

EEE 525: Very Large Scale Integration (VLSI) Design (Fall 2020)

1. Class Hours and Location

Hours: Tuesday & Thursday, 12:00 PM – 1:15 PM

Location: (1) LSEB04 (2) Zoom (link will be provided via Canvas)

2. Instructor Contact Information

Name: Jae-sun Seo

Email: jaesun.seo@asu.edu

Telephone: 480-727-2660

3. Virtual Office Hours

Tuesday 4-5pm, Thursday 3-4pm

Zoom link: <https://asu.zoom.us/j/2064266157>

Please email the instructor to set up an appointment outside the office hours above.

4. Course Website and Description

This course can be accessed at <https://canvas.asu.edu/> for announcements, lectures, and assignments.

This course introduces contemporary design of VLSI circuits. The material covers nanometer CMOS technology and scaling, design principles of digital circuits, as well as designs of core VLSI building units. Examples include arithmetic circuits, the memory system, I/O circuitries, and other important circuits for VLSI system integration. Implementations in CMOS will be overarched by considerations of key design metrics, such as timing, power, and reliability, with particular emphasis on low power consumption.

The course is consisted of two components. The first one presents practical design knowledge, including the construction of complex digital design blocks, such as ALU, sequential circuits, and the memory system. The other half will be fundamental design principles, such as the basics of nanoscale CMOS transistor, high-speed design, low-power design essentials, and design for robustness. These principles will govern the implementation and optimization of design units, over a variety of design styles and architecture. The learned knowledge and related tools will be exercised in homeworks as well as lab assignments, using the state-of-the-art 7nm educational process design kits.

5. Course Requirement and Prerequisite

This course requires the knowledge of basic CMOS operation, logic gate design, and circuit layout and analysis tools (how to do layout will not be taught). EEE 425 is the prerequisite.

6. Course Objectives

- Students will gain a fundamental understanding on how to design high-performance and low-power digital circuits and systems.
- Students will learn how to write proper hardware description language (Verilog) for synthesizable digital circuit design
- Students will learn how to design transistor-level schematic/layout of custom memory array
- Students will learn how to comprehensively use industry-standard electronic design aided (EDA) tools
- Students will learn how to properly optimize the performance/power/area of digital VLSI designs

7. Expected Learning Outcomes

- Given a digital module that fails timing and/or power constraints, students will be able to identify the reason of failure and provide a solution to meet the timing/power constraints.
- Given a digital module's functionality, students will be able to design the corresponding module in Verilog and automatically generate the layout using EDA tools

8. Textbook, Technology Requirement, Assignments, and Examinations

- a. Textbook: **CMOS VLSI Design: A Circuits and Systems Perspective**, by Neil H. E. Weste and David Harris, 4th edition
- b. You are encouraged to use a PC/Apple laptop or desktop. You will need an internet connection that can effectively stream live broadcasts (e.g. 3G, 4G, Cable or DSL Wifi).
If you are not able to personally finance the equipment needed to attend class via ASU Sync, ASU has a laptop and WiFi hotspot checkout program available through [ASU Library](#).

SYNC technology requirements

- Web browsers ([Chrome](#), [Mozilla Firefox](#), or [Safari](#))
 - [Adobe Acrobat Reader](#) (free)
 - Webcam, microphone, headset/earbuds, and speaker
 - Microsoft Office ([Microsoft 365 is free](#) for all currently-enrolled ASU students)
 - Reliable broadband internet connection (DSL or cable) to stream videos.
- c. Exams and Assignments:
 - 1 midterm exam: 22%
 - 1 final exam: 22%
 - 4 homework assignments: 8% (HW1 – HW4: 2% each)
 - 5 lab assignments: 48% (Lab 1: 5%, Lab 2: 5%, Lab 3: 5%, Lab 4: 16%, Lab 5: 17%)
 - All exams/assignments are individual in nature.
 - d. Course lecture topics:
 - Semiconductor processing basics, physical design basics, CMOS scaling
 - Device parasitics, variability, interconnect, subthreshold conduction
 - Verilog hardware design, custom hardware design
 - Arithmetic circuits (adder, multiplier, etc.)
 - Dynamic and static power optimization
 - Memory circuits (register file, SRAM, DRAM, etc.)
 - Power, clock design, timing analysis
 - I/Os, packaging, design for test

9. Grade Policies

- A+ : top 10%
- A : $> \mu + 0.5\sigma$
- A- : $> \mu$
- B+ : $> \mu - 0.5\sigma$
- B : $> \mu - 1.0\sigma$
- B- : $> \mu - 1.5\sigma$
- C : $> \mu - 2.0\sigma$
- D : else

10. ASU SYNC

This course uses Sync. ASU Sync is a technology-enhanced approach, designed to meet the dynamic needs of the class. During Sync classes, students learn remotely through live class lectures, discussions, study groups and/or tutoring. You can find out more information about ASU Sync for students here, <https://provost.asu.edu/sync/students> and <https://www.asu.edu/about/fall-2020>.

