Georgia Institute of Technology School of Electrical and Computer Engineering

ECE 6450 Introduction to Microelectronics Technology

Instructor: Dr. Alan Doolittle

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Work: 404 894-9884

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Email: alan.doolittle@ece.gatech.edu (by far, the best way to communicate with me).

Credits: 3 lecture hours, pass, fail, audit

Prerequisites: Graduate Standing

Text: The Science and Engineering of Microelectronic Fabrication, second edition, Stephen A. Campbell

Web Resources:
Official Class Web site: http://users.ece.gatech.edu/~alan/index.html

Office Hours: Officially: Wednesdays 11-12:30. Most weeks I hold “open office hours” on where you can come by for help anytime that is pre-arranged (preferably by email).
All students are strongly encouraged to consult me with any problem!

Grading Schedule:
Grades will be based on a 100 point scale, but bonus points will frequently be awarded, especially on the final making the actual weight of the final exam heavier than the numeric values quoted herein. Exams will fall approximately every 5 weeks.

The class will follow the following grading schedule. Note: Grading recommendations put forth by ECE require three grading periods plus a final exam.

Homework 10%
Exam 1 22%
Exam 2 22%
Presentation 22%
Final Exam 24%

Each homework is ungraded and adds a fixed 1 % (or 0%) if ALL of a given assignment are attempted. Note that this grading is digital, implying if 90% of a homework is attempted, the grade is still a 0. ALL of the problems must be legitimately attempted for
credit. Grading is not based on the correct answer. Homework will be representative of test problems. Previous analysis has shown a relationship of (Increased Test Score) \( \sim = 20 \times \text{(Percentage of Homework Attempted)} \) If more than 10 homework assignments are made, all those above 10 will be counted as bonus points (a good way to raise your grade a couple of points). If less than 10 are assigned, bonus points will be awarded to all to raise the homework contribution to 10%.

Tests will cover all material assigned as reading, homework and discussed in class.

**Exam Design and Grading:**
Exams will cover all material assigned as reading, homework and discussed in class. Each exam will be designed so that students who attend and participate in class, do all the homework and read the text will likely receive a B/A grade.

**What is Expected of Students**
- All students are required to follow the academic honor codes established by Georgia Tech.
- All students are expected to be respectful of other students.
- All students are responsible for materials covered in and/or assigned in class REGARDLESS of whether they attended class.
- I strongly prefer an interactive class. Let me know if you do or do not understand what is being lectured. Ask questions!

**Instructor Commitment to the Student.**
While statistics always result in some students who will perform poorly in this class, no student will perform poorly due to lack of access to the instructor. To that end, I will make every reasonable provision possible to insure your success in this class. Students are strongly encouraged to seek help from this instructor with any problem, academic, personal or otherwise. Students are also strongly encouraged to supply the instructor with constructive criticism regarding all aspects of class activity. Such criticism (even especially that considered negative) will be greatly appreciated.
Fall/Winter Semester Syllabus (Summer semester coverage is accelerated)
Dates should be considered flexible

Students are STRONGLY encouraged to read the material Before the class discussion.

Syllabus (All dates are target dates and should be considered flexible):

<table>
<thead>
<tr>
<th>Topic</th>
<th>Reading</th>
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<tbody>
<tr>
<td>Introduction to Materials Science and Electronic Materials</td>
<td>Chap. 1, Notes</td>
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<td>I.) Material types</td>
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<td>II.) Defect Types</td>
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<td>III.) Material Alloys and “Simple” Binary Phase Diagrams</td>
<td>Chap. 2, Notes</td>
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<td>Crystal Growth Techniques</td>
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<td>Solubility of Impurities</td>
<td>Chap. 3, Notes</td>
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<tr>
<td>Diffusion of Impurities</td>
<td>Chap. 4, Notes</td>
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<td>Thermal Oxidation</td>
<td>Chap. 5, Notes</td>
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<td>Ion Implantation</td>
<td>Chap. 6, Notes</td>
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<td>Rapid Thermal Processing</td>
<td>Chap. 7-8, Notes</td>
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<td>Optical Lithography</td>
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<td>Positive, negative and image reversal</td>
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<td>Etch verses Lift Off</td>
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<td>Photoresists</td>
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<td>September 10th Exam 1 (Additionally, a presentation topic must be approved)</td>
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<td>October 10th Last Day to Withdraw from a Class</td>
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<tr>
<td>DUV, E-beam and X-ray lithography</td>
<td>Chap. 9 (briefly), Notes</td>
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<td>Vacuum Science</td>
<td>Chap. 10, Notes</td>
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<td>Pumps, conductance, vacuum measurement</td>
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<td>Plasma Processing</td>
<td>Chap. 10, Notes</td>
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<td>Etching</td>
<td>Chap. 11, Notes</td>
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<td>Plasma Etching</td>
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<td>Wet Chemical Etching</td>
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<td>Chem-Mechanical Polishing</td>
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<td>Thin Films</td>
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<td>Deposition via Evaporation and sputtering</td>
<td>Chap. 12, Notes</td>
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<td>Chemical Vapor Deposition</td>
<td>Chap. 13, Notes</td>
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<td>Crystalline Semiconductors</td>
<td>Chap. 14, Notes</td>
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<td>CVD, MBE and MOCVD</td>
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<td>Dielectrics, polycrystalline materials, metals</td>
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<td>~October 6th Exam 2</td>
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Back end processing: Process Integration, Circuit Fabrication, Packaging (briefly)

