHDL's syntax is critical for writing correct and efficient code.
Use simulation extensively: Thoroughly simulate your designs to identify and correct errors before hardware implementation.
Optimize for synthesis: Write synthesizable VHDL code, ensuring that the code can be translated into a hardware implementation efficiently.
Utilize available tools: Leverage simulation and synthesis tools effectively to streamline the design process.
Keep your code readable and well-commented: This aids in debugging and future modifications.

FAQs:

1. What is the difference between combinational and sequential logic? Combinational logic's output depends solely on current inputs, while sequential logic considers past inputs as well.

2. What are the main advantages of using VHDL? VHDL enables design reusability, facilitates formal verification, and supports hardware-software co-design.

3. What are some common VHDL modeling styles? Dataflow, behavioral, and structural modeling styles are common.

4. How do I simulate my VHDL code? Use simulation tools like ModelSim or similar software to verify the functionality of your VHDL designs.

5. What is the role of synthesis in VHDL design? Synthesis translates VHDL code into a hardware description suitable for FPGA or ASIC implementation.

6. What are some common challenges in VHDL design? Debugging complex designs, managing timing constraints, and ensuring synthesizability can be challenging.

7. What are some advanced VHDL features? Generics, packages, and configuration are advanced features for reusable and complex designs.

8. How can I learn more about VHDL? Numerous online resources, tutorials, and textbooks are available for learning VHDL.

9. What are some career paths that utilize VHDL skills? VHDL skills are valuable for FPGA engineers, ASIC designers, and embedded systems developers.

Related Articles:

1. VHDL for Beginners: A Step-by-Step Tutorial: This article provides a gentle introduction to VHDL

for those with little to no prior experience.

2. Advanced VHDL Techniques for High-Performance Designs: This article covers advanced VHDL concepts for optimizing designs for speed and efficiency.

3. Designing Finite State Machines in VHDL: A detailed guide on designing and implementing FSMs using VHDL.

4. VHDL Simulation and Debugging Best Practices: This article offers tips and tricks for effective VHDL simulation and debugging.

5. Implementing Arithmetic Circuits in VHDL: This article provides practical examples of implementing arithmetic operations (addition, subtraction, multiplication) in VHDL.

6. VHDL for FPGA Design: A Practical Guide: This article focuses on the specific aspects of using VHDL for FPGA implementation.

7. Low-Power Design Techniques with VHDL: This article explores techniques for optimizing power consumption in VHDL designs.

8. VHDL Code Optimization for Synthesis: This article provides strategies for writing efficient VHDL code that synthesizes well.

9. Verilog vs. VHDL: A Comparative Analysis: This article compares and contrasts Verilog and VHDL, two popular hardware description languages.

fundamentals of digital logic with vhdl design: Fundamentals of Digital Logic with VHDL Design Stephen D. Brown, Zvonko G. Vranesic, 2009-01-01 Fundamentals of Digital Logic with VHDL Design teaches the basic design techniques for logic circuits. It emphasizes the synthesis of circuits and explains how circuits are implemented in real chips. Fundamental concepts are illustrated by using small examples, which are easy to understand. Then, a modular approach is used to show how larger circuits are designed. The book emphasizes CAD through the use of Altera's Quartus II CAD software, a state-of-the-art digital circuit design package. This software produces automatic mapping of designs written in VHDL into Field Programmable Gate Arrays (FPGAs) and Complex Programmable Logic Devices (CPLDs).

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arithmetic circuits Combinational-circuit building blocks, such as multiplexers, decoders, encoders, and code converters Sequential-circuit building blocks, such as flip-flops, registers, and counters Design of synchronous sequential circuits Use of the basic building blocks in designing larger systems It also includes chapters that deal with important, but more advanced topics: Design of asynchronous sequential circuits Testing of logic circuits For students who have had no exposure to basic electronics, but are interested in learning a few key concepts, there is a chapter that presents the most basic aspects of electronic implementation of digital circuits. Major changes in the second edition of the book include new examples to clarify the presentation of fundamental concepts over 50 new examples of solved problems provided at the end of chapters NAND and NOR gates now introduced in Chapter 2 more complete discussion of techniques for minimization of logic functions in Chapter 4 (including the tabular method) a new chapter explaining the CAD flow for synthesis of logic circuits Altera's Quartus II CAD software provided on a CD-ROM three appendices that give tutorials on the use of Quartus II software