Detailed instructions on how to access the ASU Sync class will be informed shortly, before class begins.

11. Lecture Information and Attendance/Absence Policies

- a. The lecture will be provided in a live “blended learning environment”, where students can choose to be in the classroom or choose to connect remotely using zoom. The instructor will provide the lectures remotely, where the lectures will be live streamed to both the classroom (LSEB04) and remote students via zoom.
- b. All lectures will be recorded and be posted at Canvas, so that the students can recover from technology lapses or other scheduling challenges.
- c. In order to keep the classroom attendance below 50%, the following guidelines are imposed:
On Tuesdays, students with last names beginning with A-M can attend the classroom in-person while the other half of the class should participate in the live class on Zoom via ASU Sync. On Thursdays, students with last names beginning with N-Z can attend the classroom in-person while the other half of the class should participate in the live class on Zoom via ASU Sync.
- d. Excused absences related to religious observances/practices that are in accord with [ACD 304–04](#), “Accommodation for Religious Practices”
- e. Excused absences related to university sanctioned events/activities that are in accord with [ACD 304–02](#), “Missed Classes Due to University-Sanctioned Activities”
- f. Excused absences related to missed class due to military line-of-duty activities that are in accord with [ACD 304–11](#), “Missed Class Due to Military Line-of-Duty Activities,” and SSM 201–18, “Accommodating Active Duty Military”

12. Policy regarding expected classroom behavior (e.g., use of pagers, cell phones, recording devices)

Cell phones and pagers should be turned off during class to avoid causing distractions. The use of recording devices is not permitted during class. Any violent or threatening conduct by an ASU student in this class will be reported to the ASU Police Department and the Office of the Dean of Students.

Until further notified, per ASU policy, faculty, staff, students and visitors, are required to wear face coverings in classrooms, labs, offices and community spaces.

13. Academic Integrity

Students in this class must adhere to ASU’s academic integrity policy at <https://provost.asu.edu/academic-integrity/policy>. Students are responsible for reviewing this policy and understanding each of the areas in which academic dishonesty can occur. In addition, all engineering students are expected to adhere to both the ASU Academic Integrity [Honor Code](#) and the Fulton Schools of Engineering (FSE) [Honor Code](#). All academic integrity violations will be reported to the FSE Academic Integrity Office (AIO). The AIO maintains record of all violations and has access to academic integrity violations committed in all other ASU college/schools.

Specific academic integrity announcements for this class are...[* When discussing sanctions please use language like, *recommended sanctions for these violations will be...* this allows for the fact that the AIO may want to discuss the sanction with you and it also improves the ability to increase the penalty when it is a multiple violation]

14. Copyright

All course content and materials, including lectures (**Zoom recorded lectures included**), are copyrighted materials and students may not share outside the class, upload to online websites not approved by the instructor, sell, or distribute course content or notes taken during the conduct of the course (see [ACD 304-06](#), “Commercial Note Taking Services” and ABOR Policy [5-308 F.14](#) for more information).

You must refrain from uploading to any course shell, discussion board, or website used by the course instructor or other course forum, material that is not the student's original work, unless the students first comply with all applicable copyright laws; faculty members reserve the right to delete materials on the grounds of suspected copyright infringement.

15. Policy against threatening behavior, per the Student Services Manual, [SSM 104-02](#)

Students, faculty, staff, and other individuals do not have an unqualified right of access to university grounds, property, or services. Interfering with the peaceful conduct of university-related business or activities or remaining on campus grounds after a request to leave may be considered a crime. All incidents and allegations of violent or threatening conduct by an ASU student (whether on- or off-campus) must be reported to the ASU Police Department (ASU PD) and the Office of the Dean of Students.

16. Disability Accommodations

Suitable accommodations will be made for students having disabilities. Students needing accommodations must register with the ASU Disabilities Resource Center and provide documentation of that registration to the instructor. Students should communicate the need for an accommodation in sufficient time for it to be properly arranged. See [ACD 304-08](#) Classroom and Testing Accommodations for students with disabilities.

17. Harassment and Sexual Discrimination

Arizona State University is committed to providing an environment free of discrimination, harassment, or retaliation for the entire university community, including all students, faculty members, staff employees, and guests. ASU expressly prohibits discrimination, harassment, and retaliation by employees, students, contractors, or agents of the university based on any protected status: race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, and genetic information.

Title IX is a federal law that provides that no person be excluded on the basis of sex from participation in, be denied benefits of, or be subjected to discrimination under any education program or activity. Both Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited. An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support, from the university. If you or someone you know has been harassed on the basis of sex or sexually assaulted, you can find information and resources at <https://sexualviolenceprevention.asu.edu/faqs>.

Mandated sexual harassment reporter: As a mandated reporter, I am obligated to report any information I become aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence. ASU Counseling Services, <https://eoss.asu.edu/counseling>, is available if you wish discuss any concerns confidentially and privately.

18. Syllabus Changes

Any information in this syllabus (other than grading and absence policies) may be subject to change with reasonable advance notice.