Spring 2015

Materials Science and Engineering 460

Electronic Materials and Processing: Semiconductors

Where:
- Normal lectures: Room 101 Transportation Bldg
- Evening lectures: Room 135 Mechanical Engin Bldg

When:
- 10 A.M. Monday, Wednesday, and Friday
- Evening make up meetings: Mondays ~5 pm

Credit: 3 hours

Course Description: This class introduces students to the materials science, engineering, and processing of semiconductors. The structure and chemistry of semiconductors are related to the electronic and optical properties. The course will include information on how semiconductors are produced, how to control processing to achieve desired materials properties, and how to design and produce novel materials to obtain superior performance from electronic devices. Processing techniques described will include bulk crystal fabrication, general aspects of thin film growth, MBE, CVD, and ALD. However, this course is very flexible and will include additional process techniques and semiconductor materials if desired. The responsibility is on you to help control the pace of the course and to request additional material to be covered as you wish and with discussion with the remainder of the class.

Prerequisites: A course covering modern physics and quantum mechanics concepts such as PHYS 214 and basic chemistry and materials science. It is anticipated that you are familiar with concepts from advanced solid state physics (as in MSE 304 or PHYS 460) and from electrical engineering device physics (as in ECE 340). Both solid state physics and device physics will be reviewed (quickly) so if you do not have this background and can handle a quick overview, we will review what you will need. These courses are nominally prerequisites. It is not recommended that you take this class unless you have at least one of MSE 304, PHYS 460 or ECE 340 or equivalent.

MatSE 460 Instructor:
Prof. Angus Rockett
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e-mail: arockett@illinois.edu
Office phone: 333-0417
Home phone: 398-6561 (Limit to between 6:30 A.M. and 10 P.M.)

**Lecture Notes:** No lecture notes will be distributed as the course is primarily taught out of my text. Copies of powerpoint slides used and some other information will be provided (see the Compass web site.)

**Course Textbook:**


If you find that my text is not satisfactory, I can recommend several other texts including many sources listed in the recommended readings in my book chapters. The primary alternative is Electronic Materials Science: For Integrated Circuits in Si and GaAs by James W. Mayer and S.S. Lau (Macmillian, NY). ISBN: 0-02-378140-8, Call Number: 621.38152 M452E. If you have suggestions for other texts to list in the book recommended readings please let me know.

An errata sheet for the book will be posted on Compass. If you find problems with the text, please let me know. There are certainly errors present. Too bad the people I asked to read it did not point them out before it was published rather than telling me after. Sigh. Never write a book by yourself.

**Course Objectives**

The objective of this course is to help the student develop a good background on semiconductor materials and a basic understanding of two important areas of electronic materials processing. We will attempt to make a direct connection between the basic properties of atoms and the general nature of semiconductors and defects therein. A good understanding of these areas will help lead the student towards a successful career in the semiconductor industry. This course will cover the topics listed below. However, the scope of the class is not limited to these areas. It is up to you to help determine the pace and content of this course.

**Course Requirements**

**Class Attendance:**
You are not required to attend normal lectures. However, 4% of your grade is based on your iClicker responses so while I will excuse some missed iClicker responses you need to have a good excuse to be excused. You are responsible for what is mentioned in class. This includes making assignments, correcting mistakes in the book or lectures, or topics other than those in the text or written notes. It is to your benefit to attend class. It is my intention to record the audio portion of the lectures using PowerPoint as much as I can and to make those recordings available for those who miss class. Do not count on this as the recordings often fail. You may not distribute the recordings. If you make recordings of your own you may not distribute them.
In addition, information, assignments, and other notices may be posted through the Compass web site. You are responsible for keeping track of information on Compass.

**Homework:**
There will be homework problems assigned approximately every other week. Homework must be handed in on time. Late homework will not generally be accepted. However, if you are unable to complete an assignment on time you must inform the instructor IN ADVANCE if you are to have any chance of being allowed to hand in the homework late. If you have any questions about the homework assignments, feel free to ask during class, during office hours, or whenever I am available. You should note that you can lose a full letter grade or more by doing none of the homework. Furthermore, there has been a strong relationship between people who do poorly on the exams and those who do not do the homework.

*Homework Guidelines:*
Homework must be readable. The pages for each homework assignment must be stapled together. Please put your name and the assignment number or due date on the pages in case they get separated. Try to keep your work neat and easily readable, in pen, dark pencil, or computer output. All work leading to your answer must be included. In the final expression for the quantities of interest, numbers and units must be shown.