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fundamentals of digital logic with vhdl design: *Introduction to Logic Circuits & Logic Design with Verilog* Brock J. LaMeres, 2017-04-17 This textbook for courses in Digital Systems Design introduces students to the fundamental hardware used in modern computers. Coverage includes both the classical approach to digital system design (i.e., pen and paper) in addition to the modern hardware description language (HDL) design approach (computer-based). Using this textbook enables readers to design digital systems using the modern HDL approach, but they have a broad foundation of knowledge of the underlying hardware and theory of their designs. This book is designed to match the way the material is actually taught in the classroom. Topics are presented in a manner which builds foundational knowledge before moving onto advanced topics. The author has designed the presentation with learning Goals and assessment at its core. Each section addresses a specific learning outcome that the student should be able to “do” after its completion. The concept checks and exercise problems provide a rich set of assessment tools to measure student performance on each outcome.

fundamentals of digital logic with vhdl design: *Fundamentals of Digital Logic and Microcomputer Design* M. Rafiquzzaman, 2005-07-08 Fundamentals of Digital Logic and Microcomputer Design, haslong been hailed for its clear and simple presentation of theprinciples and basic tools required to design typical digitalsystems such as microcomputers. In this Fifth Edition, the authorfocuses on computer design at three levels: the device level, thelogic level, and the system level. Basic topics are covered, suchas number systems and Boolean algebra, combinational and sequentiallogic design, as well as more advanced subjects such as assemblylanguage programming and microprocessor-based system design.Numerous examples are provided throughout the text. Coverage includes: Digital circuits at the gate and flip-flop levels Analysis and design of combinational and sequentialcircuits Microcomputer organization, architecture, and programmingconcepts Design of computer instruction sets, CPU, memory, and I/O System design features associated with popular microprocessorsfrom Intel and Motorola Future plans in microprocessor development An instructor's manual, available upon request Additionally, the accompanying CD-ROM, contains step-by-stepprocedures for installing and using Altera Quartus II software,MASM 6.11 (8086), and 68asmsim (68000), provides valuablesimulation results via screen shots. Fundamentals of Digital Logic and Microcomputer Design is anessential reference that will provide you with the fundamentaltools you need to design typical digital systems.

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Design teaches the basic design techniques for logic circuits. It emphasizes the synthesis of circuits and explains how circuits are implemented in real chips. Fundamental concepts are illustrated by using small examples. Use of CAD software is well integrated into the book. A CD-ROM that contains Altera's Quartus CAD software comes free with every copy of the text. The CAD software provides automatic mapping of a design written in Verilog into Field Programmable Gate Arrays (FPGAs) and Complex Programmable Logic Devices (CPLDs). Students will be able to try, firsthand, the book's Verilog examples (over 140) and homework problems. Engineers use Quartus CAD for designing, simulating, testing and implementing logic circuits. The version included with this text supports all major features of the commercial product and comes with a compiler for the IEEE standard Verilog language. Students will be able to: enter a design into the CAD system compile the design into a selected device simulate the functionality and timing of the resulting circuit implement the designs in actual devices (using the school's laboratory facilities) Verilog is a complex language, so it is introduced gradually in the book. Each Verilog feature is presented as it becomes pertinent for the circuits being discussed. To teach the student to use the Quartus CAD, the book includes three tutorials.

