

University of Puerto Rico  
Mayagüez Campus  
College of Engineering  
Department of General Engineering  
Master of Science and Engineering

## Course Syllabus

### 1. General Information:

Alpha-numeric codification: : CIIM 6006  
Course Title: STRUCTURE AND PROPERTIES OF MATERIALS  
Number of credits: 3  
Contact Period: 3 hours of lecture per week

### 2. Course Description:

**English:** Study of solid-state physics applied to functional materials, which will allow the explanation of the synthesis-structure-properties relationship and its application to materials processing. Discussion of the relationship between crystal structure and the phenomenon of diffraction, structural defects, lattice vibration, and their relationship with the thermal properties of materials. In addition, the principles of the semiconducting and superconducting behavior of materials will be studied, as well as the mechanistic bases of high- and low-temperature materials synthesis options, including nucleation and diffusion processes.

**Spanish:** Estudio de la física del estado sólido aplicada a materiales funcionales que permitirá explicar la relación síntesis-estructura-propiedades y su aplicación al procesamiento de materiales. Discusión de la relación entre la estructura cristalina y el fenómeno de difracción, los defectos estructurales, la vibración de la red atómica y su relación con las propiedades térmicas de los materiales. Se estudiarán, además, los principios del comportamiento semiconductor y superconductor de los materiales así como las bases mecánicas de las opciones de síntesis de materiales a alta y baja temperatura, incluyendo los procesos de nucleación y difusión.

### 3. Pre/Co-requisites and other requirements:

Graduate student with permission of the Program Coordinator.

### 4. Course Objectives:

By the end of the course students will:

- Review physics and chemistry in the context of materials science.
- Relate periodicity, structure and properties of some important crystals.
- Describe the behavior of electrons in extended solids
- Provide an understanding of the behavior of electrons in extended solids
- Discuss how a host of properties arise due to defect interactions in solids
- Propose a perspective on the ranges of properties displayed by defect interactions in solid state materials.
- Describe the different preparation techniques and reactions leading to the formation of solid state compounds.
- Identify synthesis routes and characterization for nano-structured materials.

### 5. Instructional Strategies:

conference discussion computation laboratory

seminar with formal presentation seminar without formal presentation workshop

art workshop practice trip thesis special problems tutoring

research other, please specify:

**6. Minimum or Required Resources Available:**

No specific resources are required

**7. Course time frame and thematic outline**

Outline	Contact Hours
- Introduction to solid state. Cohesion. Binding. Crystal Structure.	5
- Defect structures. Stoichiometric defects and non-stoichiometric defects. Structures related to perovskite by crystal shear. High-Tc copper oxide structures.	7
- Crystal vibration, Thermal properties. Energy bands. Semiconductor crystals. Fermi surfaces and metals. Plasmons, polaritons and polarons. Optical properties. Superconductivity. Dielectric and ferroelectric.	11
- Defect interactions. p-n junctions, rectifier. Color centers. Lasers. Phosphors	6
- Solid state reactions based on: High temperature, Sol-Gel method, Hydrothermal method, Vapor phase transport, Topotactic reactions, Intercalation, Ion-exchange, processes. Phase relationships and Crystal Growth.	12
- Nanostructures.	3
-Exam	1
<b>Total hours: (equivalent to contact period)</b>	<b>45</b>

**8. Grading System**

Quantifiable (letters)  Not Quantifiable

Standard Curve:

100-90 A; 89-80 B; 79-70 C; 69-60 D; 59-0 F

**9. Evaluation Strategies**

	Quantity	Percent
<input checked="" type="checkbox"/> Exams	1	30
<input checked="" type="checkbox"/> Final Exam	1	30
<input type="checkbox"/> Short Quizzes		
<input checked="" type="checkbox"/> Oral Reports	4	40
<input type="checkbox"/> Monographies		
<input type="checkbox"/> Portfolio		
<input type="checkbox"/> Projects		
<input type="checkbox"/> Journals		
<input type="checkbox"/> Other, specify:		
<b>TOTAL:</b>		<b>100%</b>

**10. Bibliography:**

Textbook:

West, A. R. (1999). *Basic solid state chemistry*. New York: John Wiley & Sons. There is no newer version. [Available at the Circulation Collection (QD478 .W47 1999, UPRM General Library)]

Other resources:

Gersten, J. I., & Smith, F. W. (2001). *The physics and chemistry of materials*. New York: Wiley. There is no newer version. [Available at the Circulation Collection (QD478 .G47 2001), UPRM General Library]

Kittel, C. (2005). *Introduction to solid state physics*. Hoboken, NJ: Wiley. [Available at the Circulation Collection (QC176 .K5 2005, UPRM General Library]

Selected articles from specialized journals available in: *ACS* (<http://pubs.acs.org>) [Available online via ACS Journals , UPRM General Library]


**11. According to Law 51:** Students will identify themselves with the Institution and the instructor of the course for purposes of assessment (exams) accommodations. For more information please call the Student with Disabilities Office which is part of the Dean of Students Office at (787) 265-3864 or (787) 832-4040 extensions 2040 or 3372.

Prepared by:



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Approved by:



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