16EC306 VLSI DESIGN

Hours Per Week :

L	T	P	C
3	-	2	4

Course Description and Objectives:

The aim of this course is to introduce the basic concepts of digital circuit design using hardware description language and IC fabrication process with CMOS technology and basic electrical properties of MOS transistor. The objective is to introduce CMOS logic gates and their schematics and layouts for designing digital and/or analog circuits.

Course Outcomes:

Upon successful completion of this course, students should be able to:

CO1: Analyze the operation and Electrical Behavior of MOS transistors.

CO2: Understand the fabrication process of different MOS technologies.

CO3: Design VLSI circuits and Layouts of simple MOS circuit using Lambda based design rules.

CO4: Develop subsystems (digital circuits) using various logic methods and their limitations. (Minor project)

CO5: Model the combinational and sequential circuits using VHDL.

CO6: Synthesize the digital circuits with hardware description language/schematic levels.(Lab+Minor Project)

SKILLS:

- ✓ *Estimate the layout area and power dissipation of the circuit.*
- ✓ *Customize a model for the particular logic system.*
- ✓ *Identify the design flow of front end and back end.*
- ✓ *Identify the different colour codes for the layouts.*

UNIT - 1 **L-9**

MOS TRANSISTOR INTRODUCTION: Transistor operation, I_{DS}-V_{DS} relationship, Transistor parameters - Threshold Voltage, Transconductance, Output conductance, Figure of merit; Pass transistor, NMOS inverter, Various pull ups, CMOS Inverter, Introduction of Bi-CMOS inverter.

UNIT - 2 **L-9**

MOS FABRICATION: Introduction to IC technology - MOS, PMOS, NMOS and CMOS fabrication processes; Oxidation, Lithography, Diffusion, Ion implantation, Metallization, Encapsulation.

UNIT - 3 **L-9**

MOS Circuit Design: VLSI design flow, MOS layers, Stick diagrams and layout, Design rules for NMOS, CMOS and BICMOS circuits, The delay unit, Inverter delays, Driving capacitive loads, Propagation delays, Wiring capacitances.

UNIT - 4 **L-9**

CMOS SUBSYSTEM DESIGN: Alternate gate circuits, Arithmetic circuits - Adders, Multipliers, Parity generators, Comparators, Zero and one detectors; Design capture tools, Design for testability, Simulation, Synthesis, Introduction to FPGA.

UNIT - 5 **L-9**

INTRODUCTION TO HDL: Hardware description language - VHDL design flow, Program structure, Types and constants, Functions and procedures, Libraries and packages; VHDL design elements - Structural design elements, Data flow design elements, Behavioral design elements.

LABORATORY EXPERIMENTS

Course Outcomes:

The student will be able to:

- understand operation and electrical properties of MOS transistors.
- understand fabrication process of MOS technology.
- analyze static characteristics of MOS circuits practically.
- design logic circuits for both NMOS and CMOS.
- understand different modeling styles of VHDL code.
- simulate and verify a VHDL code for different combinational and sequential circuits.

LIST OF EXPERIMENTS Total hours-30

PART-A

Design and simulate the following schematics in NMOS and CMOS Technology in Cadence.

Logic gates like NOT, NAND, NOR, AND, OR, Ex-OR, Ex-NOR, AOI, OAI.

PART-B

Design and simulate the following in Xilinx Software using VHDL.

1.	Logic gates	:	NOT, NAND, NOR, AND, OR, Ex-OR.
2.	Arithmetic Circuits	:	Adders, Subtractors, Multiplier and ALU
3.	Combinational Circuits	:	Decoder, Encoder, Multiplexer, Demultiplexer, Parity Generators and Checkers.
4.	Sequential Circuits	:	Flip-Flops, Counters, Shift Registers.

ACTIVITIES:

- *Simulate a given digital system using HDL.*
- *Synthesize digital system and implement on FPGA kit.*
- *Create schematics to digital system using CMOS.*
- *Evaluate the performance of the given system for available CMOS technologies.*
- *Draw the layout for a given schematic diagram.*

TEXT BOOKS:

1. Kamran Eshraghian, Eshraghian Dougles and A. Pucknell, “Essentials of VLSI circuits and systems”, 1st edition, PHI, 2009.

2. John F. Wakerly, “Digital Design Principles and Practices”, 3rd edition, Prentice Hall, 2010.

REFERENCE BOOKS:

1. S.M. Sze, “VLSI Technology”, 2nd edition, TMH, 2007.

2. N. Weste and K. Eshraghian, “Principles of CMOS VLSI Design”, Pearson Education, 2nd edition, 2010.

3. Bhasker.J, “A VHDL Prime” PHI, 2nd edition, 2008.