

## Course Syllabus

### 1. General Information:

Alpha-numeric codification: CIIM 6008

Course Title: DIFFRACTOMETRY AND COMPLEMENTARY TECHNIQUES

Number of credits: 3

Contact Period: Two hours of lecture and one two-hour laboratory per week

### 2. Course Description:

**English:** Study of the theory, practice, and applications of X-ray diffraction and other complementary techniques, which will allow the identification of the most suitable characterization techniques for the type of information (morphological, structural, qualitative, and quantitative) required for materials of interest. Discussion of experimental methods and applications of electron and neutron diffraction techniques, as well as electron microscopy. Presentation of the principles of complementary techniques such as SPM, XPS, Auger, Mossbauer, solid-state nuclear magnetic resonance, and SIMMS and their application to structural problems in the solid state.

**Spanish:** Estudio de la teoría, práctica y aplicaciones de la difracción de rayos X y otras técnicas complementarias que permitirá identificar las técnicas de caracterización más adecuadas para el tipo de información (morfológica, estructural, cualitativa y cuantitativa) requerida para materiales de interés. Discusión de métodos experimentales y aplicaciones de las técnicas de difracción por electrones y neutrones, así como la microscopía electrónica. Presentación de los principios de técnicas complementarias tales como SPM, XPS, Auger, Mossbauer, resonancia magnética nuclear de estado sólido y SIMMS y su aplicación a problemas estructurales en el estado sólido.

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

Graduate students: with permission of the director of the Program Coordinator.

### 4. Course Objectives:

By the end of the course students will:

- Distinguish between crystalline and non crystalline solids based on symmetry operations applications
- Identify crystal unit cells.
- Apply extinction principles to structural determination.
- Analyze the chemical composition of materials.
- Apply the structural characterization or determination based on analyses of diffraction patterns, in materials study.
- Discuss interaction between electrons and matter to characterize the material.
- Evaluate the different experimental techniques to solve materials science problems.

### 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:**

X-Ray diffractometer (XRD), Mossbauer spectrometer, and Atomic Force Microscope (AFM)

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

<b>Outline</b>	<b>Contact Hours</b>
- Crystallography, including symmetry operations and point-and space-group symmetry; crystallographic calculations; properties of common crystal structures of engineering materials	5/0
- Stereographic projection. Crystal Structure, X ray Diffraction Theory. Calculation of structure. Reciprocal Lattice.	4/5
- X-ray physics, and x-ray spectra, X-ray production (conventional and synchrotron sources), X-ray absorption, X- ray fluorescence, and X-ray safety.	5/0
- X-ray analysis techniques. Indexing of powder patterns, lattice parameter determination, phase identification, and determination of texture in materials.	4/10
- Principles of Electron Microscopy. Scanning and Transmission microscope. Energy dispersive analysis. X-ray microanalysis. Electron Diffraction Pattern Analysis.	6/9
- Scanning Probe Microscopy – theory and applications. XPS, Auger, Mossbauer Spectroscopy, Solid State NMR, SIMMS – theory and applications.	6/5
- Exam	1
<b>Total hours: (equivalent to contact period)</b>	<b>30/30</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**

	<b>Quantity</b>	<b>Percent</b>
<input checked="" type="checkbox"/> <b>Exams</b>	<b>1</b>	<b>20</b>
<input checked="" type="checkbox"/> <b>Final Exam</b>	<b>1</b>	<b>20</b>
<input type="checkbox"/> <b>Short Quizzes</b>		
<input checked="" type="checkbox"/> <b>Oral Reports</b>	<b>2</b>	<b>20</b>
<input checked="" type="checkbox"/> <b>Monographies</b>	<b>2</b>	<b>40</b>
<input type="checkbox"/> <b>Portfolio</b>		
<input type="checkbox"/> <b>Projects</b>		
<input type="checkbox"/> <b>Journals</b>		
<input type="checkbox"/> <b>Other, specify:</b>		
<b>TOTAL:</b>		<b>100%</b>

## 10. Bibliography:

### Textbook:

Cullity, B. D., & Stock, S. R. (2001). *Elements of x-ray diffraction* (3rd ed.). Upper Saddle River, NJ: Prentice Hall. There is no newer version. [Available at the Circulation Collection (QC481 .C87 2001), UPRM General Library]

### Other resources:

ASM International. Handbook Committee. (1986). *Materials characterization* (9th ed., Vol. 10). Metals Park, Ohio: American Society for Metals. There is no newer version. [Available at the Reference Collection (TA459 .A5 V.10 1998), UPRM General Library]

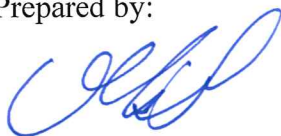
Brundle, C. R., Evans, C. A., & Wilson, S. (Eds.). (1992). *Encyclopedia of materials characterization: Surfaces, interfaces, thin films*. Boston: Butterworth-Heinemann. There is no newer version. [Available at the Reference Collection (TA418.7 .B73 1992), UPRM General Library]

Lifshin, E. (1999). *X-ray characterization of materials*. New York: Wiley-VCH. There is no newer version. [Available at the Circulation Collection (TA417.25 .X72 1999), UPRM General Library]

Selected articles from specialized journals available in: *Science Direct* (<http://www.sciencedirect.com>) [Available online via ScienceDirect, 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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