“Silicon-Based Heterostructure Devices and Circuits”

ECE 6444
Spring Semester 2014

School of Electrical and Computer Engineering
Georgia Institute of Technology

Dr. John D. Cressler

When and Where

Lecture Place: Klaus 2456
Lecture Time: Tues / Thurs 4:35-5:55

Contact Information

email: cressler@ece.gatech.edu (best way to reach me)
office: 521 TSRB
phone: (404) 894-5161
(404) 351-0198 (emergencies only)

Office Hours:

M-W-F 4:30-5:30 (please let me know you are coming)
… or by appointment
… or when my door is open stop in and say hi!

If you need me and cannot find me ... please email me!
Course Policies and Procedures

Course Prerequisites

Some “exposure” to basic semiconductor physics
Some “exposure” to basic semiconductor devices
Graduate standing, or COI

Required Textbook


It’s not cheap, but I can guarantee you it’s good! It will be used throughout the course, so you need to buy it.

There are numerous other books on semiconductor physics or semiconductor devices which may be useful for consultation if you feel weak in these areas. See, for instance,


In addition, I will be using overhead material during every lecture. You need to put it in a binder and bring it to every lecture!
Journal/Conference Reference Acronyms

Journals:
- IEEE Transactions on Electron Devices (TED)
- IEEE Electron Device Letters (EDL)
- Solid-State Electronics (SSE)
- Applied Physics Letters (APL)
- Journal of Applied Physics (JAP)
- IEEE Journal of Solid-State Circuits (JSSC)
- IEEE Transactions on Microwave Theory and Techniques (TMTT)
- IEEE Microwave and Wireless Components Letters (MWCL)

Conferences:
- Bipolar/BiCMOS Circuits and Technology Meeting (BCTM)
- International Electron Device Meeting (IEDM)
- Device Research Conference (DRC)
- International Solid-State Circuits Conference (ISSCC)
- International Microwave Symposium (IMS)
- RFIC Symposium (RFIC)
- Solid-State Devices and Materials Conference (SSDM)
- European Solid-State Device Research Conference (ESSDERC)
- European Solid-State Circuits Conference (ESSCIRC)
- Symposium on VLSI Technology (VLSI-T)
- Symposium on VLSI Circuits (VLSI-C)
- Topical Meeting on Silicon Monolithic ICs in RF Systems (SiRF)
- Nuclear and Space Radiation Effects Conference (NSREC)

Web Site

The official course web site is located at:

http://users.ece.gatech.edu/~cressler/

Go to the “Courses” button on the left, and then click on our course. Color overhead material used in lecture will be posted there, along with homeworks, reading assignments, various handouts, etc.
Lectures

Lectures will consist of a mixture of on-the-board notes, overheads, discussion about the technical material, problem solving, and digressions on life. Lecture will be considered by most to be fast-paced. Keeping up will prove essential to your success. Solving all homework problems and reading your assigned readings are both key to good grades. Based on past experience, class attendance should be viewed as mandatory for those desiring high grades. All students are responsible for all material covered in class (written or orally transmitted). Anything covered in lecture can appear on exams.

Electronic Gadgets

All eGadgets must be stowed and powered off during lecture: cell phones (including texting!), laptops, iPads, iPods, etc. A (simple) calculator will be needed for the exams.

Homework

For full-credit, homework must be turned-in on the assigned date! (in my hands by 5:00 pm). Joint work is allowed on homework, but each student MUST hand-in their own individual solution. HW will consist of qualitative, quantitative, and theoretical problems of varying difficulty and length. Computer solutions will at times be necessary. Good grammar and diction count. Using “canned” software packages for your solutions (e.g., MATLAB) is fine, but what you turn in MUST be self-documented with some English.

Exams

The exam will be open book, open notes. Any and all calculators are allowed. Partial credit will be given, but only if you provide a clear, legible, and easy-to-follow exposition of your solution. Box off your final answers. Good grammar and diction count. The exam will consist of
three main parts: *qualitative* (tell me about something), *quantitative* (calculate something for me), and *theoretical* (project your knowledge of the material into uncharted territory for me).

**Design Project**

A comprehensive team design experience (a competition actually!) will take place in the second half of the semester, and serve as the final exam for the course. This project will involve device design, modeling, and circuit design. Details will be announced later.

