Department of Physics and Engineering, Point Loma Nazarene University

PHY 443 – Solid State Physics – 3 Units

Spring 2019

Professor: Dr. Michelle Chen **E-mail:** MichelleChen@pointloma.edu
Office: Gym Lot, Trailer #2/RS 264 by 2/4/19 **Office Phone:** 619-849-2960
Office Hours: M 8:00 – 10:00 am, 12:00 – 12:30 pm;
T 12:00 – 12:30 pm;
W 8:30 – 9:30 am;
R 12:00 – 12:30 pm;
F 8:30 – 9:30 am;
and by appointment

Lecture: MWF M 7:25 – 8:20 am, (LA 102)
Final Exam: 7:30 – 10:00 am, Wednesday May 1, 2019.

Textbook: Introduction to Solid State Physics, by Charles Kittel, 8th edition, 2005.

Course Description: An introduction to the study of solids, including crystal structure, reciprocal lattices, crystal binding, phonons, and electron band theory.

Learning Outcomes: This course supports the overall learning objectives of the physics and engineering programs in building your ability: (1) to apply physical principles, mathematical reasoning, and computational techniques to solve real-world problems (LO2), (2) to demonstrate good ethics in science (LO4), and (3) to effectively communicate complicated technical information (LO5).

PLNU Mission: PLNU exists to provide higher education in a vital Christian community where minds are engaged and challenged, character is modeled and formed, and service is an expression of faith. Being of Wesleyan heritage, we strive to be a learning community where grace is foundational, truth is pursued, and holiness is a way of life.

Department Mission: The Physics and Engineering Department at PLNU provides strong programs of study in the fields Physics and Engineering. Our students are well prepared for graduate studies and careers in scientific and engineering fields. We emphasize a collaborative learning environment which allows students to thrive academically, build personal confidence, and develop interpersonal skills. We provide a Christian environment for students to learn values and judgment and pursue integration f modern scientific knowledge and Christian faith.

Attendance and Participation: Attendance is expected at each class session. In the event of an absence you are responsible for the material covered in class and the assignments given that day.

Regular and punctual attendance at all classes is considered essential to optimum academic achievement. If the student is absent from more than 10 percent of class meetings, the faculty member can file a written report which may result in de-enrollment. If the absences exceed 20 percent, the student may be de-enrolled without notice until the university drop date or, after that date, receive the appropriate grade for their work and participation. See Attendance Policy in the in the Undergraduate Academic Catalog.

Class Enrollment: It is the student's responsibility to maintain his/her class schedule. Should the need arise to drop this course (personal emergencies, poor performance, etc.), the student has the responsibility to follow through (provided the drop date meets the stated calendar deadline established by the university), not the instructor. Simply ceasing to attend this course or failing to follow through to arrange for a change of registration (drop/add) may easily result in a grade of F on the official transcript.

Academic Accommodations: While all students are expected to meet the minimum standards for completion of this course as established by the instructor, students with disabilities may require academic adjustments, modifications or auxiliary aids/services. At Point Loma Nazarene University (PLNU), these students are requested to register with the Disability Resource Center (DRC), located in the Bond Academic Center. (DRC@pointloma.edu or 619-849-2486). The DRC's policies and procedures for assisting such students in the development of an appropriate academic adjustment plan (AP) allows PLNU to comply with Section 504 of the Rehabilitation Act and the Americans with Disabilities Act. Section 504 (a) prohibits discrimination against students with special needs and guarantees all qualified students equal access to and benefits of PLNU programs and activities. After the student files the required documentation, the DRC, in conjunction with the student, will develop an AP to meet that student's specific learning needs. The DRC will thereafter email the student's AP to all faculty who teach courses in which the student is enrolled each semester. The AP must be implemented in all such courses.

If students do not wish to avail themselves of some or all of the elements of their AP in a particular course, it is the responsibility of those students to notify their professor in that course. PLNU highly recommends that DRC students speak with their professors during the first two weeks of each semester about the applicability of their AP in that particular course and/or if they do not desire to take advantage of some or all of the elements of their AP in that course.

