COURSE INFORMATION

Instructor:

Professor Clark Nguyen, 574 Cory Hall, Tel: (510)642-6251
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Office Hours: M 1-2 p.m., W 12-1 p.m., in 574 Cory

Teaching Assistants (TA's):

Head TA: Mr. Wei-Chang Li, 373 Cory Hall, Tel: (510)666-6624
E-mail: wcli@eecs.berkeley.edu

Office Hours: Tu 3-4:30 p.m., Th 10:30 a.m.–12 noon, in 367 Cory Hall (tentative)

Mr. Jalal Naghsh Nilchi, 373 Cory Hall, Tel: (510)210-5336
E-mail: jalal.naghsh.nilchi@berkeley.edu

Ms. Ruonan Liu, 373 Cory Hall, Tel: (614)285-5637
E-mail: liu847@berkeley.edu

Lecture: Tuesday, Thursday 12:30-2 p.m. in 247 Cory

Laboratory Sections:

Section xxx: Monday, 9-12 noon in 218 Cory (but will poll the class)
Section 013: Monday, 2-5 p.m. in 218 Cory
Section 014: Wednesday, 9-12 noon in 218 Cory
Section 015: Wednesday, 1-4 p.m. in 218 Cory
Section 016: Thursday, 3-6 p.m. in 218 Cory
Section 105: Friday, 12-3 p.m. in 218 Cory

Office Hours:

Office hours are the primary mechanism for individual contact with Professor Nguyen and the head TA, Mr. Wei-Chang Li. You will also have a chance to query your lab TA's during lab hours. All students are strongly encouraged to make use of office and lab hours.

Course Description:

Integration density and performance of digital and analog integrated circuits have undergone an astounding revolution in the last few decades. Over this time period, clock frequencies of microprocessors have doubled every three years, and for both logic IC's and memories, integration complexity and density has doubled every 1 to 2 years. Although innovative circuit and system design can account for some of these performance increases, technology has been the main driving force. This course will examine the basic microfabrication process technologies that have enabled the integrated circuit revolution and investigate newer technologies and layout/circuit techniques aimed at expanding this revolution to other domains, such as microelectromechanical systems (MEMS), and beyond. The goal is to

first impart a working knowledge of the methods and processes by which micro and nano devices are constructed, and then teach approaches for combining such methods into process sequences that yield arbitrary devices. Although the emphasis in this course is on transistor devices (in order to leverage material in prerequisite courses), many of the methods to be taught are also applicable to MEMS and other micro-devices, and some attention will be directed towards issues and aspects pertinent to MEMS devices.

There will be two 1.5-hour lectures per week. The lectures will be supplemented by reading assignments (indicated on the COURSE SYLLABUS), additional reading material to be distributed throughout the course, problem sets (one per week, occasionally per two weeks), one midterm exam, labs, and a final exam. Although the material covered in the lectures and in the reading is fundamentally the same, the perspectives differ, and you are all strongly encouraged to both attend the lectures and complete your reading assignments. Furthermore, there will be occasional announcements in lectures that will affect your problem sets and exams.

Lectures and laboratory, 4 units.

Prerequisites:

The prerequisites for this course are Physics 7B and EE 40. It is assumed that you are familiar with the following topics:

- Fundamentals of materials, including crystalline versus amorphous structure, and the characteristics of semiconductors, insulators, and conductors.
- Basic chemistry.
- Elementary semiconductor physics and device operation for pn junctions and MOS field-effect transistors (MOSFETs).
- Analysis and design of simple MOS analog and digital circuits.

In addition to the above, those who have taken EE 130 will find the concepts in this course much easier to understand, since greater knowledge of semiconductor physics helps to elucidate the reasons for certain aspects of device design.

Texts:

Required: R. C. Jaeger, *Introduction to Microelectronic Fabrication (Vol. V of the Modular Series on Solid State Devices)*, 2nd Ed. Upper Saddle River, New Jersey: Prentice Hall, 2002.

Various material to be distributed throughout the course.

References: (some of these on reserve in the Engineering Library)

S. Wolf and R. N. Tauber, *Silicon Processing for the VLSI Era, Volume 1: Process Technology*, 2nd Ed. Sunset Beach, California: Lattice Press, 1999.

S. Wolf, *Silicon Processing for the VLSI Era, Volume 2: Process Integration*. Sunset Beach, California: Lattice Press, 1990.

Plummer, Deal, and Griffin, *Silicon VLSI Technology: Fundamentals, Practice, and Modeling*, 2nd Ed. Prentice Hall, 2000.

W. Maly, *Atlas of IC Technologies: An Introduction to VLSI Processes*. Redwood City, California: Benjamin-Cummings Pub Co., 1987.

