# Course Outline

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| **Course title: Introduction to VLSI Design** | **Instructor name: Jun Albert Pardillo** |
| **Credit units: 3** | **Total hours: 54** |

## Course Description:

This course is designed to introduce 2nd year Electronic Engineering students to the fundamentals of Very Large Scale Integration (VLSI) design. The course will cover the basics of digital design, including combinational and sequential logic, and will then delve into the specifics of VLSI design, including transistor-level design, layout, and verification. Students will learn how to use industry-standard design tools, such as Cadence and Synopsys, to design and simulate digital circuits. They will also gain hands-on experience with the design and layout of basic digital circuits, such as adders, multipliers, and flip-flops. Throughout the course, students will be exposed to the latest trends and challenges in VLSI design, including low-power design, design for manufacturability, and design for testability. They will also learn about the impact of technology scaling on VLSI design, and how to design for different process technologies. By the end of the course, students will have a solid understanding of the principles of VLSI design, and will be able to design and simulate basic digital circuits using industry-standard design tools. They will also be prepared to take on more advanced courses in VLSI design, and to pursue careers in the semiconductor industry.

## Course Learning Outcomes (CLOs)

* Understand the fundamentals of digital design, including combinational and sequential logic.
* Grasp the specifics of VLSI design, including transistor-level design, layout, and verification.
* Utilize industry-standard design tools such as Cadence and Synopsys for digital circuit design and simulation.
* Design and layout basic digital circuits like adders, multipliers, and flip-flops.
* Analyze the impact of technology scaling on VLSI design and adapt design strategies for different process technologies.
* Prepare for advanced studies in VLSI design and careers in the semiconductor industry.

## Topics / Modules and Intended Learning Outcomes

1. Introduction to VLSI Design

* Describe the VLSI design flow and its significance in digital circuit design.
* Identify the basic concepts of electronics and computer science relevant to VLSI design.

1. Digital Design Fundamentals

* Explain the principles of combinational and sequential logic.
* Design basic digital circuits using combinational and sequential logic.

1. Transistor-Level Design and Layout

* Understand the principles of transistor-level design and its importance in VLSI.
* Execute the layout of simple VLSI designs at the transistor level.

1. VLSI Design Tools and Simulation

* Utilize Cadence and Synopsys for the design and simulation of VLSI circuits.
* Apply simulation techniques to verify the functionality and performance of VLSI designs.

1. Trends and Challenges in VLSI Design

* Discuss the latest trends in VLSI design, including low-power design and technology scaling.
* Analyze the challenges in design for manufacturability and testability in the context of VLSI.

## Weekly Activities

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| **Week No.** | **Topic** | **Activity Description** | **Expected Output** | **Assessment Tools** |
| Week 1-2 | **Introduction to VLSI Design** | Lecture on VLSI design flow and its significance. Introduction to basic concepts of electronics and computer science relevant to VLSI design. | Students will submit a summary report on the significance of VLSI design flow. | Summary Report Evaluation |
| Week 3-5 | **Digital Design Fundamentals** | Lectures and hands-on sessions on combinational and sequential logic. Design basic digital circuits using logic gates. | Design and simulate a simple digital circuit using logic simulation software. | Circuit Design and Simulation Report |
| Week 6-8 | **Transistor-Level Design and Layout** | Introduction to transistor-level design principles. Hands-on layout exercises using CAD tools. | Layout of a simple VLSI design at the transistor level. | Layout Design Project |
| Week 9-11 | **VLSI Design Tools and Simulation** | Training on using Cadence and Synopsys for VLSI design and simulation. Group project to design and simulate a VLSI circuit. | Group project report on the design and simulation of a VLSI circuit. | Group Project Evaluation |
| Week 12-14 | **Trends and Challenges in VLSI Design** | Lectures on current trends and challenges in VLSI design including low-power design and technology scaling. Discussion on design for manufacturability and testability. | Presentation on a current trend or challenge in VLSI design. | Presentation Evaluation |
| Week 15-17 | **Project Work** | Capstone project where students apply what they have learned to design, layout, and simulate a complex digital circuit. | Final project report and presentation of the designed circuit. | Final Project Report and Presentation Evaluation |
| Week 18 | **Course Review and Examination** | Review of course content and final examination. | Completion of final examination. | Final Examination |

## References

*Elahi, A. (2022). Synchronous Sequential Logic. In Fundamentals of Computer Architecture and Digital Design. Springer.*  
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*Hsu, C.H., Xu, X., Chen, H., Ruic, D. (2024). TransPlace: A Scalable Transistor-Level Placer for VLSI Beyond Standard-Cell-Based Design. In 29th Asia and South Pacific Design Automation Conference. IEEE.*  
Link: https://ieeexplore.ieee.org/abstract/document/10473978/

*Majumder, M.K., Kumbhare, V.R., Japa, A., Kaushik, B.K. (2020). Introduction to microelectronics to nanoelectronics: design and technology. Taylor & Francis.*  
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