VLSI CIRCUITS & SYSTEMS

Course Code: **EC30005**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

The VLSI design course aims for students to learn fundamental theories and techniques of digital VLSI Circuits & Systems using CMOS technology, and layout, about the digital integrated circuits domain. In addition, the course aims to enable students to analyze and design different VLSI architectures using the fundamental concepts of digital VLSI systems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Apply knowledge to analyze different methods for VLSI chip design,
CO 2: Analyze the role of key parameters of MOS transistor and formulate threshold voltage and drain current model of the transistor,
CO 3: Interpret different performance metrics of CMOS inverter circuit in terms of supply voltage and transistor size,
CO 4: Implement and optimize CMOS Circuit performance to achieve desired circuit characteristics/ performance,
CO 5: Construct CMOS sequential circuits using different design styles and compare performance such as area, speed and power consumption,
CO 6: Create different VLSI subsystems intended for societal and or industrial needs.

COURSE DETAILS

Introduction to VLSI

VLSI Design Methodology, VLSI Design Flow, VLSI Design Hierarchy, VLSI Design Styles.

MOSFET and its Characteristics

Two terminal MOS Structure, MOS Structure under external Bias Condition, Derivation of Threshold Voltage and its components, MOSFET structure and its Qualitative Analysis, MOSFET Current-Voltage Relationship and its Characteristics, MOSFET Scaling and short geometry effects (only qualitative) .

Inverter DC and Switching Characteristics

Inverter Noise Margin, CMOS Inverter DC Characteristics and its analysis, Delay time definitions, estimation of propagation delay for CMOS Inverter, Super buffer, Power dissipation in CMOS, Interconnect Parameters - Resistance, Capacitance, Inductance, Lumped RC Model, Distributed RC Model.

CMOS Combinational Circuits

CMOS NAND and NOR Gate and their qualitative analysis with sizing, CMOS Complex Logic Circuit, logical efforts, NMOS and PMOS as Pass transistor, pass transistor and CMOS Transmission Gate based logic circuit, Stick Diagram and layout of Inverter and Complex logic Circuit.

High performance CMOS logic and Sequential logic Circuits

Dynamic Logic Concept, Synchronous Dynamic Logic Circuits (Domino and NOR logic Circuit), Bistable Circuit, SR Latch, Clocked Latch and Flip Flop Circuits.

VLSI Subsystem

Approach to digital system design, Adder (CMOS, transmission gate, pass transistor based), Multiplier, SRAM (6T).

Textbooks

1. Kang, Sung-Mo, 1945-. (1996). CMOS digital integrated circuits : analysis and design (4th edition). New York :McGraw-Hill.
2. Weste, N., & Harris, D. (2023). CMOS VLSI Design: A Circuits and Systems Perspective (4th ed.). USA: Pearson.

Reference books

1. Baker, R. J., & Harry, W. (2005). LI., David E. Boyee,"CMOS Circuit Design, Layout and Simulation". USA: IEEE Press

2. Rabaey, J. M. (1999). Digital integrated circuits a design perspective(2nd edition). PHI