### **CONDENSED MATTER**

PHY 436

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Text: J. R. Hook. and H. E. Hall, <u>Solid State Physics</u>, 2nd. Ed., Wiley, 1991.

#### I. Course Outline

1. Crystal Structures (Ch. 1)

Elementary crystallography. Typical crystal structures. X-ray crystallography. Interatomic forces. Homework 1.- 1.1, 1.3, 1.9 & Additional Problems 1

2. Crystal Dynamics (Ch. 2)

Sound waves. One dimensional lattice vibrations. Phonons. Heat capacity from lattice vibrations. Anharmonic effects. Homework 2.- 2.1, 2.5, 2.7& Additional Problems 2

3. Free Electrons in Metals (Ch. 3)

Free electron model. Transport properties of the conduction electrons. Homework 3.- 3.2, 3.3, 3.6 & Additional Problems 3

4. Energy Bands (Ch. 4)

Nearly free electron theory. Metals, insulators and semiconductors. The tight binding approximation. Band structure effective masses. Homework 4.- 4.1, 4.3, 4.4 & Additional Problems 4

### Midterm

#### (TBD)

5. Semiconductors (Ch. 5)

Electrons and holes. Impurities. Absorption of electromagnetic radiation. Transport properties. Non-equilibrium carrier densities. Homework 5.- 5.1, 5.3, 5.5 & Additional Problems 5

6. Semiconductor devices (Ch. 6)

The p-n junction. Devices based on the p-n junction, Metal-oxide semiconductor technology. Molecular beam epitaxy and semiconductor technology.

 Scattering of Neutrons, Electrons, and Photons from Solids (Ch. 12) Rayleigh and Raman scattering. Raman and photoluminescence techniques. Comparison of X-rays, neutrons and electrons. Neutron scattering techniques. Determination of phonon spectra. Electron scattering.

#### Final Exam

#### **II.** Assessment of Student Performance

- 1. midterm test (15 points)
- 2. final exam (30 points)
- 3. homework problems (10 points)

Homework problems are due one week after the corresponding chapter has been completed in the lectures unless otherwise noted. Late homework will not be accepted. Homework should be presented in an <u>ordered and neat presentation;</u> points will be deducted for lack of these.

- 4. Computer project (10 points)
- 5. Seminar project (20 points)
- 6. Additional Projects (15 points): Atomic force microscope, scanning electron microscope, 3D printer.

Grading Scale		
Final Score	Letter Grade	
92.5 - 100	А	
89.5 - 92.4	A-	
86.5 - 89.4	B+	
82.5 - 86.4	В	
79.5 - 82.4	В-	
76.5 - 79.4	C+	
72.5 - 76.4	С	
69.5 - 72.4	C-	
66.5 - 69.4	D+	
59.5 - 66.4	D	
0-59.4	F	

### **III. Bibliography**

Ashcroft, N. W. and Mermin, N. D., "Solid State Physics," Rinehart and Winston (1976). Harrison, W. A., "Solid State Theory," Dover (1979).

Hofmann, "Solid State Physics," 2nd ed. Wiley-VCH (2015).

- Kittel, C., "Introduction to Solid State Physics," 6th ed. Wiley (1986).
- Myers, H. P., "Introductory Solid State Physics," Taylor and Francis (1990).

Turton, R., "The Physics of Solids," Oxford (2000)

#### Seminar Project Topics

Atomic force and Scanning tunneling microscopy Fullerenes Giant magnetoresistive effect Graphenes

Micro electromechanical devices (MEMS)

Photonic Crystals

Photovoltaics and solar cells

Quantum dots Scanning and Transmission electron microscopy Semiconductor lasers and LEDs Superconductivity X-ray diffraction methods

### Fourth Hour:

In this class, the deep learning outcomes associated with TCNJ's 4<sup>th</sup> hour are accomplished by a series of rigorous educational assignments that extend beyond the typical scheduled class time. These include extensive out-of-class problem sets and group work.

# SELECTED TCNJ POLICIES

### **Final Examinations**

The final exam is not scheduled until the middle of the semester. Therefore do not plan on any travel until after the last day of the exam period. TCNJ's final examination policy is available on the web:

http://academicaffairs.pages.tcnj.edu/college-governance/policies/final-examevaluationreadingdays-policy/

# Attendance

Every student is expected to participate in each of his/her courses through regular attendance at all class sessions. It is further expected that every student will be present, on time, and prepared to participate when scheduled class sessions begin. While attendance itself is not used as a criterion for academic evaluations, grading in this course is based on participation in quizzes to be given at the beginning of several classes. No make-ups or extensions will be given unless a student has a genuine emergency. If a student misses an exam or assignment deadline they must contact the instructor within 36 hours to explain the situation; otherwise the student will earn a zero for that exam or assignment.

Students who must miss classes due to participation in a field trip, athletic event, or other official college function or for a religious holiday should arrange with their instructors for such class absences well in advance. In every instance, however, the student has the responsibility to initiate arrangements for make-up work.

TCNJ's full attendance policy is available at:

http://policies.tcnj.edu/policies/digest.php?docId=9134

# **Academic Integrity Policy**

Academic dishonesty is any attempt by the student to gain academic advantage through dishonest means, to submit, as his or her own, work which has not been done by him/her or to give improper aid to another student in the completion of an assignment. Such dishonesty would include, but is not limited to: submitting as his/her own a project, paper, problem set, report, test, or speech copied from, partially copied, or paraphrased from the work of another (whether the source is printed, under copyright, or in manuscript form). Credit must be given for words quoted or paraphrased. The rules apply to any academic dishonesty, whether the work is graded or ungraded, group or individual, written or oral.

TCNJ's academic integrity policy is available at:

# http://policies.tcnj.edu/policies/viewPolicy.php?docId=7642

# Americans with Disabilities Act (ADA) Policy

Any student who has a documented disability and is in need of academic accommodations should notify the professor of this course and contact the Office of Differing Abilities Services (609-771-2571). Accommodations are individualized and in accordance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1992. TCNJ's Americans with Disabilities Act (ADA) policy is available at: http://affirm.pages.tcnj.edu/key-documents