

PHYCS 466 Condensed Matter Physics 1

Course Description

Structure and physical properties of matter in the solid state. Electrical and magnetic properties and band theory of solids, with application to semiconductors and metals. (3 credit hours)

Prerequisite: PHYC 260.

Course Objectives

A course objective is to introduce to the student the physical properties of solids including the electrical, magnetic, optical, thermal and mechanical properties. A second objective is to relate and guide the study of the classical, semi-classical, and quantum theories forming the basis for our understanding of condensed matter. The structure, symmetry, and bonding in solids determine in part the properties of solids and an objective of this course is the development of student understanding of these impacts. Students will also learn about the technological applications of condensed matter physics through examples highlighted in this course.

Course Rationale

Modern technology relies to a large extent on solid-state and other condensed matter devices and systems. Rapid technological advances have occurred as a result of our increased understanding of the properties of condensed matter. This course offers students the opportunity to learn the fundamentals of solid state physics as an introduction to the wider area of condensed matter physics. This knowledge is essential for persons conducting research and development on condensed matter technology, working in technical positions in industrial and government laboratories, or pursuing graduate studies in condensed matter physics.

Course Content, Format, and Bibliography

Content

Course topics include

- Crystal structure and the reciprocal lattice
- Thermal properties of solids and phonons
- Electronic structure and energetics of solids
- Free electron gases
- Band theory: metals, semiconductors and insulators
- Electrical properties and phenomena

Optical processes

Magnetic properties and phenomena

Materials characterization techniques and experiments

Mesoscopic physics topics

Format

A multi-faceted approach is used in this course, with classes consisting of multimedia lectures in the classroom, student presentations, and computer simulation sessions in departmental labs. The student will also learn from web-based, textbook, and supplementary study assignments and by working assigned problems. Course papers and student presentations on selected topics are typically required. Examinations, the grading of problem solutions, the submission and grading of the results of computer simulations of condensed matter phenomena, and the evaluation of student course papers and presentations monitor student progress in the course.

This course is taught as a dual undergraduate/graduate course. Students will be required to complete activities appropriate for the level of the course in which they are enrolled. Student performance on homework, exams and/or labs will be evaluated using different standards for undergraduate and graduate students.

Bibliography

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P. Taylor and O. Heinonen, *A Quantum Approach to Condensed Matter Physics*, Cambridge University Press, 2002.

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N. Ashcroft and N. Mermin, *Solid State Physics*, Holt, Rinehart and Winston, 1976.

R. Hummel, *Electronic Properties of Materials*, 3rd ed., Springer-Verlag, 2001.

Philip Hofmann, *Solid State Physics*, Wiley-VCH, 2008.

J. Hook and H. Hall, *Solid State Physics*, 2nd ed., John Wiley & Sons, 1995.

J. Ziman, *Principles of the Theory of Solids*, 2nd ed., Cambridge University Press, 1972.