**Grading Policy**

Course grades will be calculated according to the following weighting formula:

- Homework - 35%
- Exam - 30%
- Design Project - 35%

**Academic Honesty**

Students are expected to abide by Georgia Tech’s established Academic Honor Code (refer to the General Catalog). Academic misconduct is not acceptable in my class, and incidents will be reported to the Administration. While students are encouraged to work together on homeworks, individual solutions must be submitted for grading. No collaboration in any form is permitted on exams.

**Course Objectives**

ECE 6444 will begin with some background and motivation, and then a discussion of SiGe strained-layer epitaxy. This will be followed by a detailed examination of the SiGe HBT, including fabrication, profile design, fundamental physics, static and dynamic properties, and a host of other issues related to profile optimization. We then address circuit-
level design with SiGe HBTs, including noise, linearity, and compact modeling issues. We conclude with an overview of other emerging device types which are enabled by the emergence of strained-layer Si and SiGe epitaxy. This course is intended for graduate students in both the Microsystems and Electronic Design and Applications TIGs, as well as other students interested in novel microelectronics device and circuit technologies.

**Important Dates**

**Georgia Tech Calendar**

<table>
<thead>
<tr>
<th>Event</th>
<th>Day</th>
<th>Date</th>
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<tbody>
<tr>
<td>Class Begins</td>
<td>Tuesday</td>
<td>1/7</td>
</tr>
<tr>
<td>Spring Break</td>
<td>Monday - Friday</td>
<td>3/17-21</td>
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<tr>
<td>Class Ends</td>
<td>Thursday</td>
<td>4/24</td>
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**Class Calendar**

<table>
<thead>
<tr>
<th>Event</th>
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<th>Date</th>
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<tbody>
<tr>
<td>Exam</td>
<td>Tuesday</td>
<td>4/8</td>
</tr>
<tr>
<td>Design Project</td>
<td>Thurs 2:50-5:40</td>
<td>5/1</td>
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</tbody>
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Please mark all these dates on your calendar!

**Tentative Travel Dates**

- None at present (yippee!)

Please understand that travel is a fact of life for a professor. My travel schedule is reasonably well known at present, but in some cases it can be dynamic during the semester as meeting schedules change, etc. However, the show must go on! A guest lecturer will fill in for me during my required absences, as needed.
My Expectations of You

Class participation matters a great deal to me. In fact, it will be used to determine borderline grading cases. Meaningful participation during lecture requires preparation for lecture on your part. Read the course material. Come 5 minutes before lecture and review your previous notes. I expect all students to be respectful of their fellow students (and me). I expect you to be alive and kicking during lecture (bring coffee or soda if necessary!), and responsive to my questions. Please be on time for lecture. Please remember that this is a graduate course. That is, outside of class reading and thinking, confused scratching of the head, spending time with the math to make sure you follow it, chatting with both me and your classmates after hours about results and problems and even new research opportunities, is a necessary part of a meaningful graduate experience. What you gain from this course in large measure will be determined by what you put into it. Electronic gadgets must be powered off and stowed during lecture! Most importantly, smile, and relax … you are among friends!

My Teaching Philosophy

Simply stated, I am here for you. Period. I am concerned about any impediment to your learning and happiness, whatever that may be, and I will do whatever I can within my power to assist you. My goal in this class is to help facilitate your mastery of this material, but also to convince you of the beauty and majesty of the subject matter. Hopefully I can add some insight into life as well. It is my job to make the material clear to you. If I’m not succeeding in that, I am depending on you to make me aware of it. I like to conduct my classes informally. If you have a question, or comment, or need me to repeat something, or can’t read my writing, or you don’t follow what I’m saying - interrupt me (politely). There is no such thing as a dumb question. All questions are the potential source of deeper enlightenment for both you and me and the rest of the class. Ask! I would be happy to discuss any aspect of life with you, from your career path, to graduate school, to the academy, to industry, to the meaning of life, either inside of class or
outside of class. As you will soon see, I am very fond of quotations, and I offer them to you for your deeper reflection. They are also intended to remind you that there is much more to life than what happens at Georgia Tech!

I am looking very forward to getting to know each of you, and sharing with you a subject both near and dear to my heart!