VLSI: Technology and Design (GE)

Credits: Theory-03 **Theory Lectures: 45h**

Course Learning Objectives:

- The course deals with knowledge of materials required for VLSI technology.
- It deals with the BJT vs MOS Technology.
- Importance of MOS in VLSI.
- VLSI logic design using CMOS.

Course Learning Outcomes

At the end of this course, students will be able to
CO1: Summarize the developments in the field of Microelectronics Technologies.
CO2: Learn the VLSI technology basics.
CO3: Learn about the role of CMOS in VLSI Technology and Design
CO4: Understand the concept of implementation of various logic design using CMOS.

Prerequisites: Basic knowledge of semiconductor theory and digital circuits.

L-T-P: 3-0-1

Syllabus Contents

Unit 1 **(10 lectures)**

Introduction to VLSI Technology: Overview of VLSI and its applications; Semiconductor basics: Materials (Si, Binary Materials like GaN, GaAs).
Crystal growth techniques: Growth of bulk Silicon single crystals using Czochralski (CZ) technique, Doping while crystal growth (Distribution of dopants, Effective Segregation Coefficient), Float Zone (FZ) technique, GaAs bulk single crystal growth by Bridgman-Stockbarger technique.
Wafer Cleaning Technology: Basic Concepts, Wet cleaning, Dry cleaning

Unit 2 **(11 lectures)**

Semiconductor Devices: PN junction diode, BJT, MOS; MOS transistors: Basic operation and characteristics; VLSI technology basics (Diffusion/Ion Implantation for doping, Oxidation, Metallization, Packaging).

Unit 3 **(12 lectures)**

VLSI Design Methodology: Importance of MOS in VLSI Design(Characteristics as Power Consumption, Device density on a single Chip); MOS Structures (NMOS, PMOS, CMOS structures); various logic devices made from MOS (Registers, Memories (RAM & ROM).
VLSI design flow: behavioral, structural, data flow methods; Device and gate-level design.

Unit 4 **(12 lectures)**

CMOS Logic Design (Approx. 12 hours): CMOS inverter and its characteristics; CMOS circuit layout considerations; Introduction to simulation and verification techniques (devices/circuits); Combinational logic using CMOS (AND, OR, NOT, NAND, NOR, XOR, half adder, full adder); Sequential logic using CMOS (Flip Flops, Counters, Registers).

References:

1. Gary S.May and S.M.Sze: Fundamentals of Semiconductor Fabrication, John Wiley & Sons (2004).
2. Douglas A Pucknell, Kamran Eshraghian: Basic VLSI design, PHI.
3. Weste and Harris: CMOS VLSI Design: Circuits and Systems Perspective, Addison-Wesley.
4. Kang and Lebelbigi: CMOS Digital IC Circuit Analysis and Design, McGraw Hill.

VLSI: Technolgy And Design

(Pspice/other Simulation Software)

Credits: 01 **Lectures: 30h**

Syllabus Content

1. To measure the resistivity of semiconductor crystal with temperature by four –probe method.
2. To determine the type (n or p) and mobility of semiconductor material using Hall effect.
3. CZ technique Simulation/Float zone technique Simulation
4. Oxidation process Simulation/Diffusion Process Simulation
5. To plot the (i) output characteristics & (ii) transfer characteristics of an n-channel and p-channel MOSFET.
6. To design and plot the static and dynamic characteristics of a digital CMOS inverter.
7. To design and plot the dynamic characteristics of 2-input NAND, NOR, XOR and XNOR logic gates using CMOS technology.
8. To prepare layout for given logic function and verify it with simulations.
9. To measure propagation delay of a given CMOS Inverter circuit.

Note: Visit to Research Lab/institutions to see the live demonstrations of the processes and preparation of a report.