



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Electronics and Communication

Subject Code: BE05000371

Subject Name: VLSI Design

WEF Academic Year :	2025-26
Semester :	5
Category of the Course :	Professional Core Course

Course Outcome :

After Completion of the Course, Student will able to :

No	Course Outcomes	RBT Level*
01	Describe working of MOSFET and develop its mathematical model	UN
02	Analyze, design, and simulate various static CMOS circuits	AN
03	Analyze and simulate various dynamic CMOS circuits	AN
04	Prepare layout of MOSFET based circuits	CR
05	Understand CMOS latch-up, clocking strategy, and testing principles	UN
06	Write programs in VHDL/Verilog for digital circuits and realize them on FPGA/CPLD	AP
07	Describe working of MOSFET and develop its mathematical model	AP

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme :

Teaching/Learning Scheme in hrs/semester					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	PBL*	TH	TH/30	Theory		Practical			
						ESE (E)	PA (M)	PA (I)	PBL(I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.

Course Content :

Sr. No.	Content	Total Hrs	% Weightage
1	Introduction: Overview of VLSI design methodology, VLSI design flow, Design hierarchy, Concept of regularity, Modularity, and Locality, VLSI design style, Design quality, package technology, introduction to FPGA and CPLD, computer aided design technology.	4	8



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2	Fabrication of MOSFET : Introduction, Fabrication Process flow: Basic steps, C-MOS n-Well Process, Layout Design rules, full custom mask layout design.	5	8
3	MOS Transistor: The Metal Oxide Semiconductor (MOS) structure, The MOS System under external bias, Structure and Operation of MOS transistor, MOSFET Current-Voltage characteristics, MOSFET scaling and small-geometry effects, MOSFET capacitances	7	16
4	MOS Inverters - Static Characteristics: Introduction, Resistive load Inverter, Inverter with n-type MOSFET load (Enhancement and Depletion type MOSFET load), CMOS Inverter	7	13
5	MOS Inverters Switching characteristics and Interconnect Effects: Introduction, Delay-time definitions, Calculation of Delay times, Inverter design with delay constraints, Estimation of Interconnect Parasitic, Calculation of interconnect delay, Switching Power Dissipation of CMOS Inverters	6	16
6	Combinational MOS Logic Circuits: Introduction, MOS logic circuits with Depletion nMOS Loads, CMOS logic circuits, Complex logic circuits, CMOS Transmission Gates (TGs)	6	7
7	Sequential MOS Logic Circuits: Introduction, Behavior of Bistable elements, The SR latch circuit, Clocked latch and Flip-flop circuit, CMOS D-latch and Edge-triggered flip-flop	5	6
8	Dynamic Logic Circuits: Introduction, Basic Principles of pass transistor circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, CMOS Dynamic Circuit Techniques, High-performance Dynamic CMOS circuits	5	10
Total		45	100

This syllabus is mapped with following United Nation's Sustainable Development Goals:

- SDG 3 - Good Health and Well-being
- SDG 4 - Quality Education.
- SDG 7 – Clean and affordable energy,
- SDG 8 - Decent Work and Economic Growth,
- SDG 9 - Industry, Innovation and Infrastructure,
- SDG 11 - Sustainable Cities and Communities,
- SDG 12 - Responsible Consumption and Production,
- SDG 13 - Climate Action

Relevant BIS and other standards:

IS/IEC 61508 – Functional Safety of Electrical/Electronic Systems



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IS/IEC 61511 – Safety Instrumented Systems

Standard by Telecommunication Engineering Centre for,

Standards for telecom-grade semiconductor devices

Compliance for communication ICs

IS/ISO 9001 – Quality Management Systems

IS/ISO 14001 – Environmental Management Systems

Aligned with guidelines from: Bureau of Energy Efficiency (BEE)

Semiconductor devices used in energy-efficient systems must comply with power efficiency regulations.

(Important for semiconductor fabrication plants)

Also explore other relevant Indian and international standards.

Reference Book :

1. CMOS Digital Integrated circuits – Analysis and Design by Sung – Mo Kang, Yusuf Leblebici, TATA McGraw-Hill Pub. Company Ltd.
2. Basic VLSI Design By Pucknell and Eshraghian, PHI, 3rd ed.
3. Introduction to VLSI Systems by Mead C and Conway, Addison Wesley
4. Introduction to VLSI Circuits & Systems – John P. Uyemura
5. Fundamentals of Digital Logic Design with VHDL, Brown and Vranesic
6. FinFETs and Other Multigate Transistors. J. P. Colinge, Springer Publications

Suggested Course Practical List :

1. Introduction to programmable devices (FPGA, CPLD), Hardware Description Language (VHDL), and the use programming tool.
2. Implementation of basic logic gates and its testing.
3. Implementation of adder circuits and its testing.
4. Implementation 4 to 1 multiplexer and its testing.
5. Implementation of 3 to 8 decoder and its testing.
6. Implementation of 8 to 3 priority encoder and its testing.
7. Implementation of J-K and D Flip Flops and its testing.
8. Implementation of sequential adder and its testing.
9. Implementation of BCD counter and its testing.
10. Implementation of two 8-bit multiplier circuit and its testing.
11. Simulation of CMOS Inverter using SPICE for transfer characteristic.
12. Simulation and verification of two input CMOS NOR gate using SPICE.
13. Implementation and simulation of given logic function using dynamic logic.
14. To generate layout for CMOS Inverter circuit and simulate it for verification.
15. To prepare layout for given logic function and verify it with simulations.
16. To measure $I_{DS} - V_{GS}$ and $I_{DS} - V_{DS}$ characteristics of given n-channel and p-channel MOSFETs.



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17. To measure propagation delay of a given CMOS Inverter circuit.

Major Equipment/software:

Circuit simulator, FPGA/CPLD programming tool, Multimeter, Power supply, function generator, oscilloscope, SPICE Simulator

List of Laboratory/Learning Resources Required:

- NPTEL

Activities suggested under Self-learning/Team Work:

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7.	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8.	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills



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10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software

Note:

1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.

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