Syllabus - 2025 Spring - ELEN E6350

Instructors

- Instructor: Mingoo Seok
- TAs/CAs: TBD

Goals

This course aims to design an integrated circuit (IC) that will subsequently be fabricated in an industrial fab. The students then test the prototype chips in the following semester.

The key focus is going through the complete design cycle from concept to circuit design, layout, and verification to testing and demonstrating the fabricated IC. Given the available time, the primary goal is to conceive and design ICs that have the highest possible probability of success.

Demonstration

The outcome of the course needs to be the custom IC mounted on a printed circuit board (PCB) that demonstrates the IC functionality in its application context.

The PCB needs to provide a portable, standalone demonstration of the integrated circuit. E.g., it will typically be battery powered and have the necessary input (sensors, buttons, ...) and output (display, LEDs, speaker, ...) to demonstrate the operation of the IC.

Group Work

Students work in groups of typically 4 (or more) to complete their design.

Pre-Requisites

At least two out of the following

- EECS 4321 VLSI Circuits
- CSEE 4823 Advanced Logic Design
- ELEN 4312 Analog Electronic Circuits

This 6000-level course is open to undergraduates with the necessary preparation who obtain registration permission from the instructor and their advisor.

Technology

We plan to use a 65nm CMOS foundry process for the design and fabrication. Students will be required to sign an NDA to get access to the technology foundry kit.

IC Design Project Examples

The students are required to develop their own IC design projects, which will be checked for feasibility by the instructor and teaching staff. The projects must support the course goals outlined above and described below.

The course focuses on custom analog, digital, and power IC design (i.e., circuits that are developed at the transistor level from schematic design, through spice-type simulations, into layout). The IC should be system functionality instead of individual IP cores.

Below, we list potential projects. Feel free to consider them to develop your own proposal.

- MCU with the interface to a microphone and the SW that can record and compress the sounds
- Digital neuromorphic processor
- FPGA with the open-source tool chain
- A GPU core with the software development framework
- Microprocessor with off-chip memory interface

How to Develop Your Own IC Design Project Proposal

Remember that the key goal of this lab course is for students to experience the complete design cycle, from IC functional definition to experimental demonstration. A second equally important goal is to design ICs that can be demonstrated in its application context on a standalone PCB which contains the necessary support circuitry to provide the inputs to the IC and display the outputs from the IC.

Students are strongly encouraged to propose their project ideas, which will be reviewed for feasibility. The design complexity of the project needs to be manageable for a team of typically four students for an effective project design duration of about 12 weeks.

Timeline

The design, layout, post-layout verification, and tape-out (i.e., sending the design to the fabrication facility) of the IC will be done in the Spring semester. The IC prototypes will be manufactured in the summer and will be available for testing in the Fall semester.

The major steps in the IC design are:

Step	**Review Action**	**When**
IC functionality definition	Project selection and approval	Spring
IC system-level design, building block definitions, packaging	System and block-level review	Spring

specifications, and preliminary test plan		
IC schematic design and simulations	Design review of schematic and simulations	Spring
IC layout and post-layout verification (DRC, LVS, PEX)	Design review of layout and PEX results	Spring
Submission of tape-out checklist	IC tape-out to a foundry and Tape-out approval	Spring
Design of test and demonstration PCB	Design review of PCB and test plan	Spring
IC & PCB Fabrication (external vendors)		Summer
PCB assembly and IC test and debug	Review of test results	Fall
Submission of IC test report, presentation slides, and demo video		Fall

Timeline in this semester

Week	Lecture	Lab
1.	Intro, student introduction, team forming, project proposal	NDA, project prep
2.	Project proposal complete	Lab 1: intro, block-level APR
3.	Teams present their progress	Lab 2: SRAM complier
4.	Teams present their progress	Lab 3: Top-level APR
5.	Teams present their progress	Lab 4: APR with I/Os
6.	Teams present their progress	Lab converted to Q/A
	…	…
12.	Design review	Lab converted to Q/A
Final exam week	Design review follow up	No lab.

Grading

After the Spring semester, non-graduating students will receive a "CP" (credit pending) grade. After submission of the demonstration video, the design description, and the test report in webpage format the final grade will be assigned.

The grading of the course will be based on your design reviews, chip design submission, pcb design submission, and the final testing and demonstration of your chip.

Note for students planning to graduate in Spring.

Testing your chip is an integral part of the course experience. We strongly encourage everyone to participate in the testing. We will consider it in the selection process.

Industrial Sponsor

The class will be sponsored by industry. Apple Inc. sponsors the fabrication and packaging of the chips.

Design Reviews and Mentoring

IC design engineers from the sponsor will participate in design reviews and mentor students on their designs.

Prizes

The sponsor is offering prizes to the three best designs in the class. The sponsor does the selection of the prize winners.

Questionnaire Submission

The number of seats for the class is limited, given the limited slots for fabrication that are supported through a donation from Apple, Inc. Thus, we will admit only 30 students. To help our admission process, please fill out the application form for this class using the link below. Please submit it by Jan/5 for full consideration.

https://forms.gle/JYaHJyzXhsE4nnJz7