SEMESTER S4

VLSI DESIGN

(Common to CS/CN/CI)

Course Code	**PECST415**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	GAEST305	**Course Type**	Elective

Course Objectives:

1. To impart the key concepts of MOS technology including characteristics of CMOS and its application in digital VLSI circuits to design basic CMOS logic gates.
2. To impart the key concepts of Integrated Circuit Design and introduce various design flows.
3. To equip the learner to implement both combinational and sequential logic circuits using both semi-custom and FPGA design flow.

SYLLABUS

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Module No.	Syllabus Description	Contact Hours
1	**CMOS Fundamentals for Digital VLSI Design :** CPN junction, MOS transistor theory and operation, PMOS, NMOS, CMOS, CMOS Inverter, Voltage Transfer Curve, CMOS logic gates, Tristate Inverter, Tristate buffer. Combinational Circuits Timing - Rise Time, Fall time, Propagation Delay. Introduction to sequential logic circuits, flip-flops and latches, Timing analysis - Set-up time, Hold Time, Propagation Delay, Frequency of Operation, Static and Dynamic Timing Analysis, Pipelining	**9**
2	**Introduction to Integrated Circuits (ICs):** CMOS fabrication process overview- Photolithography, Structure of an Integrated Circuit, Types of Design flow - Custom design, Semi-custom design, array based design. A System Perspective, Hardware – Software Partitioning, example Video compression, Functional Specification to RTL, Behavioural Synthesis.	**9**

3	**Semi-custom Design flow** Abstraction in VLSI Design Flow- Gajski-Kuhn's Y-chart, Hardware design using hardware description Languages, Design Verification- Simulation using Testbench, Property Checking, Equivalence Checking, Static Timing Analysis, Logic Synthesis, Physical Design- Min-cut Partitioning, Floor plan- , Global and Detailed Placement, Global and Detailed Routing, Micro project*	**9**
4	**Finite State Machines (FSMs):** Mealy and Moore models. Verilog HDL Design and implementation of RISC stored programmed Machine. **Field Programmable Gate Arrays (FPGAs)** : FPGA Architecture- Programming Technology, Programmable logical blocks, Programmable Interconnects, Programmable I/O blocks, FPGA Design Flow, SoC Design on FPGA, Micro project*.	**9**

***** *Micro-project on FPGA / Semi-Custom Flow.*

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

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Continuous Internal Evaluation Marks (CIE):

Attendance	*Internal Ex*	*Evaluate*	*Analyse*	*Total*
5	**15**	**10**	**10**	**40**

Criteria for Evaluation (Evaluate and Analyse): 20 marks

- Ability to capture the specification and ability for RTL coding,
- Ability to analyze the circuit for resource utilization such as area consumption and power consumption. Analyze the circuit for timing violations. Optimize performance.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. • Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Utilize the MOS Circuits and design basic circuits using CMOS.	**K3**
CO2	Explain IC design flow and design a system using hardware software co-design strategy.	**K3**
CO3	Design, simulate and implement systems design in HDL using semi-custom flow.	**K4**
CO4	Design, simulate and implement digital systems using programmable devices.	**K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		3							3
CO2	3	3	3		3							3
CO3	3	3	3		3							3
CO4	3	3	3		3							3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

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Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to VLSI Design Flow	Sneh Saurabh	Cambridge University Press	1/e, 2023
2	Digital Integrated Circuits: A Design Perspective.	Jan M. Rabaey, Anantha P. Chandrakasan, Borivoje Nikolic	Pearson Education	2/e, 2003
2	Digital Systems Design Using Verilog	Charles H. Roth Jr., Lizy Kurian John, Beyeong Kil Lee,	CL Engineering	1/e, 2015
3	Advanced Digital Design with the Verilog HDL	Micahel D. Ciletti	Pearson	2/e, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Design and Computer Architecture - RISC-V Edition	Sarah L. Harris, David Harris	Morgan Kaufmann	1/e, 2022
2	Digital Design: With an Introduction to the Verilog HDL	M. Morris Mano, Michael D. Ciletti	Pearson India	5/e, 2012
3	Verilog HDL – A guide to digital design & Synthesis	Samir Palnitkar	Pearson	2/e, 2003
4	FPGA Based System Design	Wayne Wolf	Pearson	1/e, 2004
5	Embedded Core Design with FPGAs	Zainalabedin Navabi	McGraw-Hill	1/e, 2006

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Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	Introduction to Digital VLSI Design Flow, Introduction to Digital VLSI Design Flow, IIT Guwahati https://nptel.ac.in/courses/106103116
2	Introduction to VLSI Design by Prof. S. Srinivasan , IIT Madras, https://nptel.ac.in/courses/117106092
3	VLSI Physical Design by Prof. Indranil Sengupta, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc21_cs12/preview
4	Digital System Design using PLDs and FPGAs , Prof. Kuruvilla Varghese from IISc Bangalore https://archive.nptel.ac.in/courses/117/108/117108040/

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