PHYS 704
Solid State Physics
Spring 2018

Instructor: Can Ataca
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Prerequisite: PHYS 604 (Solid State Physics 1)
Lecture Hours: Monday, Wednesday, Friday 11:00-11:50 AM
Classroom: Sherman Hall 011
Textbook: Charles Kittel, *Introduction to Solid State Physics,* ISBN: 0-471-41526-X
(Recommended) Neil W. Ashcroft, N. David Mermin, *Solid State Physics*, ISBN: 978-0-03-083993-1
(Recommended) M. Ali Omar, *Elementary Solid-State Physics*, ISBN: 978-0-20-160733-8

Course Objectives: This course focuses on the electronic, optical, magnetic and dielectric properties of materials. The course starts with a discussion of the free-electron model in metals, whereby the valence electrons are assumed to be free particles. A more realistic treatment of these electrons is provided on energy bands in solids. Next semiconductors are introduced. The detailed coverage of these substances is warranted not only by their highly interesting and wide-ranging properties, but also by the crucial role played by semiconductor devices in today's technology. The next discussion will examine what happens to a solid when an electric field, static or alternating, penetrates the solid. The field polarizes the positive and negative charges in the medium; the effects of polarization on the dielectric and optical properties will be discussed. The course will then introduce the magnetic properties of matter and the fascinating phenomenon of superconductivity.

At the end of this course, you should be able to:

1. Define the free electron Fermi gas and derive its properties such as heat capacity, electrical and thermal conductivities of metals.
2. Have a detailed understanding of the energy band structures, semiconductor statistics, electrical conductivity and mobility, magnetic field effects, high electric field and hot electrons, photoconductivity, luminescence and acoustoelectric effects.

3. Derive current/voltage relations of p-n junctions, tunnel diodes, field-effect transistors, LEDs and semiconductor laser.
4. Construct a Fermi surface and calculate its energy bands with different models such as tight binding or the Wigner-Seitz method.
5. Understand the response of solids under an applied electric field, and the effects of polarization on the dielectric and optical properties. Define plasmon, polariton, polaron and exciton.
6. Specify the magnetic ordering of materials and their corresponding properties
7. Know the current understandings of superconducting materials.

Grading: Your final grade will be determined by:

Final Exam:	25%
2 Mid-Term Exams:	1st 10%, 2nd 15%
Term Project	20%
Homework:	20%
Quizzes and Attendance:	10%

Your letter grade will depend on the total score. If your total grade is:

≥ 90	, your letter grade will be	"A"
$90 > X \geq 85$,	then	"A-"
$85 > X \geq 80$,	then	"B+"
$80 > X \geq 75$,	then	"B"
$75 > X \geq 70$,	then	"B-"
$70 > X \geq 65$,	then	"C+"
$65 > X \geq 60$,	then	"C-"
$60 > X \geq 55$,	then	"D"
$55 > X$,	then	"F"

Midterms and Final Exam: Two mid-term exams will take place during the semester, during the scheduled class time. The dates of the mid-term exams are March 9th (Fri.) and April 13th (Fri.) 2018. These dates may be subject to change. The date of the final exam is determined by the university and it is on May 18th 2018 (10:30 AM-12:30 PM) Exams will include all the course material covered up to the day of the exam, if not informed otherwise. All of the exams are closed book. At least one question of each exam will be similar to the ones given in

homework/quizzes. You may bring one page of **YOUR** hand-written notes into exams. (no photocopies, print-outs are allowed.)

Quizzes and Attendance: Attendance (more than %60) is expected, but it will not have an effect on the final grade. Quizzes will be closed book exams, might take place in any time of the class and it can be an attendance-based quiz, as well.

Homework: Homework assignments will be available on the Blackboard page every Friday and are due at the beginning of the class next Friday, unless you are told otherwise. No late assignments will be accepted. I planned to assign weekly (~total of 14) homeworks. The top 10 highest graded homeworks will be counted towards your grading. This is meant to allow for things that come up unexpectedly.

Term Project: You will be given a task of writing a detailed report on an assigned subject and be required to present your subject within a 2 class-hours. The subject will be assigned at least a month before the deadline.

Topics to be covered:

Weeks	Subject
1-2	Free Electron Fermi Gas
2	Energy Bands
3-4	Semiconductor Theory
4-5	Semiconductor Devices
6	Fermi Surface and Metals
7-8	Plasmon, Polariton and Polarons
8-9	Dielectrics and Ferroelectrics
10	Optical Processes and Excitons
11	Diamagnetism and Paramagnetism
12	Ferromagnetism and Antiferromagnetism
13-14	Superconductivity

Student Responsibilities:

-Students are responsible for checking their academic e-mails and the Blackboard page of the course daily for getting updated information about the course, grades, homeworks and class notes.

-If you need to take a make-up quiz or exam, please provide a university-approved excuse (such as a nurse/doctor signed document).

Academic Integrity: By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal.