

EE460R / ECE382M 7 - VLSI Design (Fall 2022)

Instructor: [Prof. David Z. Pan](#)

Lecture hours: T/Th 12:30-2pm, EER 1.518

Unique IDs:

- EE460R Introduction to VLSI Design: 17840, 17845, 17850, 17855
- ECE 382M-7 VLSI I: 18040, 18045, 18050, 18055

Email: dpan@ece.utexas.edu, Phone: 512-471-1436

Office: EER 4.880

Office hours: M 1:30-2:30pm in person at EER 4.880

W 1:30-2:30pm by Zoom (see Canvas for Zoom link)

TA and lab hours:

- Sirish Oruganti: sirishoruganti@utexas.edu (head TA: 20 hours/week)
- Yipeng Wang: yipeng.wang@utexas.edu (10 hours / week)
- Sumanth Karanth: skaranth@utexas.edu (10 hours / week)
- The lab hours and related documents are posted at https://projects.ece.utexas.edu/courses/fall_22/ee460r382m/

Course description:

This course covers the fundamental process of designing CMOS VLSI circuits. It will begin with a review of the basics of CMOS transistor operation and the manufacturing process for CMOS VLSI chips. We will then study in detail the problem of implementing logic gates in CMOS. Specifically, we will cover layout, design rules, and circuit families. Afterwards, we will examine techniques for timing and power analysis, as well as other key issues such as interconnect. We will also examine ways to optimize timing and power. This will be followed by an overview of datapath design, specifically adders. We will also study memory arrays, including SRAM and DRAM cell and clock design. The course will conclude with a survey level treatment of various peripheral topics, including functional verification, test, design-for-test, electrical effects, and future trends. We may have guest lecturers from industry to talk about real-world design practices.

Prerequisite:

This course is intended for ECE graduate students. A knowledge of Electrical Circuits (EE411 or equivalent), and Digital Logic Design (EE316 or its equivalent) is required.

Textbook:

- N. Weste and D. Harris, *CMOS VLSI Design: A Circuits and Systems Perspective (the 4th Edition)*, 2011. Addison-Wesley.

Grading Policy:

- 10% homework

- 35% three major labs
 - Lab1: 10%
 - Lab2: 10%
 - Lab3: 15%
- 30% two in-class midterms
- 25% final exam (for EE460R) or final project (for EE382M-7)

Lecture Outline (tentative):

1. Introduction, CMOS Transistors
2. CMOS Fabrication and Layout
3. CMOS Logic
4. MOS Transistor Theory
5. DC and Transient Gate Characteristics
6. Logical Effort
7. Combinational Circuits
8. Design of Adders
9. Interconnects in CMOS Technology
10. Sequential Elements
11. Clocking
12. Hardware Description Languages, Synthesis
13. Datapath Design
14. Memories
15. Dynamic CMOS Logic
16. Deep Submicron Issues
17. CAMs, ROMs, PLAs
18. Circuit Pitfalls
19. Design for Low Power
20. Design for Testability
21. Design Verification
22. Synthesis and Optimization
23. Packaging and I/O

24. Scaling and Economics
25. Future Directions

Class information on-line:

The on-line information for this course is available on the Canvas site:

<http://courses.utexas.edu>. In order to use this site you need your EID. Some things that will be available on this site:

- All lecture slides
- Homework assignments for the semester.
- Lab documents.

Web-based, password-protected class sites are associated with all academic courses taught at The University. Syllabi, handouts, assignments and other resources are types of information that will be available within these sites. Site activities could include exchanging e-mail, engaging in class discussions and chats, and exchanging files. In addition, electronic class rosters will be a component of the sites. Students who do not want their names included in these electronic class rosters must restrict their directory information in the Office of the Registrar, Main Building, Room 1. For information on restricting directory information see:

<http://www.utexas.edu/student/registrar/ferpa/ferpa.qs.faculty.htm>

Getting help: If you have a question please ask! Do not wait till the last minute. The instructor and teaching assistants are here to help you.

Drop Policy: The last day to drop this course without permission from the Dean is the 4th class day. After this day, drops are approved only in the case of health or personal problems. An engineering student should make an appointment with his/her departmental advisor to discuss adding or dropping any course if the change will alter the classes that were originally approved by the departmental advisor. If the add or drop requires the approval of the Dean, then the student will need to schedule an appointment with an Academic Advisor in the Office of Student Affairs, ECJ 2.200 (471-4321) to discuss the request.

Additional information can be found at:

http://www.engr.utexas.edu/current/policies/pol_add-drop-wdraw.cfm

Academic Dishonesty: Cheating will not be tolerated and will be dealt with according to the policy established by the office of the Dean of Students.

Students with disability: The University of Texas at Austin provides, upon request, appropriate academic adjustments for qualified students with disabilities. For more

information, contact the Office of the Dean of Students at 471-6259, or the College of Engineering Director of Students with Disabilities at 471-4321.

Policies

Classroom Policies

Statement on Learning Success

Your success in this class is important to me. We will all need accommodations because we all learn differently. If there are aspects of this course that prevent you from learning or exclude you, please let me know as soon as possible. Together we'll develop strategies to meet both your needs and the requirements of the course. I also encourage you to reach out to the student resources available through UT. Many are listed on this syllabus, but I am happy to connect you with a person or Center if you would like.

Student Rights & Responsibilities

- You have a right to a learning environment that supports mental and physical wellness.
- You have a right to respect.
- You have a right to be assessed and graded fairly.
- You have a right to freedom of opinion and expression.
- You have a right to privacy and confidentiality.
- You have a right to meaningful and equal participation, to self-organize groups to improve your learning environment.
- You have a right to learn in an environment that is welcoming to all people. No student shall be isolated, excluded or diminished in any way.

