

EE6094 CAD for VLSI Design (電腦輔助超大型積體電路設計)

Spring Semester, 2024

Basic Information:

- Class Number: EE6094
- Career: Graduate
- Credits: 3 units
- Meeting time: Thursday, 14:00-16:50, 2024/02/22 - 2024/06/20
- Location: E1-105
- Course Website: <https://eeclass.ncu.edu.tw/>

Introduction:

Electronic Design Automation (EDA) is a critical discipline in electronics engineering, pivotal for designing complex integrated circuits (ICs) and electronic systems. EDA employs specialized software tools and algorithms to automate stages such as schematic capture, simulation, synthesis, verification, and layout. Addressing challenges posed by modern semiconductor technologies, EDA enables engineers to efficiently design, optimize, and validate electronic circuits. EDA tools support rapid prototyping, enhance design productivity, and contribute to cutting-edge electronic device creation. Rooted in computer-aided design, EDA is indispensable for ensuring the reliability, performance, and manufacturability of intricate electronic systems.

This graduate-level course aims to provide fundamental knowledge in electronic design automation. Assuming students have a basic understanding of Electric Circuits and Digital Logic IC Design, the course covers modern digital logic IC design procedures, challenges, and potential solutions. Emphasizing efficient software utilization for high-complexity IC design/optimization, the course delves into key algorithms in both front-end and back-end EDA, including modeling, architectural synthesis, logic synthesis, partitioning, floorplanning, placement, and routing. Here I provide a bonus opportunity for students who have carefully read this document. Please fill up the form with the link provided at Regulations section starting with https by February twenty-eight, then you can get a bonus. If you find the passcode which is hidden at somewhere in the slides of chapter one, you can get one more bonus. Please do not directly tell others about this Easter egg so they can enjoy the hunting process. Design metrics like area, power, timing, security, reliability, and performance are discussed across various design stages, addressing difficulties posed by current technologies. Advanced topics such as Machine Learning for EDA and new design rules for advanced technologies are also covered, drawing from recent publications, book chapters, and newsletters. The course structure includes lectures, programming assignments, a final exam, a paper presentation, and a final project, offering practical application of learned concepts.

Instructor:

- **Andy, Yu-Guang Chen**, Assistant Professor, Dept. of EE, National Central University
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- Phone: 03-4227151#34457
- Office: E1-336, Third floor, Engineering Building II
- Office hours:
 - Thu 17:00-19:00
 - I'm often available at other times (Please reserved by E-mail)

Prerequisites:

- Computer Programming (C/C++/Python)
- Data Structure
- Electric Circuit
- Digital Design or Logic Design
- Machine Learning

Textbook:

- Handouts from Instructor
- Please don't distribute handouts without prior permission

Reference books:

- "Algorithms for VLSI Design Automation," by Sabih H. Gerez, Wiley, 0471984892, 1998
- "Electronic Design Automation: Synthesis, Verification, and Test," 1st Edition, by L. T. Wang, Y. W. Chang, K. T. Cheng, Morgan Kaufmann, 0123743648, 2009
- "Machine Learning Applications in Electronic Design Automation," by Haoxing Ren, Jiang Hu, Springer Cham, 978-3-031-13073-1, 2022

Course Outline (Note: We may not have time to cover all of the topics)

- Introduction
- Basic Concept of Data Structures & Algorithms
- Scheduling & Biding
- Boolean representation
- Logic Optimization
- Partitioning
- Floorplanning
- Placement
- Global Routing
- Detailed Routing
- Clock and Power Routing
- Emerging topics

Course Schedule (Note: The schedule may be subject to change, depending on the circumstances)

Week	Date	Progress	Assignment	Note
1	2024/02/22	Course Introduction Introduction to EDA		
2	2024/02/29	Basic Concept of Data Structures & Algorithms		
3	2024/03/07	Scheduling and Binding		
4	2024/03/14	Boolean Representation (Flipped classroom, no in-person class)		
5	2024/03/21	Logic Optimization (Flipped classroom events for week 4)	PA1 Due	
6	2024/03/28	Partitioning		
7	2024/04/04	Spring Break (no-class)	Final Project Check Point I Due	
8	2024/04/11	Floorplan		
9	2024/04/18	Placement (Flipped classroom, no in-person class)	PA2 Due	
10	2024/04/25	*Handling Placement Constraints in Analog Layout Synthesis (Invited Talk)		
11	2024/05/02	Power Distribution Network and Routing (Flipped classroom events for week 9)	Final Project Check Point II Due	
12	2024/05/09	*Using Machine Learning to Predict IR-drop (Invited Talk at 05/08 15:00-17:00, no class at 05/09)		
13	2024/05/16	Routing	PA3 Due	
14	2024/05/23	Paper Presentation Evaluation (no in-person class)	Paper Presentation Video Due on 5/22 (Wed)	
15	2024/05/30	Paper Presentation Q&A session		

16	2024/06/06	Final Exam		
17	2024/06/13	Emerging Topics in CAD (Self-Learning)	PA4 Due	
18	2024/06/20	Emerging Topics in CAD (Self-Learning)	Final Project Due on 6/23 (Sun)	

Grading:

- Programming Assignments 40%
- Final Exam 20%
- Paper Presentation 20%
- Final Project 20%
- Bonus Points ??%

Attendance:

- You are NOT required to attend the class
- If you cut the class, you will be responsible for procuring any material, information, handouts, or announcements that you missed.
- We will have a bonus roll call only at _____.

Programming Assignments:

- Individual assignment
- Topics will be announced later
- Implement an EDA algorithm in C/C++, using commercial EDA tools, building ML models
- You need to write a short report
- We will have a demo session for each assignment
- Late submission
 - 80% for 1 day
 - 60% for 2 days
 - 00% for 3 or more days

Final Exam:

- We will only have a final exam at 06/06/2024. (The dates of exams are subject to change)
- The exam is open-book, open net exam. You can bring everything except communicable devices.
- In case if you can NOT attend the final exam with reasonable excuse, please let me know as early as possible so I can re-arrange your exam time.

Paper Presentation:

- Work with your group (# persons/group: 4)
- You need to have a presentation based on a research topic related to the class.
- You will need to understand it and prepare the slides.
- We use Hybrid paper presentation session
 - 25-mins long video
 - 3-min pitch talk
 - 9-min Q&A
- Be ready for tough and in-depth questions from me.
- Your grade will be based on how well you understand/present the material.
- Your classmates are your judges.
- The presentation schedule will be announced later.

Final Project

- Work with your group (# persons/group: 4)
- Register and complete one of the problems from CAD contest 2024
- <https://iccad-contest.org/tw/>
- If you doing well, you may get a chance to visit USA with scholarship

Regulations:

- You will pass this course if you get 70 points or more in the semester.
- You are expected to go through the lecture notes after class.
- Lecture notes will be posted on Portal prior to the class.
- You are encouraged to ask questions at the class. You may get bonus points by asking questions.
- You are encouraged to discuss with others for assignments. However, you must do the write-up independently and make sure you understand the solution. <https://reurl.cc/qr380q> If you cannot adequately explain the basis for your solution/code at a later date, no credit will be given even if your solution is correct. Simply “copying someone else’s homework” will be considered cheating and will not be accepted under any circumstances.
- Bonus points may occasionally be offered. You will not be penalized for not completing the extra tasks, but if you have cause to be concerned about your grade, I strongly recommend you take advantage of it when available.

Cheating:

- **Don’t do it!** My policy is to fail you in the course and report your behavior to the University.