Academic Honesty: Students should demonstrate academic honesty by doing original work and by giving appropriate credit to the ideas of others. Academic dishonesty is the act of presenting information, ideas, and/or concepts as one's own when in reality they are the results of another person's creativity and effort. A faculty member who believes a situation involving academic dishonesty has been detected may assign a failing grade for that assignment or examination, or, depending on the seriousness of the offense, for the course. Faculty should follow and students may appeal using the procedure in the university Catalog. See the catalog for definitions of kinds of academic dishonesty and for further policy information.

Final Exam: Date and Time: The final exam date and time is set by the university at the beginning of the semester and may not be changed by the instructor. This schedule can be found on the university website and in the course calendar. No requests for early examinations will be approved. Only in the case that a student is required to take three exams during the same day of finals week, is an instructor authorized to consider changing the exam date and time for that particular student. Final Exam for this course is at 7:30 – 10:00 am on Wednesday May 1, 2019.

Copyright Protected Materials: Point Loma Nazarene University, as a non-profit educational institution, is entitled by law to use materials protected by the US Copyright Act for classroom education. Any use of those materials outside the class may violate the law.

Credit Hour: In the interest of providing sufficient time to accomplish the stated course learning outcomes, this class meets the PLNU credit hour policy for a 3 unit class delivered over 15 weeks. Specific details about how the class meets the credit hour requirements can be provided upon request.

Pre-Class: In preparation for each class meeting there is a reading assignment. Because class meetings are not a standard lecture format, these reading assignments are very important to help you come prepared to class. To complete the reading assignment you must answer a few questions and submit them electronically through Canvas by 7:00 am before class. Late submissions will not be accepted. This electronic communication is so important because it is your voice in what material we emphasize during class meetings and provides me constant feedback of your understanding of the material. These submissions will be graded on the following scale: 2 = demonstrates reading, 1 = room for improvement, 0 = unsatisfactory. These points are accumulated and are worth 10% of the final grade.

Homework: Homework will be given almost every week. You are strongly encouraged to work and discuss in a group, but you must turn in your own work. No late homework will be accepted except for warranted prearranged circumstances.

Exam: There will be two in-class exams during the semester, and a comprehensive final research project presentation during final exam week. Exams will be closed book, but a sheet of formulas will be provided to you to use during your exam. Partial credit will be given for correct reasoning at any step of a problem, but only if it is communicated clearly enough for me to understand. For problems that call for solution or explanation, no credit will be given for an answer alone; the method or reasoning must also be shown. Exams are to be taken at the time indicated in the syllabus unless other arrangements are made in advance with the professor for some unavoidable circumstance, and otherwise cannot be made up. You must take ALL the exams in order to pass the class. **Final Examination Policy:** Successful completion of this class requires taking the final examination **on its scheduled day (Wednesday May 1, 2019, 7:30 – 10:00 am)**.

Assessment and Grading: The points you receive during the course are weighted accordingly:

Pre-Class	10 %
Homework	20 %
Exams	50 %
Final Research Project	20 %

The grade you earn in this course is based on the following scale:

A	A-	B+	B	B-	C+	C	C-	D+	D	D-
S≥ 91.0	91.0 >S≥ 89.5	89.5 >S≥ 87.5	87.5 >S≥ 81.0	81.0 >S≥ 79.5	79.5 >S≥ 77.5	77.5 >S≥ 71.0	71.0 >S≥ 69.5	69.5 >S≥ 67.5	67.5 >S≥ 61.0	61.0 >S≥ 57.0

PHY443: Solid State Physics (Spring 2019)

(Tentative Syllabus, Subject to Updates)

