ECE 444 - Theory and Fabrication of Integrated Circuits

Instructors:
The lecture part of this course is taught by various professors, including Joseph Lyding, Xiuling Li and James Coleman. You will learn well from any of these professors, who are rising stars or established veterans in the area of solid-state electronics. Generally, lecture sections are not interchangeable. Each professor covers slightly different material based on his or her expertise, and gives their own exams on their own schedule. The lab part of the course is overseen by Dane Sievers, but run on a daily basis by TAs.

Prerequisites:
Taking ECE 340 before ECE 444 is highly recommended.

When to Take It:
Most people take this class shortly before graduating since it always fills up quickly and is difficult to get into. If you want to take this class, register the minute your registration window opens. Our university is famous for the lab portion of this class. It is a unique opportunity not available to undergraduates at any other university in the country. Alumni rave about this class and it is an opportunity you should make every effort to capitalize on. If you enjoyed ECE 340 and intend to pursue a career in semiconductors, you absolutely must take this course.

Class Content:
This lecture portion of this course explains how devices like transistors, capacitors, and gates are built into silicon chips used in computers, called integrated circuits. Students begin by learning about how silicon wafers are formed. Students then learn about doping regions of silicon by using masks, photolithography, etching, and furnaces. Students also learn how different devices are connected with miniscule wires. In addition to learning the basic techniques used in lab, students learn more advanced techniques which are too expensive for the lab portion of this course, but are used commonly in industry. The course is primarily qualitative, with a few brief, heavily math based portions. Students who were overwhelmed by the intense math of ECE 340, but were fascinated by the underlying concepts, will enjoy and succeed in ECE 444.

In the lab portion of this course, you make an integrated circuit, in the famous clean room in the Micro and Nano Technology Lab, starting with a bare silicon wafer. You perform oxidation, photolithography, etching, doping, and metallization in several steps to produce capacitors, diodes, BJTs, and MOSFETs. Producing one wafer full of these devices takes about ten weeks. Testing the devices takes the remainder of the semester. Yes, your devices will actually work at the end of the semester!

Work:
Homework is assigned in class, averaging a few written problems each week. The homework is outstanding for both solidifying the material learned in class and preparing for the exams. Homework is a moderately small time commitment. There is no textbook in the class, so be sure to go to class everyday and take good notes! A lot of the test questions come directly from the discussions you have in class, and if you don't pay attention, you won't be able to get them right. The lab is closed form, meaning you only work 3 hours a week, during your scheduled time. For the first three quarters of the lab, time commitments are minimal. There are a few quick prelabs at the beginning of the semester. Halfway through the semester there is a moderately time consuming lab report, intended to familiarize you with software used in class. Toward the end of the class there are two substantial, time intensive lab reports. Although tedious, these lab reports bring most students to an epiphany of understanding of integrated circuits. All of the abstract concepts learned in ECE 340 become real, and you finally understand.

Life After:
Taking ECE 444 opens up doors to research opportunities, graduate school, and jobs. The ECE 444 website lists hundreds of semiconductor companies that will fight to hire students who have taken ECE 444. Students who love ECE 444 could enjoy working at a company with an integrated circuit fabrication facility (a “fab”). A big keyword for job searches is “process technology”. This career path can also open up opportunities for travel to China and Taiwan, where a huge portion of the world's integrated circuits are manufactured. Anyone interested in moving to Taiwan should consider TSMC and UMC, Taiwan’s semiconductor powerhouses. Major US companies are AMD, IBM, and Intel. The course is also helpful for circuit designers, helping them understand the physical aspects of the devices they design on CAD systems.