Universidad de Puerto Rico, Recinto de Rio Piedras

Facultad de Ciencias Naturales, Departamento de Física

Título: **INTRODUCTION TO SOLID STATE PHYSICS**

Código: PHYS 4047
Créditos: 3
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Hours: Tuesday, Thursday 9:00-10:40; C-312

Prerequisites: PHYS 4046
Academic Period: Second Semester 2017-2018. Office hours Friday 10-11:30am

Course Description: The objective of this course is to give an introduction of the basic concepts of solid state physics. During the semester it is expected that 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.
- Will learn about the relevance of solid state physics to the actual technology.

Instructional Strategies. Lecture. Discussion with the students of typical problems. Discussion the solid state physics in the framework of technological applications. Presentation of a collection of viewgraphs of solid specimens, equipment and experimental results. Homework and student presentations.

Evaluation Strategies. The course will be evaluated with homework 70% and students presentations 30%.

Grading. Standard A to F system.

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).

H. PROGRAM AND TIME TABLE.

WEEK	TOPICS	APPLICATIONS, ACTIVITIES
1	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.	Bring to class: crystal models, High resolution Transmission Electron images,
2	THE RECIPROCAL LATTICE AND X-RAY DIFFRACTION Diffraction of electromagnetic waves by crystals. The reciprocal lattice. Primitive vectors. First Brillouin zone. The X-ray diffractometer. **HOMEWORK 1**	Bring to class PPT slides about UPRRP X-Ray diffractometer and x-ray patterns from real samples. Show differences between single crystal, polycrystalline, nanocrystal and amorphous samples.
3	CRYSTAL VIBRATIONS. Linear chain. Monatomic basis. The Dynamical Matrix. Optical and acoustic modes. Normal modes. Density of states. Quantization of the lattice vibrations. Phonons	Show phonon dispersion relation of real crystalline material, in particular diamond.
4	Phonon heat capacity. Einstein and Debye models. Anharmonic contributions. Thermal conductivity. **HOMEWORK 2**	Explain the case of diamond as excellent heat conductor.
5	FREE ELECTRON FERMI GAS The approximation of the free electron. Fermi Dirac distribution. Density of states. Fermi energy	Compare electrical conductivity of metals with different electron densities.
6	Free electrons contribution to the heat capacity. Ohm’s law. Electron motion in electric and magnetic fields. **HOMEWORK 3**	Explain de Hall effect.
7	ENERGY BANDS Electron energy bands. The origin of the energy gap. Bloch functions. Kronin-Penney Model. Effective mass.	Show software that calculates the eigenstates of a set of N coulombic and square wells.
8	**SEMICONDUCTORS** Holes. Crystal momentum. Electron and holes statistics. **HOMEWORK 4**	**Bring again Hall effect as a way to determine nature of carriers.**
9	Intrinsic semiconductors. Conductivity. Donor and acceptor ionization.	Photoconductivity, luminescence, and applications

10	Impurity conductivity. p-n junctions. **HOMEWORK 5**	Solar cells, LEDs
11	OPTICAL PROPERTIES Optical reflectance. Index of refraction. Plasmons. Dielectric function of an electron gas. **HOMEWORK 6**	Optical and electrical properties of ITO as transparent electrode. Optical properties of silver
12	Polaritons. Contribution of the polaritons to the dielectric function. Excitons.	The color of gems.

Accommodation of students with disabilities. Los estudiantes que requieren acomodo razonble o reciben servicios de Rehabilitación Vocacional deben comunicarse con el profesor al inicio del semestre para planificar el acomodo y equipo necesario conforme a las recomendaciones de la oficina que atiende los asuntos para personas con impedimentos en la unidad.

Academic Integrity. La Universidad de Puerto Rico promueve los más altos estándares de integridad académica y científica. El artículo 6.2 del Reglamento General de Estudiantes de la UPR (Certificación 13, 2009-2010 de la Junta de Síndicos) establece que “la deshonestidad académica incluye, pero no se limita a: acciones fraudulentas, la obtención de notas o grados académicos valiéndose de falsas o fraudulentas simulaciones, copiar total o parcialmente la labor académica de otra persona, plagiar total o parcialmente el trabajo de otra persona, copiar total o parcialmente las respuestas de otra persona, plagiar total o parcialmente el trabajo de otra persona, copiar total o parcialmente las respuestas de otra persona a las preguntas de un examen, haciendo o consiguiendo que otro tome en su nombre cualquier prueba o examen oral o escrito, así como la ayuda o facilitación para que otra persona incurra en la referida conducta”. Cualquiera de estas acciones estará sujeta a sanciones disciplinarias en conformidad con el procedimiento disciplinario establecido en el Reglamento General de Estudiantes de la UPR vigente.