Date	Topic	Reading	Page
T 01/08/19	Introductions	None	
W 01/09/19	Crystal Structure I	Chapter 1	pp.1-11
F 01/11/19	Crystal Structure II	Chapter 1	pp. 11-22
M 01/14/19	Crystal Structure II	Chapter 1	pp. 11-22
W 01/16/19	The Bragg Law, Scattered Wave Amplitude	Chapter 2	pp. 23-32
F 01/18/19	Brilliouin Zones	Chapter 2	pp. 33-38
M 01/21/19	**No Class (Martin Luther King Jr. Day)**		
W 01/23/19	Fourier Analysis of the Basis	Chapter 2	pp. 39-43
F 01/25/19	Fourier Analysis of the Basis	Chapter 2	pp. 39-43
M 01/28/19	Binding in Crystals	Chapter 3	pp. 47-60
W 01/30/19	Binding in Crystals II	Chapter 3	pp. 60-70
F 02/01/19	Elasticity in Crystals	Chapter 3	pp. 73-85
M 02/04/19	Elasticity in Crystals	Chapter 3	pp. 73-85
W 02/06/19	Crystal Vibrations I: Monoatomic Basis	Chapter 4	pp. 89-99
F 02/08/19	Crystal Vibrations II: Two Atoms	Chapter 4	pp. 99-102
M 02/11/19	Crystal Vibrations II: Two Atoms	Chapter 4	pp. 99-102
W 02/13/19	Phonon Heat Capacity	Chapter 5	pp. 105-117
F 02/15/19	Phonons, Plank's Distribution, Phonon Density of States	Chapter 5	pp. 117-121
M 02/18/19	Phonon Density of States, Debye Aapproximation	Chapter 5	pp.121-127
W 02/20/19	Debye, Einstein Approximation, Thermal Conductivity	Chapter 5	
F 02/22/19	Thermal Conductivity, Umclapp Scattering, Review	Chapter 5	
M 02/25/19	The Electron Gas; Specific Heat	Chapter 6	pp. 134-147
W 02/27/19	**Test #1 (Chapters 1 - 5)**		
F 03/01/19	The Hall Effect and Thermal Conductivity	Chapter 6	pp. 163-169
M 03/04/19	***No Class (Spring Break)***		
W 03/06/19	***No Class (Spring Break)***		
F 03/08/19	***No Class (Spring Break)***		
M 03/11/19	Nearly Free Electrons, Energy Bands	Chapter 6	pp. 169-182
W 03/13/19	Nearly Free Electrons, Bloch Functions, Kronig-Penny Model		
F 03/15/19	Wave Equation of Electron	Chapter 7	pp. 163-169
M 03/18/19	Nearly Free Electrons, Bloch Functions, Kronig-Penny Model	Chapter 7	pp. 169-180
W 03/20/19	Continue; Wave Equations of Electrons	Chapter 7	pp. 180-182
F 03/22/19			
M 03/25/19	Central Equation at Zone Boundary	Chapter 7	pp. 176 - 182
W 03/27/19	Direct and Indirect Optical Absorbtion (Project Guidelines)	Chapter 8	pp.186-191
F 03/29/18	Equatino of Motion; Effective Mass, Intrinsic Carrier Concentration	Chapter 8	pp.191-209
M 04/01/19	Impurity Conductivity, Donors and Acceptors	Chapter 8	pp. 209-217
W 04/03/19	Nanostructures	Chapter 18	
F 04/05/19	Nanostructures	Chapter 18	
M 04/08/19	Nanostructures	Chapter 18	
W 04/10/19	Superconductors	Chapter 10	
F 04/12/19	Superconductors	Chapter 10	
M 04/15/19	Review / Catch-Up		
W 04/17/19	**Test #2**		
F 04/19/19	***No Class (Easter Break)***		
M 04/22/19	***No Class (Easter Break)***		
W 04/24/19	Catch Up / Work on Project		
F 04/26/19	Catch Up / Work on Project		
M 04/29/19			
W 05/01/19	**Final Exam (7:30 - 10:00 am)**		
F 05/03/19			