

# Physics 4047 - Introduction to Solid State Physics (Fonseca)

- Number of Credits: 3
- Prerequisites:
- Luis F Fonseca
- Office: FB 127
- University of Puerto Rico – Rio Piedras Campus  
Department of Physics

## Text

- Introductory Solid State Physics, Charles Kittel (Wiley) 7th edition (1996)

## Bibliography

- Introductory Solid State Physics, Mayers
- Solid State Physics. J. R. Hook and H.E Hall
- Elementary Solid State Physics, A Omar

## Minimum Required Facilities

- Traditional lecture room

## Instructional Strategy

- Lectures

## Student Evaluation

- Standard A to F grading system. Grading will depend on performance in periodic problem sets.

## 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. Semiconductors. Optical properties of solids. Cooperative phenomena, ferromagnetism, ferroelectricity.

## Objectives

After the completion of this course the student will be 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 modern technology.

## Contents

### The Crystal Lattice

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

### The Reciprocal Lattice and Xray Diffraction

Diffraction of electromagnetic waves by crystals

The reciprocal lattice

Primitive vectors

First Brillouin zone

The Xray diffractometer

### Crystal Binding

Van der Waals Interactions

Ionic Crystals

Madelung Constant

Covalent crystals

Metals

Atomic radii

### Crystal Vibrations

Dispersion relation, speed of sound

Optical and acoustic modes

Normal modes

Density of states

Quantization of the lattice vibrations

Phonons

Phonon heat capacity

Einstein and Debye models

Thermal conductivity

### Free Electron Fermi Gas

Fermi Dirac distribution

Density of states

Fermi energy

Free electrons contribution to the heat capacity

Ohms law

Electron motion in electric and magnetic fields

Hall effect

Energy Bands

Origin of the energy gap

Bloch functions

Kronin-Penney Model

Energy bands

Effective mass

Semiconductors

Holes

Crystal momentum

Electron and holes statistics

Intrinsic semiconductors

Donors and acceptors

Conductivity

Optical Properties

Optical reflectance

Index of refraction

Plasmons

Dielectric function of an electron gas

Light absorption in semiconductors

Photo and electro-luminescence

LEDs

Defects

Cooperative Phenomena

Ferroelectricity and magnetism

Phase transitions