With these rights come responsibilities:

- You are responsible for taking care of yourself, managing your time, and communicating with the teaching team and with others if things start to feel out of control or overwhelming.
- You are responsible for acting in a way that is worthy of respect and always respectful of others.
- Your experience with this course is directly related to the quality of the energy that you bring to it, and your energy shapes the quality of your peers' experiences.
- You are responsible for creating an inclusive environment and for speaking up when someone is excluded.

- You are responsible for holding yourself accountable to these standards, holding each other to these standards, and holding the teaching team accountable as well.

Personal Pronoun Preference

Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender, gender variance, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by a name different than what appears on the roster, and by the gender pronouns you use. Please advise me of this preference early in the semester so that I may make appropriate changes to my records.

University Policies

Academic Integrity

Each student in the course is expected to abide by the University of Texas Honor Code: **“As a student of The University of Texas at Austin, I shall abide by the core values of the University and uphold academic integrity.”** **Plagiarism is taken very seriously at UT.** Therefore, if you use words or ideas that are not your own (or that you have used in previous class), you must cite your sources. Otherwise you will be guilty of plagiarism and subject to academic disciplinary action, including failure of the course. You are responsible for understanding UT's Academic Honesty and the University Honor Code which can be found at the following web address: http://deanofstudents.utexas.edu/sjs/acint_student.php

Q Drop Policy

If you want to drop a class after the 12th class day, you'll need to execute a Q drop before the Q-drop deadline, which typically occurs near the middle of the semester. Under Texas law, you are only allowed six Q drops while you are in college at any public Texas institution. For more information, see: <http://www.utexas.edu/ugs/csacc/academic/adddrop/qdrop>

University Resources for Students

Your success in this class is important to me. We will all need accommodations because we all learn differently. If there are aspects of this course that prevent you from learning or exclude you, please let me know as soon as possible. Together we'll develop strategies to meet both your needs and the requirements of the course. There are also a range of resources on campus:

Services for Students with Disabilities

This class respects and welcomes students of all backgrounds, identities, and abilities. If there are circumstances that make our learning environment and activities difficult, if you have medical information that you need to share with me, or if you need specific arrangements in case the building needs to be evacuated, please let me know. I am

committed to creating an effective learning environment for all students, but I can only do so if you discuss your needs with me as early as possible. I promise to maintain the confidentiality of these discussions. If appropriate, also contact Services for Students with Disabilities, 512-471-6259 (voice) or 1-866-329-3986 (video phone).
<http://ddce.utexas.edu/disability/about/>

Counseling and Mental Health Center

Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support.
<http://www.cmhc.utexas.edu/individualcounseling.html>

The Sanger Learning Center

Did you know that more than one-third of UT undergraduate students use the Sanger Learning Center each year to improve their academic performance? All students are welcome to take advantage of Sanger Center's classes and workshops, private learning specialist appointments, peer academic coaching, and tutoring for more than 70 courses in 15 different subject areas. For more information, please visit <http://www.utexas.edu/ugs/slc> or call 512-471-3614 (JES A332).

Undergraduate Writing Center: <http://uwc.utexas.edu/>

Libraries: <http://www.lib.utexas.edu/>

ITS: <http://www.utexas.edu/its/>

Student Emergency Services: <http://deanofstudents.utexas.edu/emergency/>

Important Safety Information:

If you have concerns about the safety or behavior of fellow students, TAs or Professors, call BCAL (the Behavior Concerns Advice Line): 512-232-5050. Your call can be anonymous. If something doesn't feel right – it probably isn't. Trust your instincts and share your concerns.

Title IX Reporting

Title IX is a federal law that protects against sex and gender-based discrimination, sexual harassment, sexual assault, sexual misconduct, dating/domestic violence and stalking at federally funded educational institutions. UT Austin is committed to fostering a learning and working environment free from discrimination in all its forms. When sexual misconduct occurs in our community, the university can:

1. Intervene to prevent harmful behavior from continuing or escalating.

2. Provide support and remedies to students and employees who have experienced harm or have become involved in a Title IX investigation.
3. Investigate and discipline violations of the university's relevant policies.

Faculty members and certain staff members are considered "Responsible Employees" or "Mandatory Reporters," which means that they are required to report violations of Title IX to the Title IX Coordinator. **I am a Responsible Employee and must report any Title IX related incidents** that are disclosed in writing, discussion, or one-on-one. Before talking with me, or with any faculty or staff member about a Title IX related incident, be sure to ask whether they are a responsible employee. If you want to speak with someone for support or remedies without making an official report to the university, email advocate@austin.utexas.edu For more information about reporting options and resources, visit titleix.utexas.edu or contact the Title IX Office at titleix@austin.utexas.edu.

The following recommendations regarding emergency evacuation from the Office of Campus Safety and Security, 512-471-5767, <http://www.utexas.edu/safety/>

Occupants of buildings on The University of Texas at Austin campus are required to evacuate buildings when a fire alarm is activated. Alarm activation or announcement requires exiting and assembling outside.

- Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building.
- Students requiring assistance in evacuation shall inform their instructor in writing during the first week of class.
- In the event of an evacuation, follow the instruction of faculty or class instructors. Do not re-enter a building unless given instructions by the following: Austin Fire Department, The University of Texas at Austin Police Department, or Fire Prevention Services office.
- Link to information regarding emergency evacuation routes and emergency procedures can be found at:

www.utexas.edu/emergency