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fundamentals of digital logic with vhdl design: Digital Design and Computer Architecture David Harris, Sarah Harris, 2012-08-24 Digital Design and Computer Architecture, Second Edition, takes a unique and modern approach to digital design, introducing the reader to the fundamentals of digital logic and then showing step by step how to build a MIPS microprocessor in both Verilog and VHDL. This new edition combines an engaging and humorous writing style with an updated and hands-on approach to digital design. It presents new content on I/O systems in the context of general purpose processors found in a PC as well as microcontrollers found almost everywhere. Beginning with digital logic gates and progressing to the design of combinational and sequential circuits, the book uses these fundamental building blocks as the basis for the design of an actual MIPS processor. It provides practical examples of how to interface with peripherals using RS232, SPI, motor control, interrupts, wireless, and analog-to-digital conversion. SystemVerilog and VHDL are integrated throughout the text in examples illustrating the methods and techniques for CAD-based circuit design. There are also additional exercises and new examples of parallel and advanced architectures, practical I/O applications, embedded systems, and heterogeneous computing, plus a new appendix on C programming to strengthen the connection between programming and processor architecture. This new edition will appeal to professional computer engineers and to students taking a course that combines digital logic and computer architecture. - Updated based on instructor feedback with more exercises and new examples of parallel and advanced architectures, practical I/O applications, embedded systems, and heterogeneous computing - Presents digital system design examples in both VHDL and SystemVerilog (updated for the second edition from Verilog), shown side-by-side to compare and contrast their strengths - Includes a new chapter on C programming to provide necessary prerequisites and strengthen the connection between programming and processor architecture - Companion Web site includes links to Xilinx CAD tools for FPGA design, lecture slides, laboratory projects, and solutions to exercises - Instructors can also register at textbooks.elsevier.com for access to: Solutions to all exercises (PDF), Lab materials with solutions, HDL for textbook examples and exercise solutions, Lecture slides (PPT), Sample exams, Sample course syllabus, Figures from the text (JPG, PPT)

fundamentals of digital logic with vhdl design: Digital Design Frank Vahid, 2006 Digital Design provides a modern approach to learning the increasingly important topic of digital systems design. The text's focus on register-transfer-level design and present-day applications not only leads to a better appreciation of computers and of today's ubiquitous digital devices, but also provides for a better understanding of careers involving digital design and embedded system design. The book's key features include: An emphasis on register-transfer-level (RTL) design, the level at which most digital design is practiced today, giving readers a modern perspective of the field's applicability. Yet, coverage stays bottom-up and concrete, starting from basic transistors and gates, and moving step-by-step up to more complex components. Extensive use of basic examples to teach and illustrate new concepts, and of application examples, such as pacemakers, ultrasound machines, automobiles, and cell phones, to demonstrate the immediate relevance of the concepts. Separation of basic design from optimization, allowing development of a solid understanding of basic design, before considering the more advanced topic of optimization. Flexible organization, enabling early or late coverage of optimization methods or of HDLs, and enabling choice of VHDL, Verilog, or SystemC HDLs. Career

insights and advice from designers with varying levels of experience. A clear bottom-up description of field-programmable gate arrays (FPGAs). About the Author: Frank Vahid is a Professor of Computer Science & Engineering at the University of California, Riverside. He holds Electrical Engineering and Computer Science degrees; has worked/consulted for Hewlett Packard, AMCC, NEC, Motorola, and medical equipment makers; holds 3 U.S. patents; has received several teaching awards; helped setup UCR's Computer Engineering program; has authored two previous textbooks; and has published over 120 papers on digital design topics (automation, architecture, and low-power).

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examples and exercises, enables both students and practitioners to master and implement modern digital design techniques with confidence.

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process. Readers learn good design practices and guidelines to ensure that an RTL design can accommodate future simulation, verification, and testing needs, and can be easily incorporated into a larger system or reused. Discussion is independent of technology and can be applied to both ASIC and FPGA devices. With a balanced presentation of fundamentals and practical examples, this is an excellent textbook for upper-level undergraduate or graduate courses in advanced digital logic. Engineers who need to make effective use of today's synthesis software and FPGA devices should also refer to this book.

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of digital systems. To design such systems requires a strong knowledge of Application Specific Integrated Circuits (ASICs) and Field Programmable Gate Arrays (FPGAs), as well as the CAD tools required. Hardware Description Language (HDL) is an essential CAD tool that offers designers an efficient way for implementing and synthesizing the design on a chip. HDL Programming Fundamentals: VHDL and Verilog teaches students the essentials of HDL and the functionality of the digital components of a system. Unlike other texts, this book covers both IEEE standardized HDL languages: VHDL and Verilog. Both of these languages are widely used in industry and academia and have similar logic, but are different in style and syntax. By learning both languages students will be able to adapt to either one, or implement mixed language environments, which are gaining momentum as they combine the best features of the two languages in the same project. The text starts with the basic concepts of HDL, and covers the key topics such as data flow modeling, behavioral modeling, gate-level modeling, and advanced programming. Several comprehensive projects are included to show HDL in practical application, including examples of digital logic design, computer architecture, modern bioengineering, and simulation.

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