

**EEL 4310 Digital Integrated Circuits Design**  
**Class Periods:** T, 10, 5:10PM-6PM; R, 10-11, 5:10PM-7:05PM  
**Location:** LAR 0330  
**Academic Term:** Spring 2019

**Instructor**

**Name:** Dr. Domenic Forte  
**Email:** [dforte@ece.ufl.edu](mailto:dforte@ece.ufl.edu)  
**Telephone:** 352-392-1525  
**Office Hours:** Tuesdays, 8:30AM-10:30AM, MAE226D

**Teaching Assistants**

- 1) Kelli Borowski, [klborowski@ufl.edu](mailto:klborowski@ufl.edu) [Grading, Cadence and Project Help]
- 2) Sreeja Chowdhury, [sreejachowdhury@ufl.edu](mailto:sreejachowdhury@ufl.edu), MAE1226 [Grading and General Questions]
- 3) Shuo Yang, [sy@ufl.edu](mailto:sy@ufl.edu), MAE119 [Grading and General Questions]

**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.

**Outcomes are addressed by this course:** EE2, a, c, e, I, k

**Materials and Supply Fees**

N/A

**Recommended Textbooks and Software**

- i. Introduction to Microelectronic Fabrication **(Required)**  
Author - Richard C. Jaeger  
Publication date and edition - 2nd Edition, Modular Series on Solid State Devices, Volume 5, Prentice Hall  
dISBN Number - 0-201-44494-7
- ii. Digital Integrated Circuits, A Design Perspective **(Required)**  
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

**Topics to be covered**

<b>Wk</b>	<b>Date</b>	<b>Tentative Topics</b>
1	1/6-1/12	Syllabus, Design/Fabrication Flow, Moore's Law, and Transistor Layout
2	1/13-1/19	Fabrication Steps and Design Rules; MOSFET Basic Operation
3	1/20-1/26	Cadence Setup and Training
4	1/27-2/2	MOSFET Operation Cont. and Body Bias
5	2/3-2/9	Combinational MOS Logic Circuits
6	2/10-2/16	Combinational Circuits Cont., CMOS Block Diagrams and Layout
7	2/17-2/23	CMOS Gate Delay, Transistor Sizing, Elmore Delay and Logical Effort
8	2/24-3/2	SRAM Layout and Architecture, Intro to DRAM and NAND Flash
9	3/3-3/9	----- SPRING BREAK -----
10	3/10-3/16	Continue SRAM, DRAM, Flash, and ROM
11	3/17-3/23	Anatomy of Chips in Modern Computing Devices (SOCs in smartphones), Latches and Registers
12	3/24-3/30	Continue Latches and Registers, Setup/Hold Time Constraints
13	3/31-4/6	Advanced Process Integration, Dennard Scaling, and Alignment Errors
14	4/7-4/13	Advanced Contacts, Metallization, Spacers, FinFETs, and Local Interconnects
15	4/14-4/20	Classical and Advanced Packaging
16	4/21-4/27	Review

**Assignments, Projects, and Exams Tentative Schedule**

<b>Wk</b>	<b>Date</b>	<b>Tentative Deadlines</b>
1	1/6-1/12	Homework #1 Assigned
2	1/13-1/19	Homework #1 Due;
3	1/20-1/26	Cadence Project 1 Assigned;
4	1/27-2/2	Quiz; Homework #2 Assigned
5	2/3-2/9	Cadence Project 1 Due; Cadence Project 2 Assigned
6	2/10-2/16	Homework #2 Due;
7	2/17-2/23	Exam #1; Homework #3 Assigned
8	2/24-3/2	Cadence Project 2 Due; Final Cadence Project Assigned
9	3/3-3/9	SPRING BREAK
10	3/10-3/16	Homework #3 Due; Homework #4 Assigned
11	3/17-3/23	Homework #4 Due
12	3/24-3/30	Exam 2
13	3/31-4/6	Homework #5 Assigned
14	4/7-4/13	Homework #5 Due
15	4/14-4/20	Homework #6 Assigned
16	4/21-4/27	Homework #6 Due; Final Cadence Project Due
17	4/28-5/4	Final Exam

### **Attendance Policy, Class Expectations, and Make-Up Policy**

- Due to quantity and research nature of material, it is important to make every attempt to attend class
- No exam make-up unless a valid excuse is presented beforehand. All valid excuses must be approved by the Professor.
- All homework and projects must be handed in on time or credit will be deducted (10% each day).

### **Format of Homework**

- All 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.
- All homework must be written legibly so that it can be graded. Illegible solutions will be given zero credit.
- All homework must be stapled. Any homework that is not stapled will receive zero credit.

### **Projects**

- Three Cadence layout projects will be assigned throughout the semester. The first 2 are completed individually while the final project 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 60%
  - (Quiz #1) (10%)
  - (Exam #1) (15%)
  - (Exam#2) (15%)
  - (Comprehensive Final Exam) (20%)
- Homework 10%
- Projects 30%
  - (Project #1) (5%)
  - (Project #2) (10%)
  - (Project #3) (15%)

### **Grading Policy**

Percent	Grade	Grade Points
90.0 - 100	A	4.00
86.7 - 89.9	A-	3.67
83.4 - 86.6	B+	3.33
80.0 - 83.3	B	3.00
76.7 - 79.9	B-	2.67
73.4 - 76.6	C +	2.33
70.0 - 73.3	C	2.00
66.7 - 69.9	C-	1.67
63.4 - 66.6	D+	1.33
60.0 - 63.3	D	1.00
56.8 - 59.0	D-	0.67
0 - 56.7	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 requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

### ***Course Evaluation***

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/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://www.dso.ufl.edu/sccr/process/student-conduct-honor-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.

### ***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: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>

### ***Campus Resources:***

#### ***Health and Wellness***

##### **U Matter, We Care:**

If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) or 352 392-1575 so that a team member can reach out to the student.

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

**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 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://www.dso.ufl.edu/documents/UF\\_Complaints\\_policy.pdf](https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf).

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