Process Integration

Examples:
- Silicon BJT
- Various on-chip Capacitors, resistors etc...
- CMOS Example
- Optoelectronic Devices (LEDs/Laser Diodes)
- III-V RF transistor

Multilayer metalization (briefly)
Packaging (briefly)

“Modern” Topics
- Low-k Dielectrics
- Copper Interconnects
- Damascene Processing
- SiGe Alloys

Characterization (Time Permitting)

Structural
- X-ray diffraction, TEM, SEM, AFM, and STM

Electrical
- CV, DLTS, Hall, IV, EBIC

Optical
- Photoluminescence, FTIR

Compositional
- EDS, SIMs, Auger Analysis, XPS

Presentations Schedule (flexible depending on class size):
October 29th – December 5th

Final Exam Period: Dec 12 (Fri) 11:30am - 2:20pm
**Presentation Details:**

It is my desire to make your presentation topic as interesting and as useful to you as possible. Ideally, the topic should be relevant to your desired research topic and may be used, in part, as an introductory section to your thesis. All topics must be unique. No topic can be shared by another student. Papers regarding topics partially covered in class should provide much more detail than what was covered in our text and class discussions. If chosen carefully, the paper can be a benefit to your research instead of a time liability.

The topic is accepted by written (paper) on or before the first exam. Fill out and turn in the form at the end of this syllabus (in person). The topics are on a first come first claim basis and all must be unique (no joint presentations). **NOTE** that this is a fabrication technology class and thus, a review of a device is not an appropriate topic. **How a device is made or how a material is fabricated or characterized is an appropriate topic.**

Some suggested topics include, but are not limited to:

**More general:**
Deep-submicron CMOS fabrication, PECVD deposition, ICP etching, Rapid thermal processing, MOCVD, Oxide deposition, oxide characterization techniques, IC reliability testing, low damage plasma etching, polymer processing, DUV lithography, emersion lithography, phase shift lithography, packaging technologies, any characterization topic, etc...

**More specific topics could include:**
(HFET/MESFET/MODFET/HEMT/HBT/BJT/FINFET) processing in the (silicon / silicon-germanium / antimony / arsenic / phosphide / nitride / carbide) material systems, SiC power devices (FET, BJT, SIT, Thyristors, Diodes), Si DRAMs, MEMs, Oxide characterization via (corona discharge, CV, thermal stress) measurements, Fabrication of (semiconductor laser/LEDs/modulators), power switches, non-linear optical devices, optical bandgap devices/materials, yield, reliability, etc...

Additional help can be found by consulting trade journals such as Semiconductor International, Semiconductor Technology, Compound Semiconductor, IBM Resource Journal etc...

*I WANT TO SEE DETAIL!!!! TELL ME WHAT YOU LEARNED!* Ideally, I would like you to tell me something I do not already know. In the absence of this, (because I will likely be familiar with most topics) it should answer a “yes” to the question; “If I heard this topic from you for the first time, would I understand the topic well?”

**Presentation specifications:**
Length dependent on class size: Generally 10-15 minutes with details to come later. Given in PowerPoint with both hard and electronic copies supplied to the instructor prior to your scheduled presentation. Presentation topics scheduled by random lottery order.
Presentations will be graded based on mastery of the subject matter.

Grading Breakdown:

- Meeting Assignment Requirements 25%
  This includes 10% for having a preloaded and verified operational PowerPoint presentation.
- Presentation (organization/clarity etc...) 25%
- Content (detail, detail, detail...) 50%

*Your final WILL have 1-2 questions from each presentation. Thus, everyone is required to attend the presentations.*
Presentation Topic Selection Form

Name (as appears on class role): _____________________________________________

I have read this syllabus and specifically have read the grading procedures: ________
(Initials)

Title of Presentation ______________________________________________________

Rough idea of subtopics to be included (so I know you have at least read up on the topic a little before making your selection)

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________