UNIVERSITY OF PUERTO RICO
RIO PIEDRAS CAMPUS
COLLEGE OF NATURAL SCIENCES
DEPARTMENT OF PHYSICS
UNDERGRADUATE PROGRAM

Title: Introduction to Solid State Physics

Code: PHYS 4047

Number of Credits: 3

Prerequisites: PHYS 4046

Description

This is an introductory course in Solid State Physics for Physics majors. Topics included are: Crystal structure, crystal binding, elastic properties, lattice vibrations and thermal properties. The free-electron gas model, the Fermi surface and metals. Optical properties of solids, polarons, plasmons. Cooperative phenomena, ferromagnetism, ferroelectricity.

Objectives

After the completion of this course the student will able to understand the basic concepts of solid state physics. During the semester the student: will develop a comprehensive understanding of the basic issues in solid state physics, learn about the contributions of electrons and ions to the properties of the solids, will understand the intimate interplay between experiment and theory in the area of solid state physics and will learn about the relevance of solid state physics to the actual technology.

Course Content

Topic	Assigned time (hours)
1. Definition of crystal lattice. Lattice types in three dimensions (Bravais lattices). Examples. Primitive vectors. The basis. Unitary cell and conventional cell. Wigner-Seitz cell. The diamond and the hexagonal structures. BCC, FCC and SC lattices. Lattice planes. Miller indices.	3
2. Diffraction of electromagnetic waves by crystals. The reciprocal lattice. Primitive vectors. First Brillouin zone. The X-ray diffractometer	3
3. Van der Waals Interactions. Ionic Crystals. Madelung Constant. Covalent crystals. Metals. Atomic radii.	3
4. Linear chain. Monatomic basis.	3
5. Optical and acoustic modes. Normal modes. Density of states. Quantization of the lattice vibrations. Phonons.	3

6. Phonon heat capacity. Einstein and Debye models.	3
7. Anharmonic contributions. Thermal conductivity.	3
8. Fermi Dirac distribution. Density of states. Fermi energy.	3
9. Free electrons contribution to the heat capacity. Ohms law. Electron motion in electric and magnetic fields. Hall effect.	3
10. Origin of the energy gap. Bloch funtions. Kronin-Penney Model. Energy bands. Effective mass.	3
11. Holes. Crystal momentum. Electron and holes statistics.	3
12. Intrinsic semiconductors. Conductivity. Donor and acceptor ionization.	3
13. Impurity conductivity.	3
14. Optical reflectance. Index of refraction. Plasmons. Dielectric function of an electron gas.	3
15. Polaritons. Contribution of the polaritons to the dielectric function. Excitons.	3
Total hours	45 contact hours

Instructional Strategy

Lecture. Discussion with the students of typical problems. Discussion the solid state physics in the framework of industrial applications. Presentation of a collection of viewgraphs of solid specimens equipment and experimental results. Homeworks.

Minimum Require Facilities

Traditional lecture room.

Student Evaluation

The course will be evaluation with three partial exams with a weight of 20% of the evaluation and the homeworks with a weight of 40% of the evaluation.

Grading System

The overall score is determined by calculating the percentage of points obtained by the student. Grades are then assigned according to the standard curve: 100-90% = A, 89-80% = B, 79-70% = C, 69-60% = D, 59-0% = F.

Bibliography

Introductory Solid State Physics, Charles Kittel, John Wiley & Sons, 7th edition. (1996). Introductory Solid State Physics, Mayers, Taylor & Francis, UK, (1997). Solid State Physics. J. R. Hook and H.E Hall, Second Edition, John Wiley & Sons. NY (1991).

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