ECE 571—Microelectronic Fabrication
Department of Electrical and Computer Engineering
University of Massachusetts-Amherst
Spring 2008

Course Instructor: Sigfrid Yngvesson, 142B Marston Hall, yngvesson@ecs.umass.edu
Office Hours: TBD
Lab Instructor: Sanghyun Lim, 14A Marcus Hall, sanghyun@engin.umass.edu
TA: Ravi Mamidi, rmamidi@ecs.umass.edu
Organization: Lecture------T/Th 9:30—10:45 AM, ELAB 327
Lab:Tue 1:00—5:00 or Wed 1:00—5:00 or Th 1:00—5:00 or Fri 1:00-5:00; 15A Marcus Hall
Prerequisites: ECE 344 or equivalent background
Credits: 4 (with laboratory)

Course Goals

• To understand the processes used in microelectronic circuit fabrication and the physical concepts behind these processes.
• To fabricate bipolar and MOS devices starting from bare silicon wafers, performing all processing steps from beginning to end, characterizing the wafers during the process. Testing the finished devices and comparing results with calculations and computer simulations.

Lecture---Outline of Topics:

• Overview of Processing
• Thermal Oxidation
• Optical Photolithography
• Doping by Diffusion and Ion Implantation
• Metallization and Interconnection
• Film Deposition/Epitaxy
• Packaging, Yield, and Process Integration
• Current State-of-the-art Trends
• Future Prospects and Challenges

Course Materials:

• The only required textbook for the course is “Introduction to Microelectronic Fabrication,” second edition, by Richard C. Jaeger, Pearson/Prentice Hall, 2002.
• The textbook will be supplemented with several handouts.
• The laboratory manual is the “Microelectronics Fabrication Engineering Laboratory Manual,”
• Several Reference Texts are on reserve in Physical Sciences Library:

1. S.M. Sze, Semiconductor Devices, Physics and Technology
2. S.M. Sze, Editor, VLSI Technology
3. S.K. Ghandi, VLSI Fabrication Principles, Si and GaAs
5. A. Grove, Physics and Technology of Semiconductors

Grading: 40% Laboratory (note break-down of lab. grading on separate sheet), 25% Exam 1, 25% Exam 2, 10% Homework
Laboratory Location: Marcus Hall, Room 15A

Laboratory Section Grouping Policy

Scheduled Laboratory Sections:

- **Section 1** – Tuesdays, 1:30-5:30 PM
- **Section 2** – Wednesdays, 1:30-5:30 PM
- **Section 3** – Thursdays, 1:30-5:30 PM
- **Section 4** – Fridays, 1:30-5:30 PM

Typically, each lab section will consist of two student groups, with each group comprised of three students. We will try our best to place students into the lab section of their choice, but ultimately the lab sections will consist of approximately six students each. Some flexibility on the part of the students may be necessary in order to efficiently organize the lab sections. During the laboratory orientation the student groups will be subdivided into three specialty areas (photolithography, etching and oxidation/diffusion). By dividing the workload into specialty areas the students learn their “jobs” more quickly than they would if they had to learn all of the process steps at once. Later in the semester the students cross-train each other in the other specialty areas.

Laboratory Orientation

The first lab session (referred to as Lab 0) will meet on February 5th, 6th, 7th and 8th. This orientation lab will consist of basic training in cleanroom protocols, chemical safety training and a general overview of how the lab will operate over the course of the semester. Unlike the subsequent lab sessions no preparation will be required for this lab. You will receive your lab manuals at the end of this session.

What happens in the Lab?

In the lab students are provided with the materials and training necessary to fabricate a variety of common discrete microelectronic devices (transistors, capacitors, resistors). Initially there is a very steep learning curve. Students will need to learn how to operate a wide variety of processing and test equipment as well as how to function in a cleanroom environment. Fortunately, since the basic fabrication steps are at least somewhat repetitive the learning curve becomes less steep after a few weeks.

How will students be graded in the Laboratory?

The laboratory component of ECE 571 comprises 40% of your total grade for the course. The grading breakdown for that 40% is as follows:

- Pre-lab and Post-lab reports: 5%
  - First report: 5%
  - Second report: 5%
  - Final report: 15%
- Lab performance: 10%

Details of each of these categories are provided below.
Pre-lab and Post-lab reports
Each week the instructor or TA will email to all ECE 571 students a short list of questions. The pre-lab questions are designed to ensure that the students have read and understand the lab manual write-up for the coming week’s lab. The post-lab questions are designed to ensure that the students understood what they did in the previous lab and have also properly documented their work. The students should answer the questions as thoroughly as possible and email them back to the instructor or TA. (See the pre-lab/post-lab hand out for more details).

First Lab Report
The first lab report of the semester will be due after all student groups have finished the boron re-oxidation process step. The report should detail the process steps undertaken by the students. It should also include all in-process test data gathered by the students up to that point in the fabrication process.

Second Lab Report
The second lab report of the semester will be due after all student groups have finished the gate oxidation process step. The format is exactly the same as the first lab report. Note that the second report is a cumulative report, so all process and test data up to that point in the fabrication process should be included. Any corrections needed on the first report should also be incorporated into the second lab report.

Final Laboratory Report
The final lab report of the course should include all of the process and test data gathered during the entire fabrication process. The report should include (but not be limited to) a full and coherent description of the fabrication process from start to finish, as well as all in-process and electrical test data. The first two lab reports should be your guides as to what we are looking for in an excellent report. (See the final report handout for more details). The due date for the final report is typically the last day of final exams for the spring semester.

Lab Performance
The student’s overall performance in the lab sessions will receive a grade equal to 10% of the course grade. Criteria used to grade a student’s lab performance will include the following:

Does the student show up for lab on time and well prepared?
Does the student show consistent progress in understanding the operation of the equipment?
Does the student show consistent progress in understanding the fabrication process?
Does the student demonstrate an understanding of the device physics that underlie many of the tests that are done as part of the fabrication process?
Is the student able to follow precise directions while working in the lab?
Does the student comply with all safety procedures while working in the lab?
Does the student demonstrate that he/she can communicate and work effectively in a team environment?