

Devi Ahilya University, Indore, India Institute of Engineering & Technology				III Year B.E. (Electronics and Telecommunication Engg.)			
Subject Code & Name	Instructions Hours per Week			Credits			
5ETRE1 VLSI DESIGN	L	T	P	L	T	P	Total
	3	1	2	3	1	1	5
Duration of Theory Paper: 3 Hours							

Course Learning Objective:

The course is designed

1. To gain an in-depth understanding of the design flow and various VLSI design methods as well as the essential considerations and difficulties in CMOS VLSI design.
2. To gain a comprehensive understanding of the structure and functionality of MOS transistors, including small and large signal models, threshold voltage control, and analysis of current-voltage characteristics.
3. Develop an understanding of how to build and analyze CMOS inverters, including how to calculate propagation delays, rise and fall times, noise margins, and power dissipation.
4. Become familiar with several types of CMOS logic circuits, such as transmission gate logic, pass transistor logic, pseudo-NMOS logic, and dynamic logic circuits. To acquire knowledge in the design of semiconductor memory circuits and combinational and sequential logic circuits.
5. Gain an understanding of the fundamentals of CMOS analog circuit design, including current sources, operational amplifiers, single-stage and differential amplifiers, and large and small signal models, as well as their frequency responses. Identify the methods used in analog circuits for frequency adjustment and stability.

Prerequisites:

Knowledge of semiconductor devices is required and digital electronics.

COURSE CONTENTS

UNIT -I

Introduction: Challenges, motivating factors for recent trends in VLSI, VLSI design flow, VLSI design style, Logic synthesis, high-level synthesis design flow, data and control graph generation, resource allocation, operation scheduling algorithms, ASAP, ALAP, resource occupancy, mobility, time constraints and resource constraints scheduling, resource binding and critical path analysis.

UNIT - II

MOS transistor: Structure and operation of MOS transistor, threshold voltage of MOSFET, controlling of threshold voltage, MOSFET current-Voltage Characteristics. Transconductance, Drain conduction. Aspect ratio, process parameters, second-order effects, MOS small signal, and Large signal model, MOS capacitances.

UNIT - III

CMOS Inverter: Analysis of resistive load inverter and CMOS inverter circuits, CMOS inverter transfer characteristic, CMOS Symmetric circuit design, propagation delay calculation, rise time, fall time, noise margin, and power dissipation for CMOS Inverter. Effect of threshold voltage and supply voltage on Delay and power dissipation.

UNIT - IV

CMOS circuit Design: CMOS logic, pseudo-NMOS logic, pass transistor logic, Transmission Gate logic, and Dynamic logic circuit design. Designing of Combinational logic circuit, sequential logic circuit design, and semiconductor memory circuit.

UNIT - V

CMOS Analog Circuit Design: Large signal models, small signal models, current sources, single stage amplifiers, differential amplifiers, operational amplifiers, frequency response, a frequency response of amplifiers, the frequency response of operational amplifiers, stability, and frequency compensation.

Course Outcome:

Students earned credits will develop the ability to

CO. No.	CO	PO
CO1	Understand the fundamental concepts and methodologies of CMOS VLSI design, including the entire VLSI design flow.	PO-1, PO-3, PO-12
CO2	Analyze the structure, operation, and characteristics of MOS transistors, including threshold voltage control and current-voltage relationships.	PO-2, PO-4
CO3	Design and analyze CMOS inverter circuits, including the calculation of propagation delay, noise margins, and power dissipation.	PO-1, PO-3, PO-5
CO4	Design various CMOS logic circuits, such as combinational and sequential logic circuits, using different logic styles.	PO-3, , PO-5, PO-9
CO5	Explore and implement CMOS analog circuit designs, focusing on amplifiers, frequency response, stability, and frequency compensation.	PO-1, PO-4, PO-5, P12

CO-PO Relationship

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	2		2									3
CO2		3		3								
CO3	2		3		3							
CO4			3		3				2			
CO5	3			3	3							2

BOOKS RECOMMENDED:

- [1] Sung-mo Kang and Yusuf Leblebici, CMOS Digital Integrated Circuit Analysis and Design, 3rd Edition, Tata McGraw-Hill.
- [2] Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic, Digital Integrated Circuits: A Design Perspective, Prentice Hall of India, Second Edition.
- [3] Neil H. E. Weste and K. Eshraghian, Principles of CMOS VLSI Design, Second Edition, Pearson Education Asia.
- [4] B. Razavi, Design of Analog Integrated Circuits, McGraw Hill Education, 2018.
- [5] Giovanni De Micheli, Synthesis and Optimization of Digital Circuits, Tata McGraw Hill

List of Practical Assignments/Experiments:

Practical will be performed on CADANCE EDA tool.