M. J. Madou, *Fundamentals of Microfabrication: The Science of Miniaturization*, 2nd Ed. CRC Press, 2002.

B. Streetman and S. Banerjee, *Solid-State Electronic Devices*, 6th Ed. Prentice Hall, 2005.

Reading Assignments:

Reading assignments include sections of the required textbook, distributed readings, and supplementary notes handed out in lecture. Reading assignments are indicated in the COURSE SYLLABUS and will also be included in problem assignments where appropriate. Supplementary notes will be handed out for topics where lecture coverage is substantially different from the textbook. Students are responsible for all material in the reading. In particular, the scope of coverage for problem sets, the midterm, the labs, and the final examination, includes the reading assignments as well as lecture material.

Problem Sets:

There will be a number of problem sets over the course of the semester, assigned over 1, 1.5, or 2 week periods, depending upon difficulty and complexity. Each new problem set will normally be posted on the course website the day the previous problem set is due, which will be on a Wednesday or Friday morning, 8 a.m. Problem sets should be turned in to the EE 143 box in Cory Hall near 140 Cory by 8 a.m. the day that it is due.

Laboratory:

The laboratory is intended to reinforce the material covered in lecture and in problem sets by providing hands-on experience fabricating transistor and micromechanical devices using actual microfabrication processing equipment in a scaled cleanroom facility housed in 218 Cory. The fabrication tools available for processing include furnaces for oxidation, annealing, and sintering; a photoresist spinner; a contact printing-based lithographic exposure tool; etch and rinse sinks; a metal evaporator; and various instrumentation to measure and characterize completed microdevices. Students will not only learn to operate such equipment, but perhaps more importantly, will also learn some of the "black art" associated with processing that can only be conveyed via hands-on participation. Students will also learn to correctly sequence processing steps and sub-steps; to properly record all relevant processing data needed to debug problems seen later in the process; to be mindful of essential safety precautions; and to observe the minimum cleanroom etiquette that maintains process cleanliness and insures sufficient device yield.

The schedule of laboratory activities is summarized in the course syllabus. Specific activities to be undertaken during each week are described under the laboratory link on the course website at

http://www-inst.eecs.berkeley.edu/~ee143/s14/

Here, the following information resides:

1) Under "Overview and Video Tutorials", information describing various process modules to be used in the laboratory.
2) Under "Laboratory Handouts", global instructions for each week of the lab with data templates to help you properly (and defensively) record your data during processing. This section also includes weekly self-evaluation quizzes that you should complete before coming to lab section.
3) Under "Lab Part I: Fabrication", detailed information on the layout and devices to be fabricated, plus step-by-step processing instructions, i.e., process travelers, to be followed for both transistor and MEMS devices. Specific information on requirements for Lab Report 1 is also included in this section.
4) Under "Lab Part II: Device Characterization", detailed information and instructions to guide you in characterizing fabricated devices from Part I. This section also provides instructions on generating your Lab Report 2.

5) Under "Laboratory Reference", various additional information, including information on safety, cleaning, and chemical disposal procedures.

As mentioned above, you will generate two lab reports at significant points during the process: One immediately after the fabrication process is complete; and a second after devices have been characterized. These two reports will make up the bulk of your lab grade. A smaller portion of the grade will be derived from your performance in the lab and from your diligence in completing the self-evaluation quizzes before the lab sections.

Midterm:

There will be a midterm exam in this course to be held on the date shown in your COURSE SYLLABUS. We will try to adhere to this date so much as possible. The midterm will be a 1.5 hour exam. More information on the exam will be provided later.

Final Exam:

The final exam will be comprehensive, covering all of the material in the course. This includes everything covered in problem sets, lectures, and readings. The exam will be held during the Examination Period at the scheduled time. The date is shown in your course outline.

Computer Accounts/CAD Tools:

All students in this course should have "named" accounts on the EECS instructional computers, which include UNIX, Windows, and MacOSX platforms. Matlab runs on all of them. Students can use the computers in the EE 140 laboratory (i.e., 353 Cory), or the computer labs in 199, 105 and 119 Cory, or in other labs listed in the link:

http://inst.eecs.berkeley.edu/~inst/iesglabs.html

Most of you should already have computer accounts that work in those labs. If not, then you can get a "named" account by going to following link:

http://inst.eecs.berkeley.edu/connecting.html#accounts.

and following the instructions (which entail going to 199 Cory and logging in as "newacct" with password "newacct", among other things). You will need to wait 24 hours after you log on and create your account before coming to see Loretta, who will take care of the rest of the process.

Once you create your account, you should have access to all of the necessary software for your course work.

Alternatively, in some semesters, handouts are given with accounts on them. In this case, there is no need to go to the above links to get accounts.

Grading Policy:

Course grades will be assigned according to the following tentative grading formula.

Problem Sets:	15%
Laboratory:	30%
Midterm Exam:	25%
Final Exam:	30%