IV B.Tech – I Semester
(17EC703) VLSI DESIGN

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	1	-	3

Pre-Requisites: Electronic Devices and Circuits, Digital IC Applications

Course Objectives:

- To understand the various IC fabrication methods and its electrical properties of CMOS, NMOS.
- To impart the knowledge of design rules and design and analyze the layout of a circuit.
- To impart the knowledge of Scaling and its Performance analysis.
- To understand various logic families of FPGA and analyze and develop digital VLSI systems using VHDL
- To understand the need for low power VLSI circuits and analyze low power reduction techniques

UNIT-I: Introduction and Basic Electrical Properties of MOS Circuits

Introduction to IC technology, Fabrication process: nMOS, pMOS and CMOS. Ids versus Vds Relationships, Aspects of MOS transistor Threshold Voltage, MOS transistor Trans, Output Conductance and Figure of Merit. nMOS Inverter, Pull-up to Pull-down Ratio for nMOS inverter driven by another nMOS inverter, and through one or more pass transistors. Alternative forms of pull-up, The CMOS Inverter, Latch-up in CMOS circuits, Bi-CMOS Inverter, Comparison between CMOS and BiCMOS technology.

UNIT-II: MOS and Bi-CMOS Circuit Design Processes

MOS Layers, Stick Diagrams, Design Rules and Layout, General observations on the Design rules, 2µm Double Metal, Double Poly, CMOS/BiCMOS rules, 1.2µm Double Metal, Double Poly CMOS rules, Layout Diagrams of NAND and NOR gates and CMOS inverter, Symbolic Diagrams-Translation to Mask Form.

UNIT-III: Basic Circuit Concepts

Sheet Resistance, Sheet Resistance concept applied to MOS transistors and Inverters, Area Capacitance of Layers, Standard unit of capacitance, Some area Capacitance Calculations, The Delay Unit, Inverter Delays, Driving large capacitive loads, PropagationDelays, Wiring Capacitances, Choice of layers.

Scaling of MOS Circuits: Scaling models and scaling factors, Scaling factors for device parameters, Limitations of scaling, Limits due to sub threshold currents, Limits on logic levels and supply voltage due to noise and current density. Switch logic, Gate logic.

UNIT-IV: Chip Input and Output circuits

ESD Protection, Input Circuits, Output Circuits and L(di/dt) Noise, On-Chip clock Generation and Distribution.

Design for Testability: Fault types and Models, Controllability and Observability, Ad Hoc Testable Design Techniques, Scan Based Techniques and Built-In Self-Test techniques.

UNIT-V: FPGA Design

FPGA design flow, Basic FPGA architecture, FPGA Technologies, FPGA families- Altera Flex 8000FPGA, Altera Flex 10FPGA, Xilinx XC4000 series FPGA, Xilinx Spartan XL FPGA, Xilinx Spartan II FPGAs, Xilinx Vertex FPGA. Case studies: FPGA Implementation of Half adder and full adder.

Introduction to synthesis: Logic synthesis, RTL synthesis, High level Synthesis.

UNIT-VI: Introduction to Low Power VLSI Design

Introduction to Deep submicron digital IC design, Low Power CMOS Logic Circuits: Over view of power consumption, Low –power design through voltage scaling, Estimation and optimization of switching activity, Reduction of switching capacitance. Interconnect Design, Power Grid and Clock Design.

Course Outcomes:

After successful completion of the course, the students can be able to:

S. No	Course Outcome	BTL
1.	Understand the various IC fabrication methods and it's electrical properties of CMOS, NMOS	L2
2.	Apply the Concept of design rules and design and analyze the layout of a circuit.	L3
3.	Understand the basic circuit concepts and how it impacts scaling and it's performance analysis	L3
4.	Understand the Chip Input and Output circuits and analyze the concepts in testing which can help them design a better yield in IC design	L3
5.	Understand various logic families of FPGA and analyze and develop digital VLSI systems using VHDL	L4
6.	Understand the need for low power VLSI circuits and analyze low power reduction techniques	L2

Correlation of COs with POs & PSOs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	1	2	1	1	-	1	1	-	1	2	2
CO 2	3	3	2	1	2	2	1	-	1	1	-	-	3	3
CO 3	3	2	3	1	2	2	1	-	1	1	-	-	2	2
CO 4	3	2	3	1	2	2	1	-	1	1	-	-	3	3
CO 5	3	2	1	1	1	1	-	-	1	1	-	-	2	1
CO 6	3	2	1	1	1	1	1	-	1	1	-	-	2	2

Text Books:

1. Essentials of VLSI Circuits and Systems - Kamran Eshraghian, Douglas and A. Pucknell &Sholeh Eshraghian, Prentice-Hall of India Private Limited, 2005 Edition.
2. CMOS Digital Integrated Circuits Analysis and Design- Sung-Mo Kang, Yusuf Leblebici, Tata McGraw-Hill Education, 2003.

Reference Books:

1. Advanced Digital Design with the Verilog HDL, Michael D.Ciletti, Xilinx Design Series, Pearson Education
2. Analysis and Design of Digital Integrated Circuits in Deep submicron Technology, 3rd edition, David Hodges.