

VLSI Circuits and Technology 2

EEE 6323

Class Periods: Tuesday | Period 8 – 9 (3:00 PM - 4:55 PM); Thursday | Period 9 (4:05 PM - 4:55 PM)

Location: Zoom, MAEA 0303

Academic Term: Spring 2024

Instructor:

Name: Prof. Swarup Bhunia

Email Address: swarup@ece.ufl.edu

Office Phone Number: 352-392-5989

Office Hours: **Wednesday 4-5pm or by appointment (in-person at MALA 4050B or via Zoom)**

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

Please contact through the Canvas website

- Atri Chatterjee, a.chatterjee@ufl.edu, Zoom link in Canvas page, **TBA**
- Aritra Dasgupta, aritradasgupta@ufl.edu, Zoom link in Canvas page, **TBA**
- Peyman Dehghanzadeh, p.dehghanzadeh@ufl.edu, Zoom link in Canvas page, **TBA**

Course Description

This three-credit course delves into advanced aspects of very large scale integrated circuit design, emphasizing testability, performance evaluation, and the utilization of industrial VLSI software. It focuses on constructing sophisticated CMOS VLSI circuits to provide hands-on experience in this field.

Course Pre-Requisites / Co-Requisites

EEE 5322 - VLSI Circuits and Technology. Students with foundational knowledge in digital circuit design would be eligible to meet the prerequisite. Instructor's permission needed.

Course Objectives

This course aims to cultivate a fundamental comprehension of CMOS integrated circuit design, laying the groundwork for understanding system on chip (SoC) architecture. It covers essential aspects such as low power, security, and testable SoC design methods. Students will gain expertise in analyzing, designing, and implementing CMOS circuits, while also grasping key considerations that optimize chip success in the design process.

Materials and Supply Fees

None

Required Textbooks and Software

- Title: CMOS VLSI Design 4e: A circuits and systems perspective
- Author: Neil H.E. Weste, David Harris
- Publication date and edition: 2010, 4th Edition, Pearson
- ISBN number: ISBN-10: 9789332542884

In addition, handouts developed by instructor may be downloaded from Canvas.

Recommended Materials

- Title: Digital Integrated Circuits, A Design Perspective
- Author: Jan. M. Rabaey, A. Chandrakasan, and B. Nikolic
- Publication date and edition: 2003, 2nd Edition, Prentice Hall
- ISBN number: ISBN-10: 0130909963

Course Schedule

Course Title, Prefix, and Number

Course Instructor and Academic Term

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Week 1: Syllabus, Introduction to AVLSI, CMOS gate design review
 Week 2: Layout, DC and Transient Analysis, Logical Effort,
 Week 3: Multi-stage logic and networks, power dissipation and analysis, Introduction to MIPS architecture
 Week 4: Introduction to SoCs (System on chip), Circuit Families: Combinational and sequential circuits; FSM design; Advanced Circuit Design: Arithmetic Circuits, DSP (Digital Signal Processing) circuits, Hardware Description Languages
 Week 5: Synthesis: Binary Decision Diagrams, ROBDDs, And-inverter-graphs, Logic Minimization, basics of standard cell library, Gatelevel synthesis
 Week 6: Timing and Power Analysis: Basics of timing analysis, Delay calculation using standard cell library, Timing optimization, Power Analysis: Basics of power analysis, power calculation using standard cell library, power optimization: Supply voltage scaling, Threshold voltage scaling
 Week 7: Midterm Exam
 Week 8: Integration of Test Architecture: Basics of testing, structure of scan-chain, random test-pattern generation, ATPG fundamentals
 Week 9: Memory Subsystems: SRAM, DRAM cells, Different memory designs: 10-T, 6-T SRAM cells. Design of Different memory architectures: Single port memory, Dual port memory, Content Accessible memory, Decoders/
 Exam 1 solution
 Week 10: Digital Design Flow, Introduction to Processor Architecture
 Week 11: System on chip (SoC) architecture, intellectual property (IP) integration using RISCv processor as a case study
 Week 13: AI/ML hardware fundamentals and emerging trend
 Week 14: Final Project demos, presentation and review.
 AVLSI Final Design project, Report Due Monday April 19, 2024, there will be design demos in the NELM's lab on and after April 4th, 2024.

Attendance Policy, Class Expectations, and Make-Up Policy

Excused absences must be consistent with university policies in the Graduate Catalog (<https://catalog.ufl.edu/graduate/regulations>) and require appropriate documentation. Additional information can be found here: <https://gradcatalog.ufl.edu/graduate/regulations/>

Evaluation of Grades

****Assessment Guidance from the ECE Graduate Committee:** Course evaluation components should include:

1. At least one component that individually evaluates each student's understanding of course material and ability to apply concepts.
2. At least one evaluation activity that takes place in class.
3. When a project is involved, evaluation rubrics should be explicitly stated.
4. When team work is expected, individual student contribution verification method should be explicitly stated.

If an in-class exam is administered then 1 and 2 are fulfilled. In the case of a project, a project report that is graded per the stated evaluation rubrics and states which work was done by each student in the project team will address both 3 and 4.

Assignment	Total Points	Percentage of Final Grade
Homework Sets (10) (Individual / group)	100 each	40%
Midterm Exam	100	30%
Final Project (group)	100	30%
		100%

Grading Policy

The following is given as an example only.

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

[UF Graduate Catalog](#)
[Grades and Grading Policies](#)

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.ua.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.ua.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform,

including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University’s core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- HWC OE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <https://distance.ufl.edu/getting-help/>; <https://distance.ufl.edu/state-authorization-status/#student-complaint>.