VLSI Circuits and Technology
EEL 5322   Section: HYBR
Class Periods: T, 10, 5:10PM-6:00PM; R, 10-11, 5:10PM-7:05PM
Location: Online (80-99%)
Academic Term: Spring 2021

Instructor:

Name:	Dr. Domenic Forte
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Telephone:	352-392-1525
Office Hours:	Zoom, Tuesdays from 8AM-10AM

Teaching Assistant/Peer Mentor/Supervised Teaching Student:
Please contact through the Canvas website
- Rabin Acharya, rabin.acharya@ufl.edu, Zoom, Mondays from 4-5PM
- Yunkai Bai, baiyunkai@ufl.edu, Zoom, Wednesdays from 4-5PM
- David Koblah, dkoblah@ufl.edu, Zoom, Fridays from 3-4PM

Course Description

Fabrication, Layout, Analysis, and Design of Digital Circuits using MOS Transistors. *Lecture. Credits 3.*

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.

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
     Publication date and edition – 4th Edition, Wiley-IEEE Press
     ISBN Number - 978-1119481515, 2019

Course Schedule

Wk	Date	Tentative Topics	Book Chapter
1	1/11-1/17	Syllabus, Design/Fabrication Flow, Moore's Law, and Transistor Layout	Jaegar Chap 1
2	1/18-1/24	Fabrication Steps and Design Rules; Alignment Errors	Rabaey Chap 2.1-2.3; Jaegar Chap 9.2
3	1/25-1/31	MOSFET Operation, Current Models, and Body Bias	Rabaey Chap 3
4	2/1-2/7	Parasitic Capacitance; CMOS Inverter and Voltage Transfer Curve;	Rabaey Chap 5.1-5.3
5	2/8-2/14	Intro to Semiconductor Memories;	Rabaey Chap 12.1
6	2/15-2/21	SRAM Operation, Design, and Layout; Decoders and Sense Amps	Rabaey Chap 12.2-12.4
7	2/22-2/28	DRAM, Flash, and ROM	Rabaey Chap 12.2-12.4
8	3/1-3/7	CMOS Inverter Delay and Power; CMOS Logic Gates,	Rabaey Chap 5.4-5.5. 6.1
9	3/8-3/12	Stick Diagrams and Layout; CMOS Gate Delay and Sizing	Rabaey Chap 6.1-6.3, Int D
10	3/15-3/21	Intro to Sequential Logic; Basic Latch and Register Designs	Rabaey Chap 7.1-7.2
11	3/22-3/28	Latch/Register cont.; Setup/Hold Time Constraints; Advanced Latch and Register Design	Rabaey Chap 7.3-7.6
12	3/29-4/4	Advanced MOS Process Integration, Dennard Scaling	Jaegar Chap 9.1, 9.3-9.4
13	4/5-4/11	Advanced Contacts, Metallization, Spacers, Local Interconnects, and FinFETs	Jaegar Chap 7
14	4/12-4/18	Classical and Advanced Packaging	Jaegar Chap 8
15	4/19-4/21	Review	

Assignments, Projects, and Exams Tentative Schedule

Wk	Date	Tentative Deadlines
1	1/11-1/17	Homework #1 and Cadence Tutorial 1 Assigned;
2	1/18-1/24	Cadence Tutorial 1 due (1/17); Tutorial 2 Assigned;
3	1/25-1/31	Cadence Tutorial 2 due (1/24); Tutorial 3 Assigned;
4	2/1-2/7	Cadence Tutorial 3 Due (1/31); Homework #1 due (2/4); Homework #2 Assigned
5	2/8-2/14	Exam #1 (2/11); Cadence Project 1 Assigned;
6	2/15-2/21	
7	2/22-2/28	
8	3/1-3/7	Homework #2 Due (3/4); Cadence Project 1 Due (3/7); Homework #3 Assigned
9	3/8-3/12	Exam #2 (3/11); Final Cadence Project Assigned;
10	3/15-3/21	
11	3/22-3/28	
12	3/29-4/4	Homework #3 Due (4/1); Homework #4 Assigned
13	4/5-4/11	Exam #3 (4/8)
14	4/12-4/18	
15	4/19-4/25	Homework #4 Due (4/20); Final Cadence Project Due (4/24)
16	TBD	Final Exam

Online Course Recording
Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

F2F Course Policy in Response to COVID-19
We will have face-to-face instructional sessions to accomplish the student learning objectives of this course. In response to COVID-19, the following policies and requirements are in place to maintain your learning environment and to enhance the safety of our in-classroom interactions.

•   You are required to wear approved face coverings at all times during class and within buildings. Following and enforcing these policies and requirements are all of our responsibility. Failure to do so will lead to a report to the Office of Student Conduct and Conflict Resolution.

•   This course has been assigned a physical classroom with enough capacity to maintain physical distancing (6 feet between individuals) requirements. Please utilize designated seats and maintain appropriate spacing between students. Please do not move desks or stations.

•   Sanitizing supplies are available in the classroom if you wish to wipe down your desks prior to sitting down and at the end of the class.

•   Follow your instructor's guidance on how to enter and exit the classroom. Practice physical distancing to the extent possible when entering and exiting the classroom.

•   If you are experiencing COVID-19 symptoms (Click here for guidance from the CDC on symptoms of coronavirus), please use the UF Health screening system and follow the instructions on whether you are able to attend class. Click here for UF Health guidance on what to do if you have been exposed to or are experiencing Covid-19 symptoms.

•   Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work. Find more information in the university attendance policies.

Attendance Policy, Class Expectations, and Make-Up Policy
This class will be presented online using Zoom and requires access to a working webcam and stable internet connection. I prefer that students keep their camera on during the class so that I can see you as I would during normal face-to-face classes. Studies show that if we can see each other's faces then we will have more engagement, more student success, and more faculty success. However, this is not a requirement. I understand if on certain days you can't have your camera on due to internet bandwidth limitations, other family members, health issues, or any other reasons.

•   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 (http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance) 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 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 Examination   56%
  - (Exam #1)   (14%)
  - (Exam #2)   (14%)
  - (Exam#3)   (14%)
  - (Comprehensive Final Exam)   (14%)
- Homework   14%
- Cadence   30%
  - (Tutorial #1)   (1.25%)
  - (Tutorial #2)   (1.25%)
  - (Tutorial #3)   (2.5%)
  - (SRAM Assignment)   (10%)
  - (Final Project)   (15%)

Grading Policy

Percent	Grade	Grade Points
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
81.0 – 83.9	B	3.00
78.0 - 80.9	B-	2.67
75.0 - 79.9	C+	2.33
72.0 – 74.9	C	2.00
69.0 - 71.9	C-	1.67
66.0 - 68.9	D+	1.33
63.0 - 65.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:
http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades

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/.

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/policies/student-honor-code-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
• Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@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.

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

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 suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.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://care.dso.ufl.edu.

On-Line Students Complaints*: http://www.distance.ufl.edu/student-complaint-process.