Table of Content

CHAPTER 1 Fundamentals of VLSI Design **01-22**

1.1 Introduction to VLSI Technology
1.2 Evolution and Classification of Integrated Circuits
1.3 VLSI Design Levels and Abstraction
1.4 VLSI Design Styles and Methodologies
1.5 VLSI Design Flow and EDA Tools
1.6 Applications of VLSI in Modern Electronics

CHAPTER 2 Semiconductor Devices and CMOS Technology **23-42**

2.1 Semiconductor Fundamentals and MOSFETs
2.2 NMOS and PMOS Transistor Operation
2.3 CMOS Technology and CMOS Inverter
2.4 CMOS Logic Gates and Circuit Characteristics
2.5 CMOS Scaling and Short-Channel Effects
2.6 FinFET and Emerging Transistor Technologies

CHAPTER 3 Digital CMOS VLSI Circuit Design **43-66**

3.1 Static and Dynamic CMOS Logic
3.2 Combinational Logic Circuit Design
3.3 Sequential Logic Circuit Design
3.4 Flip-Flops, Registers and Counters
3.5 Arithmetic and Memory Circuits
3.6 Performance Analysis of CMOS Circuits

CHAPTER 4 Analog and Mixed-Signal VLSI Design **67-104**

4.1 Fundamentals of Analog VLSI Design
4.2 Current Mirrors and Differential Amplifiers
4.3 Operational Amplifiers and Analog Building Blocks
4.4 Analog-to-Digital and Digital-to-Analog Converters
4.5 Phase-Locked Loops and Mixed-Signal Circuits
4.6 Noise, Signal Integrity and Performance Analysis

CHAPTER 5 HDL and RTL-Based VLSI Design **105-126**

5.1 Hardware Description Languages
5.2 Verilog HDL Fundamentals
5.3 VHDL Fundamentals and Design Concepts
5.4 Combinational and Sequential RTL Design

5.5 Finite State Machine Design
5.6 RTL Simulation, Synthesis and Optimization

CHAPTER 6 VLSI Synthesis and Physical Design **127-153**
6.1 EDA Tools and Automated Design Flow
6.2 Logic Synthesis and Technology Mapping
6.3 Floorplanning and Power Planning
6.4 Placement and Clock Tree Synthesis
6.5 Routing and Physical Verification
6.6 Timing Analysis and Design Closure

CHAPTER 7 VLSI Testing and Verification **154-176**
7.1 Fundamentals of VLSI Testing
7.2 Fault Models and Fault Simulation
7.3 Design for Testability and Scan Testing
7.4 Built-in Self-Test Techniques
7.5 Functional and Formal Verification
7.6 Verification Challenges in Modern VLSI

CHAPTER 8 Low-Power and High-Performance VLSI Design **177-198**
8.1 Sources of Power Dissipation
8.2 Dynamic and Static Power Reduction
8.3 Voltage and Frequency Scaling
8.4 Power Gating and Clock Gating
8.5 High-Performance CMOS Design
8.6 Energy-Efficient VLSI Design Techniques

CHAPTER 9 FPGA, ASIC and System-on-Chip Design **199-221**
9.1 FPGA Architecture and Technology
9.2 FPGA Design Flow and Implementation
9.3 ASIC Architecture and Design Flow
9.4 Standard-Cell and Application-Specific Design
9.5 System-on-Chip Architecture and IP Cores
9.6 Hardware–Software Co-Design

CHAPTER 10 Advanced VLSI Technologies and Applications **222-244**
10.1 VLSI for Artificial Intelligence and Machine Learning
10.2 Multi-Core, 3D IC and Chiplet Technologies
10.3 Hardware Security and Reliable VLSI Systems

10.4 VLSI for IoT, Edge and Embedded Systems
10.5 VLSI Applications in Automotive, Healthcare and Communication
10.6 Future Trends and Emerging Opportunities in VLSI

CHAPTER 11 Advanced VLSI Design, Emerging Technologies and Future Systems **245-278**
11.1 Advanced VLSI Design Methodologies
11.2 Advanced Packaging and Heterogeneous Integration
11.3 Neuromorphic, Quantum and Emerging Computing Hardware
11.4 VLSI for Edge AI and Intelligent Computing Systems
11.5 Sustainable, Reliable and Secure VLSI Systems
11.6 Future Directions and Opportunities in VLSI Technology

References **279-281**