COURSE SYLLABUS -- Physics 5335, Fall, 2016, Physics of Semiconductors
11:00 - 11:50 am, Monday, Wednesday, and Friday, Math Room 110

Instructor: Dr. Charles W. Myles, Professor of Physics. Office: Science Room 18. Phone: 834-4563.
Office Hours: 3:00 - 4:00pm MWF, 10:00 - 11:00am TR, & by appointment.
Email: Charley.Myles@ttu.edu. A class email distribution list will be developed & we can have email discussions. I make important class announcements by email! Please check your email DAILY & tell me if you change your email address! Do you want to know more about me? If so, I suggest that you look at my Physics Department Webpage: http://www.phys.ttu.edu/~cmyles/
Course Website: http://www.phys.ttu.edu/~cmyles/Phys5335/5335.html.

Note that parts of this page & its sub-pages are under construction/renovation!
d. Important Announcements. e. Other items about this class. Please check this page often.

Objectives
To introduce students to the basic physics of semiconductor materials. Emphasis will be on the microscopic properties most relevant to their use as electronic materials. This ISN’T a device course! (Physics 5336 IS a device course!) This course is designed to complement & supplement Physics 5304 (Solid State) NOT to replace it! This course should NOT be taken instead of Physics 5304!

Expected Learning Outcomes
Upon successful completion of this course, students will be able to:
1. Understand the basic physical and electronic characteristics of crystalline semiconductor materials.
2. Understand the physical origins of electronic energy bands, lattice vibrational spectra, and other microscopic physical properties of semiconductors.
3. Understand, in broad outline, the standard theory techniques used to calculate electronic energy bands, lattice vibrational spectra, and other microscopic physical properties of semiconductors, and also be able to apply these techniques to simple model materials.
4. Understand the underlying microscopic physics behind the transport properties of semiconductors (electronic, magnetic, and thermal conduction and related properties).
5. Be able to use semi-classical methods to calculate various transport properties of some semiconductor materials.
6. Understand basic optical properties of semiconductors and be able to calculate some of these in special cases.

Assessments of Learning Outcomes
The expected learning outcomes for the course will be assessed through certain problems on the homework, certain problems on the mid-term exam, and by a semester project for which the student writes a paper and also gives an oral presentation on the work.

Student Responsibilities: Come to class prepared, do the homework, read the material before I lecture over it, and keep up as we go along.

Physics Level
This course is for MS & PhD students interested in semiconductors. Engineering students are welcome! Some knowledge of elementary quantum mechanics & elementary statistical physics is assumed. Some knowledge of elementary solid state physics would be helpful, but isn’t essential. This is a graduate course. It would help (but isn’t vital) if you had (at least) a senior level solid state physics course at the level of the book by C. Kittel. Our text level is between some undergraduate & graduate texts.

Textbook

Supplements
Not required, but useful to have, especially if you do semiconductor materials-related research.
Other Possible Supplements

There are many books on semiconductors & devices at various levels of depth & difficulty. In Room 18, I have shelves full of them! The library has many more. Mine are available to look at & check out. In a graduate course, I expect you to go to sources other than the texts to obtain different treatments of the material! I’ll sometimes lecture from outside the text. The text & the supplements have extensive bibliographies for each chapter. USE THEM! Web resources are abundant!

Course Topics and Lectures

The order of topics will be approximately the same in the text by Balkanski & Wallis. However, material from the supplemental texts & other sources (research notes, published papers, etc.) will often be used. The topics will be a survey of basic, microscopic semiconductor materials physics. As a survey, each topic must be covered rapidly. A goal is to cover, as an overview, selected topics in Chs. 1-10 of the text. Detailed coverage will be announced as we go. An approximate schedule of topics is below.

Grades

Homework = 40%, Midterm Exam = 30%, Project = Paper + Presentation = 30%.

Grades are based on homework, one exam & a project with a paper and a class presentation.

Homework

Homework problems will be assigned regularly. Doing it is your best means of learning physics! It is impossible to do this without working problems! Homework is due at 5pm on the due date. To keep up, do assignments as soon as material is covered. Problems are NON-TRIVIAL! If you wait to the last day, you likely will run into trouble! No late homework will be accepted. Homework may be done individually or in consultation with others.

The latter is encouraged; this is how scientists & engineers work in real situations!

Exam

There will be one exam near midterm. This will be a mostly qualitative exam with for which most answers should be in English sentences, not mathematical formulas. It will be aimed at evaluating the students’ grasp of the physics & identification of the most relevant physical processes. Also, it may have a take home portion with problems to assess progress in using relevant mathematical tools.

Semester Project

Library Research Paper + Presentation: On an advanced topic or application of semiconductor physics that we don’t have time for in class. The paper is due near the end of the semester. Oral presentations on the same subject will take place then. Please have the topic picked by mid-semester. Topics must be approved by me before you begin. The paper should be 5 to 10 typed pages & written in the style of a scientific paper, with all sources properly cited. The presentation should be about 0.5 hour long. It can be (but isn’t required to be!) done in Power Point.

