

**University of Puerto Rico
Rio Piedras Campus
Natural Science Faculty
Physics Department,
San Juan, PR 00925-2537**

Course Title: Research Seminar

Suggested Coding: FISI 6995 -052 Katiyar (Science & Technology of Nanoceramics for Multifunctional Applications)

No. Hours / Credits: 3-4 hours per week / 1-2 credits per semester

Prerequisites Co-requisites and Other Requirements:

FISI4032 (Methods of Mathematical Physics) or equivalent and permission of the investigator in laboratory or the Director of the Department.

Course Description:

Advanced studies and training in specialized topics of synthesis and characterization of functional nanomaterials and their applications. The focus of the course is on studying physical properties of materials and their applications in nano-devices.

Goals:

At the end of the course, each student will have demonstrated an ability to determine:

- Research skills in synthesizing nanomaterials and thin film fabrications
- Crystallography of the materials
- Optical and spectroscopic properties
- Electrical, dielectric, ferroelectric, and magnetic properties
- Raman and infrared spectroscopy of materials
- Develop critical thinking skills about concepts of physics in the context of above physical properties and their correlations,
- Integrate fundamental concepts of physics in a particular area of research
- Critically analyze any existing scientific literature
- Make a value judgment of scientific research for possible applications in devices.

Content Outline and Time Distribution:

Weeks	No. Hours	Topics
weeks 1-6	18	The first step will consist of 6 weeks of course related to basic concepts of physics in relation to structural and physical properties of materials
weeks 7-10	12	In this period, the students will learn about the materials synthesis and fabrication of nanoparticles and their characterization by various

		microscopic techniques. These materials can be oxide ferroelectrics, resistive switching oxides, and/or cathode materials for Li-ion/Li-S batteries
weeks 11-15	15	In this period, the focus of the course will be on the study of ferroelectric, magnetic, dielectric, vibrational spectroscopic properties, and electrochemical properties of the multifunctional nanomaterials and their applications for energy, sensor and/or memory devices .

Instructional Strategies:

The instructional method of the seminar is based on the discussion of frontier functional material research and their multifunctional applications in energy related research. The discussions will often involve recent review articles on the subject.

Minimum resources available: audiovisual and conference room projectors, and SPECLAB research facilities.

Evaluation Strategies:

Attendance and active participation of students in the discussion are essential (25%). Each student makes a presentation of the results of research in which it participates and discusses the relevant scientific literature (50%). the increase in the level of proficiency in the particular area of research in physics (25%) is evaluated.

Rating system: approved or not approved

Suggested Textbooks:

Physical Properties of Materials by Nye;
 Elementary Crystallography by M.J. Buerger,
 Raman and Infrared spectroscopy by G. Turrell;
 Chemical Applications of group theory by F.A. Cotton;
 Thin Film Growth: Physics, Materials Science and Applications, Edited by Zexian Cao, eBook (2011).

Rights of Students with Disabilities:

The University of Puerto Rico complies with state and federal laws and regulations concerning discrimination, including Law 51 of the Commonwealth of Puerto Rico and the federal law known as the 1990 Americans with Disabilities Act (ADA). Students who receive vocational rehabilitation services or require any assistance should inform the teacher (a) in charge of the course about this situation for reasonable accommodation to have equal access to education and services offered by the University of Puerto Rico accordance with the recommendations Affairs Office for Persons with Disabilities (OAPI) the Dean of Students.