You are encouraged to work together and discuss the homework assignments. If you are having difficulty with a particular topic, you are encouraged to read the same topic in the books that are available in the Grainger Engineering Library to try to work towards a solution. In any case, feel free to see the professor for assistance. Homework assignments that you turn in must be your own work and not copied from someone else’s solutions even if you work together on the problems. (Copying someone else’s solutions and submitting it as your own work is unacceptable!!) **Plagiarized homework will result in loss of credit for the full homework grade, not just that particular homework.**

**Exams:**
There will be three one-hour exams. Each of the exams will consist of several problems or questions and will typically be closed-book and closed-notes. An equation sheet and some of the required physical properties and constants may be provided. The hour exams will be planned to take 50 minutes to complete.

You will normally need a scientific calculator for the homework and exams. It is your responsibility to bring one. If you must, problems may be done by hand to order of magnitude. Use of calculators may be restricted on some exams. Listen for announcements in class concerning this. The use of calculators with extended memory capability, tablets, and other such devices is not allowed as they may store information not permitted for use on the exams. You may not use smart phones as calculators.

Extra credit on exams may be adjusted according to their difficulty. There are no set number of grades of a given level anticipated nor are the break points between grades defined or set to pre-
existing values. Expectations will be judged somewhat according to how the remainder of the class performs. I will consider whether students are graduate or undergraduates when determining break points among grades but the graduate and undergraduate students will not be graded on different scales. Note that in the past these two groups have performed roughly equivalently. It is possible that a grade over 90% may be required to achieve an A-, over 80 to achieve a B- and so on may occur. Do not assume that the grade decades necessarily define the grade breakpoints one way or the other.

I recognize that senior undergraduates and graduate students need to travel for conferences and interviews. If you must be out of town please let me know so that I can make accommodations. Normally you will be accommodated somehow in this case. You may be required to show proof that you did in fact travel for legitimate reasons.

Nobody is guaranteed to be excused from any exam or any homework even in cases of “legitimate” excuses. However, normally I will excuse you on the basis of hardship (death in the family or documentable illness) or for religious reasons. However, this must be documented. If you expect to miss classes for religious reasons you must document that and communicate your plans within the first two weeks of class. If there are a sufficient number of students who ask to be excused from one of the exams because of conflicts, a make-up exam will be scheduled. It is not guaranteed that the difficulty of the two exams will be comparable although we will hope to be close. If you are unable to attend an exam you must inform the instructor. IN ADVANCE if you are to have any chance of being excused and being allowed to make up the exam.

Concerning issues of absence for religious reasons: these are well known at the start of the semester. If you expect to be accommodated for religious reasons you must tell me within the first six class meetings. Failure to notify me of religious obligations by lecture six may result in not being granted an excused absence.

**Monday make up lectures:**

Due to necessary travel there will be lectures on Monday evenings, 5-6 pm many or all weeks. If you can not make those lectures it is your responsibility to make that clear to the instructor in advance. In some cases exams may be scheduled during these make up lectures but if there are students with conflicts during those times a make-up exam will be scheduled.

**Term Paper and Presentation:**

The term paper and presentation are described in a separate document. The final draft of the term paper and a presentation of the work will be due at and constitute the final examination.

**iClicker Questions:**

Due to the large size of the class, I will be using iClickers to check on your understanding of individual topics. You can expect that I might ask clicker questions in class at any time. If you are not in class you will receive a zero on the question. There is no requirement that you attend class. However, your grade on the iClickers will be affected by lack of attendance.
The iClicker questions will be graded taking the top 80% of the answers. I may ask more than one iClicker question per class or I may ask none. Given the 20% allowed missed answers I will not be accepting excused absences for missed iClicker questions. If you lose your iClicker get a new one and let me know so that we can register it. By this approach you have an automatic excused absence for 20% of the iClicker questions.

Please note that if I catch you responding with someone else’s clicker then both you and they will fail the course. This is equivalent to taking a test for someone else and is a violation of the student code.

**Grading Criteria:**

Your grade will be determined as follows:

- **Homework:** 10%
- **Each Hour Exam:** 22% (total 66%)
- **Term Project:** 20%
- **iClicker responses:** 4%

**The campus code of ethics will be strictly enforced.** Students copying or plagiarizing on assignments are subject to disciplinary action up to and including dismissal from the university. I am serious about that. Do your own work and do not cheat.