# CONDENSED MATTER

PHY 436

Instructor: Dr. Romulo Ochoa e-mail:ochoa@tcnj.edu
SC-P132 PH: 771-3162

Text: J. R. Hook. and H. E. Hall, Solid State Physics, 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.

7. 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 (TBD)

**II. Assessment of Student Performance**

1. midterm test (20 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 ordered and neat presentation; points will be deducted for lack of these.
4. Computer project (10 points)
5. Seminar project (30 points)

| Grading Scale | |
|---|---|
| Final Score | Letter Grade |
| 92.5 - 100 | A |
| 89.5 – 92.4 | A- |
| 86.5 – 89.4 | B+ |
| 82.5 – 86.4 | B |
| 79.5 – 82.4 | B- |
| 76.5 – 79.4 | C+ |
| 72.5 – 76.4 | C |
| 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).
Feynman, R. P., "Lectures on Physics," Addison-Wesley (1965).
Harrison, W. A.,"Solid State Theory," Dover (1979).
Hecht, "Optics," 2nd ed. Addison-Wesley (1987).
Kittel, C., "Introduction to Solid State Physics," 6th ed. Wiley (1986).
Myers, H. P., "Introductory Solid State Physics," Taylor and Francis (1990).
Pankove, J. I., "Optical Processes in Semiconductors," Dover (1975).
Turton, R., "The Physics of Solids," Oxford (2000)


Seminar Project Topics

Atomic force microscopy
Co-crystals
Diamagnetism and Paramagnetism
Ferromagnetism
Fullerenes
Giant magnetoresistive effect
Graphenes

Micro electromechanical devices (MEMS)
Nanodiamonds
Photonic Crystals
Photovoltaics and solar cells
Piezoelectricity
Quantum dots
Quantum Hall effect
Scanning electron microscopy
Scanning tunneling microscope
Semiconductor lasers and LEDs
Superconductivity
Transmission electron microscopy
X-ray diffraction methods

**IV. Attendance**

Students are expected to attend class but if they choose not to this will have no negative effect on their grade. Students that do attend and participate or show effort in class may receive extra credit on their tests.
No makeup labs, tests, or exams will be given unless there is an emergency situation. In that case students are expected to contact the instructor no later than 24 hours after the missed lab or test; otherwise they will be given a zero grade for the missed evaluation.

TCNJ's attendance policy can be found at: http://www.tcnj.edu/~recreg/policies/attendance.html

**V. 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, 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 on the web:*
http://www.tcnj.edu/~academic/policy/integrity.html.

**VI. 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 on the web:*
http://www.tcnj.edu/~affirm/ada.html .