

# Course Syllabus

**Course Number & Name:** EEL 4310 and EEL5322 - Digital Integrated Circuits Design

**Credits and Contact Hours:** 3 crs; 3 classes per week of 50 minutes each

**Instructor's or Course Coordinator's Name:** Dr. Scott E. Thompson

Contact info Prof. Scott Thompson

535 Engineering Bldg

846-0320

Office hours: M W F 6<sup>th</sup> period days of live class

Plus e-learning discussion board (<https://lss.at.ufl.edu/>)

(plus additional office hours arranged via email [thompson@ece.ufl.edu](mailto:thompson@ece.ufl.edu))

Cadence TA Maysom Afzhari ([m.asghari@ufl.edu](mailto:m.asghari@ufl.edu))

## **Textbook Title, Author, and Year:**

Title - 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

Title - 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

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

## 1. Supplemental Material:

## Specific Course Information

1. **Catalog Description:** Fabrication, Layout, Analysis and design of digital and circuits using MOS Transistors
2. **Prerequisites or Co-requisites:** EEL 3396, EEL 3308
3. **Required, Elective, or Selected Elective (Table 5-1):**

## Specific Goals for the Course

### 1. 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 have a semester long team SRAM chip design project using commercial software Cadance. Project will cover advanced topics such as manufacturing variations.

1. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by this course:**

EE2, a, c, e, I, k

## Topics to Be Coverer

Week 1: Moore's Law, History and Future of Computing, Chipworks tear down of a mobile computer (iPhone and iPad), Jaeger Chapter 1.

Week 2: Design rules, Chap. 2 .1, 2.2 and 2.3 of Rabaey, 1.2, 1.3.1

Week 3: Contacts and Interconnects Chap. 7 Jaeger and handouts. MOS Process Integration Chap. 9 of Jaeger and State of the art CMOS planar and FinFET SOC process flow: 28nm, 20nm, 14nm, 10nm Logic Technologies and advanced layout issues: Optical Proximity correction and Restrictive Design Rules

Week 4-5: What is VLSI, **Cadence Design Training**, Statistics Review, and Introduction to micro fabrication with emphasis on process variation Chap. 5 .1, 5.2, 5.3, 5.4 of Jaeger, plus handouts and Chipworks reverse engineering reports

Week 6-7: CMOS Logic, DRAM, NAND, CMOS image sensor chips fabrication, bit cell or pixel cell, and array architecture Chap. 8.7 of Jaeger and Chapter 2.2 Rabaey plus handouts

Week 8-9: Layout Layers and X-sections Design Rules, Resistance, Capacitance, MOSFET

Chap. 4.1 to 4.3 and Chap. 3.3 of Rabaey and 9.2, 9.3 Jaeger

Week 10: MOS Transistors, CMOS Inverters, Chap. 3.3 and Chap. 5 of Rabaey

Week 11: CMOS Inverters, Chap. 5 of Rabaey

Week 12: Combination Logic, Compound Gates, Chap. 6 of Rabaey

Week 13: Transmission Gates, Memory, Chap. 6 and Chap. 12 of Rabaey

Week 14: Memory, Pseudo NMOS, Pass Trans. Logic, Chap. 6 of Rabaey

Week 14: Pre-charge Logic, and Dynamic Logic, Chap. 6 of Rabaey

Week 15: Domino Logic, Logic Comparison, Noise Chap. 6 of Rabaey

- Grading:

Class exams

100 Points Test 1 Friday Sept. 24

100 Points Test 2 Wednesday Oct. 22

150 Points Test 3 Monday Nov. 19

250 Points Comprehensive Final: 12/15/2021 @ 3:00 PM - 5:00 PM

Cadences assignment 1 (25 points)

Group SRAM Design project (150 points) Final Class Project Due Dec 8 (midnight)

Homework 10 points per assignment

- Test and projects and homework different for EEL 4310 and EEL5322
- No exam make-up unless valid excuse. All valid excuses must be approved by the Professor
- Final Grading Scale
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- $\geq 90\% \rightarrow A$ ;  $\geq 86.67\% \rightarrow A-$ ;  $\geq 83.33\% \rightarrow B+$ ;  $\geq 80\% \rightarrow B$ ;  $\geq 76.67\% \rightarrow B-$ ;  $\geq 73.33\% \rightarrow C+$ ;  $\geq 70\% \rightarrow C$ ;  $\geq 66.67\% \rightarrow C-$ ;  $\geq 63.33\% \rightarrow D+$ ;  $\geq 60\% \rightarrow D$ ;  $\geq 56.67\% \rightarrow D-$ ;  $< 56.67\% \rightarrow E$

- Attendance: All lecture classes will be recorded via zoom during the regularly scheduled live class and will be made available online shortly after the lecture. A zoom link will be provided before the lecture. Students are free to attend the live lecture in person, participate in the live lecture over zoom, or watch the posted lecture.

## Course Summary:

Date	Details	Due
Wed Nov 7, 2018	Assignment <a href="#">SRAM Cell</a>	due by 11:59pm
Mon Sep 21, 2020	Assignment <a href="#">sample Test 1V2</a>	due by 11:59pm
Mon Sep 28, 2020	Assignment <a href="#">TEST 1 Friday Sept 25</a>	due by 11:59pm
Wed Oct 21, 2020	Assignment <a href="#">Cadence Tutorial 1 Assignment</a>	due by 11:59pm
Fri Oct 23, 2020	Assignment <a href="#">TEST 2 Friday Oct 23 please start 11 to 11:45am on Friday</a>	due by 2:59pm
Mon Oct 26, 2020	Assignment <a href="#">Cadence Tutorial 2 Assignment</a>	due by 11:59pm
Fri Nov 6, 2020	Assignment <a href="#">Cadence Tutorial 3 Assignment</a>	due by 11:59pm
Fri Nov 20, 2020	Assignment <a href="#">Test 3 Friday Nov 20</a>	due by 3:59pm
Fri Dec 18, 2020	Assignment <a href="#">Final Exam Dec 18 12:30pm -2:30</a>	due by 11:59pm
August 2021		

Calendar						
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
25 July 2021	26 July 2021	27 July 2021	28 July 2021	29 July 2021	30 July 2021	31 July 2021
Previous month	Previous month	Previous month	28 Previous month	29 Previous month	30 Previous month	31 Previous month
1 August 2021	2 August 2021	3 August 2021	4 August 2021	5 August 2021	6 August 2021	7 August 2021
8 August 2021	9 August 2021	10 August 2021	11 August 2021	12 August 2021	13 August 2021	14 August 2021
15 August 2021	16 August 2021	17 August 2021	18 August 2021	19 August 2021	20 August 2021	21 August 2021
		Today				

Calendar

<b>Sunday</b>	<b>Monday</b>	<b>Tuesday</b>	<b>Wednesday</b>	<b>Thursday</b>	<b>Friday</b>	<b>Saturday</b>
22 August 2021 22	23 August 2021 23	24 August 2021 24	25 August 2021 25	26 August 2021 26	27 August 2021 27	28 August 2021 28
29 August 2021 29	30 August 2021 30	31 August 2021 31	1 September 2021 1 Next month	2 September 2021 2 Next month	3 September 2021 3 Next month	4 September 2021 4 Next month

**Course assignments are not weighted.**