VLSI

1.Introduction to VLSI

- Overview of VLSI technology and its importance
- VLSI design flow
- Basic fabrication process
- Design hierarchy and abstraction levels

2. Digital Logic Design

- Combinational logic circuits
- Sequential logic circuits
- Logic gates, multiplexers, decoders, and flip-flops
- Finite State Machines (FSMs)

3. CMOS Technology

- MOSFET basics
- CMOS fabrication process
- CMOS inverter
- Static and dynamic behavior of CMOS circuits

4. VLSI Design Techniques

- Layout design rules
- Stick diagrams
- Layout of basic logic gates
- Design for testability

5. VLSI Design Methodologies

- Full-custom design
- Semi-custom design
- Standard cell-based design
- FPGA-based design
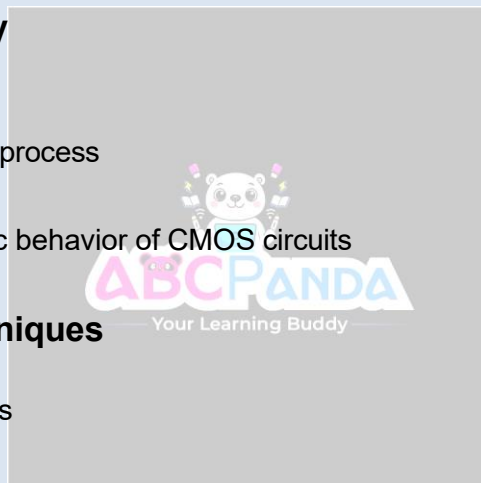
6. Physical Design

- Floorplanning
- Placement
- Routing
- Clock tree synthesis
- Design rule checking (DRC)

7. Analog VLSI Design

- Basics of analog circuits
- Operational amplifiers
- Analog-to-digital and digital-to-analog converters
- Noise and interference in analog circuits

8. VLSI Testing and Verification

- Fault models
- Test generation
- Design for testability (DFT)
- Built-in self-test (BIST)
- Verification techniques

9. CAD Tools for VLSI Design

- Introduction to EDA tools
- Schematic capture and simulation
- Layout design tools
- Timing analysis tools
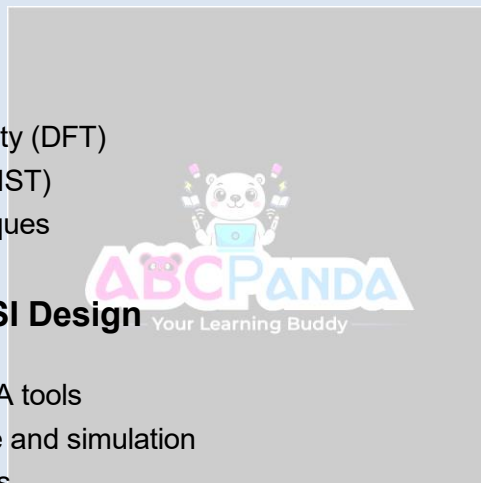
Advanced Topics:

1. Introduction to VLSI

● Overview of VLSI Technology

- ○ Evolution of VLSI
- ○ Applications of VLSI

● Introduction to Semiconductor Devices

- ○ Basics of semiconductor physics
- ○ Diodes, transistors (BJT, MOSFET)

2. Digital Logic Design

- **Fundamental Concepts**
  - Binary numbers, Boolean algebra
  - Logic gates and truth tables
- **Combinational Circuits**
  - Multiplexers, decoders, encoders, adders
- **Sequential Circuits**
  - Flip-flops, registers, counters
- **Finite State Machines (FSMs)**
  - Design and analysis of FSMs

3. CMOS Technology

- **Introduction to CMOS**
  - CMOS logic, characteristics, and scaling
- **CMOS Inverter**
  - Static and dynamic behavior
- **Basic CMOS Circuits**
  - NAND, NOR, XOR gates

4. VLSI Fabrication Process

- **Overview of Fabrication Steps**
  - Wafer preparation, photolithography, etching, doping
- **Layout Design Rules**
  - Design rules and design rule checking (DRC)

5. CMOS Circuit Design

- **Combinational and Sequential CMOS Logic Circuits**
- **Design of Arithmetic Circuits**
  - Adders, multipliers
- **Power and Delay Analysis**
  - Power dissipation, timing analysis, and optimization

6. VLSI Design Methodologies

- **Full-Custom vs. Semi-Custom Design**
- **Standard Cell Design**
  - Libraries, layout, and characterization
- **ASIC Design Flow**
  - Specification, RTL design, synthesis, place and route

7. VHDL/Verilog for Digital Design

- **Introduction to Hardware Description Languages (HDLs)**
  - VHDL/Verilog syntax and semantics
- **RTL Design and Simulation**
  - Writing testbenches, simulation tools
- **Synthesis and Verification**
  - Synthesis tools, static timing analysis, formal verification

8. FPGA Design and Prototyping

- **Introduction to FPGAs**
  - Architecture and applications
- **FPGA Design Flow**
  - Design entry, synthesis, implementation, and testing
- **FPGA Development Boards and Tools**
  - Hands-on labs with FPGA boards

9. Analog and Mixed-Signal VLSI Design

- **Analog Circuit Design**
  - Operational amplifiers, comparators, data converters (ADC/DAC)
- **Mixed-Signal Design**
  - PLLs, VCOs, and signal integrity issues

10. VLSI Testing and Verification

● **Testing Techniques**

  ○ Fault models, fault simulation, test pattern generation

● **Design for Testability (DFT)**

  ○ Scan chains, Built-In Self-Test (BIST)

● **Verification Methodologies**

  ○ Functional verification, UVM

11. Advanced VLSI Topics

● **Low Power Design Techniques**

  ○ Techniques for power reduction at the architectural and circuit level

● **High-Speed VLSI Design**

  ○ Design considerations for high-frequency circuits

● **3D ICs and Advanced Packaging**

  ○ 3D stacking, Through-Silicon Vias (TSVs)

12. Semiconductor Manufacturing and Industry Practices

● **Design for Manufacturability (DFM)**

● **Yield and Reliability Analysis**

● **Industry Standards and Tools**

  ○ EDA tools, standard design flows