Approximate Grade Scale: 100 ≥ A ≥ 90 > B > 78 > C ≥ 65 > D ≥ 52 > F ≥ 0

Approximate Lecture Schedule

(Balkanski & Wallis = B, Yu & Cardona = Y, Seeger = S)

<table>
<thead>
<tr>
<th>Topic</th>
<th>Chapters</th>
<th>Approx. No. of Lectures</th>
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<tbody>
<tr>
<td>1. Introduction &amp; Survey:</td>
<td>B, Ch. 1; Y, Ch 1; S, Ch 1</td>
<td>3</td>
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<tr>
<td>2. Electronic Energy Bands (Basics):</td>
<td>B, Ch. 2; Y, Ch 2; S, Ch 2</td>
<td>3</td>
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<tr>
<td>3. Electronic Energy Bands (Semiconductors):</td>
<td>B, Ch. 3; Y, Ch 2; S, Ch 2</td>
<td>4</td>
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<tr>
<td>4. Kinematics &amp; Dynamics of Electrons &amp; Holes:</td>
<td>B, Ch. 4; Y, Ch. 5; S, Ch 4</td>
<td>4</td>
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<tr>
<td>5. Electronic Effects of Impurities &amp; Defects:</td>
<td>B, Ch. 5; Y, Ch 4</td>
<td>3</td>
</tr>
<tr>
<td>6. Semiconductor Statistics:</td>
<td>B, Ch. 6; S, Ch 3</td>
<td>3</td>
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<tr>
<td>7. Lattice Vibrations; Phonons:</td>
<td>B, Ch. 7; Y, Ch 3</td>
<td>4</td>
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<tr>
<td>8. Charge Carrier Scattering/Transport (selected):</td>
<td>B, Ch. 8; Y, Ch. 5; S, Chs. 4, 5</td>
<td>4</td>
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<tr>
<td>9. Diffusion (selected):</td>
<td>S: Ch. 5</td>
<td>2</td>
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<tr>
<td>10. Surfaces and Interfaces:</td>
<td>B, Ch. 9; Y, Ch. 8; S, Ch 14</td>
<td>3</td>
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<td>11. Optical Properties (selected):</td>
<td>B, Ch. 10; Y, Chs 6 &amp; 7; S, Chs 11 &amp; 12</td>
<td>3</td>
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<tr>
<td>12. “Hot” Electrons &amp; Breakdown:</td>
<td>Y, Ch 5; S, Chs. 6, 10</td>
<td>2</td>
</tr>
<tr>
<td>13. Quantum Confinement:</td>
<td>B, Ch. 20; Y, Ch 9; S, Chs 9 &amp; 14</td>
<td>2</td>
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TOTAL 40

This is not meant to be rigid, but to give us an idea where we are going. Some topics in some chapters may be omitted; some topics from outside sources will be included.
IMPORTANT DATES

Thurs., Sept. 1: Last day to add a course.
Wed., Sept. 14: Last drop date with refund.
Mon., Oct. 31: Last drop date.
Wed., Dec. 7: Last class.

Mon., Sept. 5: Labor Day, NO CLASS!
Wed., Nov. 23-Sun., Nov. 27: Thanksgiving, NO CLASS!
Mon., Dec. 19: Grades are due!

Thurs., Oct. 20-Sat., Oct. 22: I will be out of town! I’ll try to arrange a substitute for Fri., Oct. 21

TO BE SCHEDULED: Fri, Dec 9 – Wed, Dec 19 (Final Exam time): Student presentations.

ACADEMIC INTEGRITY

Academic dishonesty will not be tolerated. Students caught in this type of behavior will be punished to the fullest extent allowed by TTU. See TTU Student Handbook or Catalogue.

CLASSROOM CIVILITY AND ETIQUETTE

Students are expected to assist in maintaining an environment which is conducive to learning. To assure that everyone has an opportunity to gain from class time, you are expected to adhere to the following

Simple Rules of Classroom Etiquette

1. In the classroom, students are prohibited from using cell phones (either talking OR texting!), eating/drinking, making offensive remarks, reading newspapers or other unrelated material, visiting with your neighbor, sleeping or engaging in other forms of distraction. Inappropriate behavior of this kind shall result in, minimally, a request to leave class.

2. It is extremely rude, to both the instructor and to other students, to leave during a lecture or to arrive very late. Since attendance of lectures is optional, please do not come to class if you are unable to attend for the full duration or if you are not able to arrive on time! Physical illness is an obvious exception to this rule. Since class begins at Noon, “oversleeping” is never an excuse for lateness. If you have an expected reason to leave early, please tell the instructor at the beginning of class and sit in a convenient location for leaving without disturbing the class.

DISABILITY STATEMENT

Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact the instructor as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services during the instructor’s office hours. Please note instructors are not allowed to provide classroom accommodations to a student until appropriate verification from Student Disability Services has been provided. For additional information, you may contact the Student Disability Services office in 335 West Hall or 806-742-2405.