Georgia Institute of Technology School of Electrical and Computer Engineering

ECE 6450 Introduction to Microelectronics Technology

Instructor: Dr. Alan Doolittle

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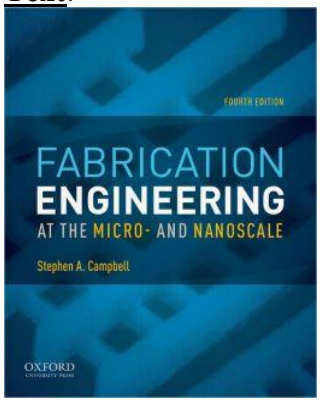
Credits: 3 lecture hours, pass, fail, audit **Prerequisites**: Graduate Standing

Text:



Replaces: The Science and Engineering of Microelectronic Fabrication, Stephen A. Campbell

Web Resources:
Official Class Web site: https://alan.ece.gatech.edu/index.htm

Office Hours: Officially: Thursdays 11:15-12:15. Most weeks I hold "open office hours" on Tuesday Wednesday, and Thursday where you can come by for help anytime that is pre-arranged (preferably by email but feel free to drop by). ***All students are strongly encouraged to consult me with any problem!***

Special Pandemic and Emergency Considerations: ***Campus is planning to be fully open for the entirety of Fall semester and as of class start, no plans to deviate from this arrangement exist. In this mode of operation, all exams, presentations, final exams, and homework will be handed in, in person, in class.*** Backup Plans: However, should a pandemic occur or any other event that warrants deviation from in class teaching, several class options will be considered: 1) Depending on enrolled class size the class will be divided into two groups to maintain physical distancing and each group will attend classes in person once a week on the designated day while the rest of the class is watching the broadcast from the class. These groups will be communicated via email and

assignments posted on the class web site. You are encouraged to attend the in-person class sessions unless you have a compelling reason not to do so. 2) Assignments and homework as well as exams 1 and 2 will be assigned through the course website http://alan.ece.gatech.edu/index_files/ECE3040index.htm , email and submitted digitally via email (or Canvas in some very limited cases with the instructors directions). 3) If the "event" lasts into the times for exam 2, design projects may be substituted for some exams and will also be submitted digitally. 4) Open book take home exams may be substituted for any exam. Depending on the situation at the time, the final exam may be either in class or may use the online options including Honorlock digital proctoring system which requires the students to have access to a webcam, microphone, and reliable Internet connection.

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% Target Date: September 16th.
Exam 2	22% To be determined.
Presentation	22% Typically the last 5 weeks of class but depends on number enrolled
Final Exam	*24% (Scheduled for Monday, Dec 8th - 11:20 AM - 2:10 PM)

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 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) ~ =20 x (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.
Note: Since the final presentations are presented in random order, some may continue into the reading period.
***Note:** If the grades need to be "curved", bonus points will be provided to function the same as a curve. However, you must get the bonus questions correct to obtain the value of a curve. This implements a "earned curve".

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 interactive classes. Let me know if you do or do not understand what is being taught. 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 ensure 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.

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit http://www.catalog.gatech.edu/policies/honor-code/ or http://www.catalog.gatech.edu/rules/18/.

Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404)894-2563 or http://disabilityservices.gatech.edu/, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Student-Faculty Expectations Agreement

At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See http://www.catalog.gatech.edu/rules/22/ for an articulation of some basic expectation that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

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):

Topic	***Reading***
Introduction to Materials Science and Electronic Materials	Chap. 1, Notes
I.) Material types	
II.) Defect Types	
III.) Material Alloys and "Simple" Binary Phase Diagrams	
Crystal Growth Techniques	Chap. 2, Notes
Solubility of Impurities	
Diffusion of Impurities	Chap. 3, Notes
Thermal Oxidation	Chap. 4, Notes
Ion Implantation	Chap. 5, Notes
Rapid Thermal Processing	Chap. 6, Notes
Optical Lithography	Chap. 7-8, Notes
Positive, negative and image reversal	
Etch verses Lift Off	
Photoresists	

~September 16th Exam 1
Additionally, a presentation topic must be approved by this date.

DUV, E-beam and X-ray lithography	Chap. 9 (briefly), Notes
Vacuum Science	Chap. 10, Notes
Pumps, conductance, vacuum measurement	
Plasma Processing	Chap. 10, Notes
Etching	Chap. 11, Notes
Plasma Etching	
Wet Chemical Etching	
Chem-Mechanical Polishing	
Thin Films	
Deposition via Evaporation and sputtering	Chap. 12, Notes
Chemical Vapor Deposition	Chap. 13, Notes
Crystalline Semiconductors	Chap. 14, Notes
CVD, MBE and MOCVD	
Dielectrics, polycrystalline materials, metals	

~October 27th or 29th Exam 2

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):
November 1st – December 6th

Final Exam Period: Dec 15 (Wed) 11:20 AM - 2:10 PM

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)