VLSI Circuits and Technology 1

EEE 5322 Section 0001
Class Periods: T, 10, 5:10PM-6:00PM; R, 10-11, 5:10PM-7:05PM
Location: WEIL 0279
Academic Term: Spring 2023

Instructor:

Name:	Dr. Domenic Forte
Email:	dforte@ece.ufl.edu
Telephone:	352-392-1525
Office Hours:	Zoom, Tuesdays from 9:00AM-11:0AM

Supervised Teaching Student:

Please contact through the Canvas website
- Tasnuva Farheen, tasnuvafarheen@ufl.edu, Office Hours TBD

Course Description

Introduction to VLSI circuit technology and manufacturing. Fabrication, device models, layout, parasitics, and simple gate circuits.

Course Pre-Requisites / Co-Requisites

- EEL 3308: Electronic Circuits I
- EEL 3701C: Digital Logic

Course Objectives

Specific Outcomes of Instruction: This course focuses on analysis and design of modern digital circuits. Silicon technology and transistors are introduced and described from a digital point of view, and the performance of various circuits is derived and estimated. CMOS digital circuits will be designed and analyzed. Students will layout and design digital complex circuits using layout software and SPICE and cover advanced topics such as manufacturing variations.

Materials and Supply Fees

N/A

Required Textbooks and Software

i. Introduction to Microelectronic Fabrication
Author - Richard C. Jaeger
Publication date and edition - 2nd Edition, Modular Series on Solid State Devices, Volume 5, Prentice Hall
ISBN Number - 0-201-44494-7
ii. Digital Integrated Circuits, A Design Perspective
Author - Jan. M. Rabaey, A. Chandrakasan, and B.Nikolic
Publication date and edition - 2nd Edition, Prentice Hall
ISBN Number - 0-13-090996-3, 2003
iii. Computer and Software required: Workstations with CADENCE Design system on campus, off-campus can use XWindows or X-terminal on a high-speed internet link to UF Campus Computers, or can use equivalent IC design software

Recommended Materials

i. CMOS: Circuit Design, Layout, and Simulation
Author: R. Jacob Baker

Course Schedule

Wk	Date	Tentative Topics	Book Chapter
1	1/9-1/15	Syllabus, Design/Fabrication Flow, Moore's Law, and Transistor Layout	Jaegar Chap 1
2	1/16-1/22	Fabrication Steps and Design Rules; MOSFET Operation	Rabaey Chap 2.1-2.3
3	1/23-1/29	Current Models, Body Bias, Intro to SCEs, MOSFET Parameter Extraction	Rabaey Chap 3
4	1/30-2/5	Parasitic Capacitance, CMOS Inverter, Voltage Transfer Curve, and Static Noise Margin	Rabaey Chap 5.1-5.3
5	2/6-2/12	Exam 1 Review	
6	2/13-2/19	Intro to Semiconductor Memories; SRAM Operation, Design, and Layout; Decoders and Sense Amps	Rabaey Chap 12.1-12.4
7	2/20-2/26	DRAM, Flash, and ROM	Rabaey Chap 12.2-12.4
8	2/27-3/5	CMOS Inverter Delay and Power; CMOS Logic Gates; Stick Diagrams and Layout	Rabaey Chap 5.4-5.5. 6.1; Int D
9	3/6-3/12	Exam 2 Review	
10	3/13-3/19	SPRING BREAK	
11	3/20-3/26	CMOS Gate Delay and Sizing; Intro to Sequential Logic; Basic Latch and Register Designs;	Rabaey Chap 6.2, Rabaey Chap 7.1-7.2
12	3/27-4/2	Setup/Hold Time Constraints; Pipelining and Time Borrowing; Schmidt Trigger Design	Rabaey Chap 7.5-7.6
13	4/3-4/9	Threshold Voltage Calculation; Advanced MOS Process Integration, Dennard Scaling	Jaegar Chap 9.1, 9.3-9.4
14	4/10-4/16	Exam 3 Review	
15	4/17-4/23	Advanced Contacts, Metallization, Spacers, Local Interconnects; FinFETs; Classical and Advanced Packaging (time permitting)	Jaegar Chap 7-8
16	4/24-4/30	Final Exam Review	

Assignments, Projects, and Exams Tentative Schedule

Wk	Date	Tentative Deadlines
1	1/9-1/15	Homework #1 and Cadence Tutorial 1 Assigned;
2	1/16-1/22	Cadence Tutorial 1 due (1/16); Tutorial 2 Assigned;
3	1/23-1/29	Cadence Tutorial 2 due (1/23); Tutorial 3 Assigned;
4	1/30-2/5	Cadence Tutorial 3 Due (1/30); Homework #1 due (2/2); Homework #2 Assigned
5	2/6-2/12	Exam #1 (2/9); Cadence Project 1 Assigned;
6	2/13-2/19	
7	2/20-2/26	Cadence Project 1 Due (2/23);
8	2/27-3/5	Homework #2 Due (3/2); Homework #3 Assigned
9	3/6-3/12	Exam #2 (3/9); Final Cadence Project Assigned and Group Formation;
10	3/13-3/19	SPRING BREAK
11	3/20-3/26	

12	3/27-4/2	
13	4/3-4/9	Homework #3 Due (4/6); Homework #4 Assigned
14	4/10-4/16	Exam #3 (4/13)
15	4/17-4/23	Final Cadence Project Due (4/20)
16	4/24-4/30	Homework #4 Due (4/25)
17	4/30-5/7	Final Exam (5/3)

Attendance Policy, Class Expectations, and Make-Up Policy

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies:

https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/

In addition,

- Due to quantity and of material, it is important to make every attempt to attend class. Slides will be posted but not annotated materials and work on blackboard (except under extenuating circumstances).
- No exam make-up unless a valid excuse is presented beforehand. All valid excuses must be approved by the Professor. Excused absences must be in compliance with university policies in the Graduate Catalog (https://catalog.ufl.edu/graduate/regulations/) and require appropriate documentation.
- All homework assignments must be submitted in class or online before the deadline (no exceptions) since solutions are posted after lecture.
- All tutorials and projects must be handed in on time or credit will be deducted (10% each day).

Format of Homework

- All homework must be written legibly so that it can be graded. Illegible solutions will be given zero credit.
- Homework can be submitted on Canvas or in class. If submitted in class, the homework must contain a cover sheet with the student's name, UFID, homework assignment number, and due date. Any homework without this information will receive zero credit. If submitted in class, the homework must be stapled. Any homework that is not stapled will receive zero credit.

Projects

- Three Cadence tutorials and two layout/simulation projects will be assigned throughout the semester. All are completed individually except for the final project which is completed in groups.
- All project materials will be checked for plagiarism using Turnitin software feature in Canvas. See University Honesty Policy below.

Evaluation of Grades

- Class Examinations   60%
  - (Exam #1)   (15%)
  - (Exam #2)   (15%)
  - (Exam#3)   (15%)
  - (Comprehensive Final Exam)   (15%)
- Homework   5%
- Attendance and Participation   5%
- Cadence   30%
  - (Tutorial #1)   (1.5%)
  - (Tutorial #2)   (2.5%)
  - (Tutorial #3)   (3.5%)

(SRAM Assignment)	(7.5%)
(Final Project)	(15%)

Grading Policy

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:
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

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.aa.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.aa.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 broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

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
• Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@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/state-authorization-status/#student-complaint.